

THE FUTURE OF
WORK IN

**CENTRAL
AMERICA**

AND THE

**DOMINICAN
REPUBLIC**



THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

© 2024 International Bank for Reconstruction and Development / The World Bank
1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

This work is a product of the staff of The World Bank with external contributions. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of The World Bank, its Board of Executive Directors, or the governments they represent.

The World Bank does not guarantee the accuracy, completeness, or currency of the data included in this work and does not assume responsibility for any errors, omissions, or discrepancies in the information, or liability with respect to the use of or failure to use the information, methods, processes, or conclusions set forth. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Nothing herein shall constitute or be construed or considered to be a limitation upon or waiver of the privileges and immunities of The World Bank, all of which are specifically reserved.

Rights and Permissions

The material in this work is subject to copyright. Because The World Bank encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given.

Please cite the work as follows: Moroz, Harry and Mariana Viollaz. 2024. *The Future of Work in Central America and the Dominican Republic*. Washington, DC: World Bank.

Any queries on rights and licenses, including subsidiary rights, should be addressed to World Bank Publications, The World Bank, 1818 H Street NW, Washington, DC 20433, USA; fax: 202-522-2625; e-mail: pubrights@worldbank.org.

Cover design: Mauricio Díaz

Contents

Abbreviations and Acronyms	VIII
Acknowledgements and Data Notes	X
Executive Summary	XI
The Limited Reach of Technology in Central America and the Dominican Republic	XI
CADR's Incomplete Transition to the Future of Work	XIII
The Factors Behind CADR's Incomplete Transition	XV
The Importance of Technological Change Abroad	XVII
Facilitating Technological Progress That Benefits Workers	XVIII
Chapter 1 Jobs in Central America and the Dominican Republic	1
Setting the stage: Labor Market Dynamics and Technological Progress	1
Growth and Employment Dynamics	3
<i>Economic Growth</i>	3
<i>Productivity</i>	4
<i>Employment</i>	5
Labor Supply	7
<i>Labor Force Participation and Employment</i>	7
<i>Job Quality</i>	9
<i>Skills</i>	10
<i>Migration</i>	12
Labor Demand	13
Chapter 2 The Labor Market Impacts of Technological Progress	16
Setting the Stage: The History of the Future of Work	16
Technology's Labor Market Impacts: Changes in What Workers Do and How They Do It	17
Technology's Labor Market Impacts: The Evidence from Advanced Economies	20
Technology's Labor Market Impacts: The View Outside of Advanced Economies	22

Chapter 3 Technological Progress and Labor Market Transformation in CADR Countries	24
Setting the Stage: Technological Progress and Its Employment Impacts	24
Changes in Tasks	24
<i>Changes in Tasks: Computerization</i>	24
<i>Changes in Tasks: Artificial Intelligence and Mobile Robotics</i>	35
Changes in Working Arrangements	38
<i>Changes in Working Arrangements: Remote Work</i>	38
<i>Changes in Working Arrangements: Platform Work</i>	42
Chapter 4 Barriers to and Enablers of the Future of Work in CADR Countries	46
Setting the Stage: Looking Beyond Technological Potential	46
The Channels of Employment Change	47
<i>Employment Structure</i>	48
<i>Supply of Skills</i>	53
<i>Adoption and Diffusion of Technology</i>	57
<i>Globalization</i>	63
Chapter 5 Policy Recommendations	68
Setting the Stage: Facilitating Technological Progress from Which Workers Can Benefit	68
Promote the Adoption and Diffusion of Technology by Building Firm Capabilities	70
Strengthen Pathways for Skills Development and Deployment	75
<i>Deploy Labor Market Insight Tools</i>	76
<i>Build Foundations-driven, Demand-oriented Education and Training Systems</i>	77
<i>Design Digitally Enabled, Fit-for-purpose Intermediation Programs</i>	83
Adapt Social Protection and Labor Market Policies to New Forms of Work	85
References	87

Boxes

Box 2.1: Competitive Markets and Technology Adoption	17
Box 2.2: Spatial Differences in the Labor Market Impacts of Technological Progress	21
Box 4.1: The Availability of Technology Skills in Costa Rica and Panama	56
Box 5.1: Promoting Competition, Rightsizing Regulations, and Expanding Access to Finance to Facilitate Technology Adoption	71
Box 5.2: Green Jobs in CADR	72
Box 5.3: The Labor Market Benefits of Early Childhood Education	78
Box 5.4: Incorporating Digital Skills Training into Technical and Vocational Education and Training	79
Box 5.5: The Complex Interaction of Technology, Labor Markets, and Gender	80
Box 5.6: Using SkillCraft to Connect Disadvantaged Young People to the Labor Market	84
Box 5.7: Public Gig Work Platforms	85

Figures

Figure ES1: Lags in Technology Adoption in CADR Countries	XII
Figure ES2: Use of Computers and the Internet at Work, 2021	XII
Figure ES3: Classifying Tasks by Their Automatability	XIII
Figure ES4: Routine and Nonroutine Task Intensity in CADR Versus the United States, 2021	XIII
Figure ES5: Share of Jobs at High Risk of Automation, Original and Adjusted Measures, 2021	XIV
Figure ES6: Changes in the Routine Intensity of Work, 2011–19	XV
Figure ES7: Online Gig Workers, 2022	XV
Figure ES8: Evolution of the Task Content of Migrants in the United States, 1970–2021	XVIII
Figure 1.1: GDP Per Capita, 2002–21	3
Figure 1.2: GDP Growth, 2002–19	3
Figure 1.3: Labor Productivity Across Sectors, 2019	4
Figure 1.4: Labor Productivity Growth Across Sectors, 2002–19	5
Figure 1.5: Employment Growth, 2002–19	5
Figure 1.6: Change in Employment Share by Sector, 1960–2010	6
Figure 1.7: Employment Share by Sector, 1991–2019	6
Figure 1.8: Labor Force Participation Rate, 2021	7
Figure 1.9: Female Labor Force Participation Rate, 2021	7
Figure 1.10: Female-Male Gap in Labor Force Participation Rate, 2021	8
Figure 1.11: Unemployment Rate, 2002–21	8
Figure 1.12: Female-Male Gap in Unemployment Rate, 2002–21	9
Figure 1.13: Young People in NEET Status, 2021	9
Figure 1.14: Employment Share by Wage and Self-Employment, 2019	9
Figure 1.15: Employment Share by Wage Employment, 2002–19	9
Figure 1.16: Informality Rate, 2021	10
Figure 1.17: Schooling and Learning-Adjusted Schooling, 2019	11
Figure 1.18: Learning Poverty, 2019	11
Figure 1.19: Employment Rate by Education, 2021	11

Figure 1.20: Informality Rate by Education, 2021	11
Figure 1.21: Employment Share by Skill Level, 2021	12
Figure 1.22: Change in Employment Share by Skill Level, 2011-21	12
Figure 1.23: Net Migration Rate, 2021	13
Figure 1.24: Migrants from CADR countries, 1990–2020	13
Figure 1.25: Share of CADR Outmigrants in the United States, 2020	13
Figure 1.26: Remittance Inflows, 2022	13
Figure 1.27: New Business Density, 2020	14
Figure 1.28: Firms Choosing Inadequate Education as Biggest Obstacle, 2016	14
Figure 2.1: Classifying Tasks by Their Automatability	18
Figure 2.2: The Labor Market Impacts of Technological Change in CADR	23
Figure 3.1: Change in Employment Share by Skill Level, circa 1980s to circa 2000s	25
Figure 3.2: Changes in the Routine Intensity of Work, 2011–19	26
Figure 3.3: RTI and Task Intensity of CADR Countries, 2021	27
Figure 3.4: RTI by Economic Sector, 2021	27
Figure 3.4: RTI by Economic Sector, 2021 (continued)	28
Figure 3.5: RTI by Sociodemographic Characteristics, 2021	29
Figure 3.6: Returns to Routine and Nonroutine Tasks, 2010s	29
Figure 3.7: Three-Year migrants in the United States, 1970–2021	30
Figure 3.8: Three-Year CADR Migrants in the United States, 1970–2021	30
Figure 3.9: Employment of Three-Year Migrants in Manufacturing Jobs in the United States, 1970–2021	31
Figure 3.10: Employment of Three-Year Migrants in Construction Jobs in the United States, 1970–2021	31
Figure 3.11: Change in Employment Share by Skill Level of Three-Year Migrants and United States Nonmigrants in the United States, 1980–2021	32
Figure 3.12: Evolution of the Task Content of Three-Year Migrants in the United States, 1970–2021	33
Figure 3.13: Evolution of the Task Content of Three-Year CADR Migrants by Gender in the United States, 1970–2021	34
Figure 3.14: Average Hourly Wage of Three-Year Migrants in the United States, 1980–2021	35
Figure 3.15: Susceptibility of the Workforce to Automation, 2021	35
Figure 3.16: Probability of Automation by Sociodemographic Characteristics, 2021	36
Figure 3.17: Share of Jobs at High Risk of Automation, Original and Adjusted Measures, 2021	37
Figure 3.18: Average Probability of Automation, 2021	38
Figure 3.19: Share of Workers with at Least 10 and 50 Percent of Tasks Exposed to GPTs, 2021	38
Figure 3.20: Share of Workers in Jobs with High Amenability to Working from Home, 2021	39
Figure 3.21: Share of Wage Workers Working from Home Prior to the Pandemic, 2019	40
Figure 3.22: Share of Self-Employed Working from Home Prior to the Pandemic, 2019	40
Figure 3.23: Share of Workers Working from Home During the Pandemic, 2021	41
Figure 3.24: Share of Workers Working from Home During the Pandemic, 2020	41
Figure 3.25: Global Demand for Online Gig Work, 2016–23	43
Figure 3.26: Online Gig Workers, 2022	44
Figure 3.27: Characteristics of Workana Freelancers, 2022	45
Figure 4.1: Factors Contributing to Cross-Country Variation in Routine Task Intensity, 2010–2021	48
Figure 4.2: Deindustrialization in CADR and High-Income Countries, 1991–2021	50

Figure 4.3: Change in the Industrial Share of Employment, 1991–2019	50
Figure 4.4: Digitally Deliverable Services Exports, 2005–21	51
Figure 4.5: Use of Digital Platforms, 2020	52
Figure 4.6: SME Engagement with Digital Tools, 2020 and 2022	53
Figure 4.7: Education of the Employed Population in CADR Countries, 2000–21	54
Figure 4.8: Share of Students Meeting Minimum Proficiency in Reading and Math, 2022	55
Figure B4.1.1: Penetration of Technology and Disruptive Technology Skills, 2022	56
Figure 4.9: The Digital Adoption Index, 2016	57
Figure 4.10: The Frontier Technology Readiness Index: ICT, 2022	57
Figure 4.11: The Contribution of ICT and Non-ICT Assets to Economic Growth, 2000s–10s	58
Figure 4.12: Lags in Technology Adoption in CADR Countries	59
Figure 4.13: Diffusion of the Internet and Cell Phones, 2021	59
Figure 4.14: Use of Computers and the Internet at Work, 2021	60
Figure 4.15: Use of Digital Platforms, 2021	60
Figure 4.16: Share of Jobs at High Risk of Automation by Sector, 2021	61
Figure 4.17: Imports of ICT Goods and ICT Services as Share of Total Trade, 2021	62
Figure 4.18: Prices of ICT Service Baskets, 2022	63
Figure 4.19: Net Inflows of Foreign Direct Investment, 1970–2022	64
Figure 4.20: Share of Output in GVCs by Sector, 2021	64
Figure 4.21: Relationship Between Routine Task Intensity Index and GVCs, 2010–2021	65
Figure B5.2.1: Share of Green Jobs in CADR Countries Overall and by Gender, 2021	73
Figure B5.2.2: Share of green jobs in CADR countries by sector, 2021	73
Figure B5.2.3: Green Talent in Costa Rica and Comparator Countries, 2023	74
Figure B5.5.1: Use of Computers and the Internet at Work by Gender, 2021	81
Figure B5.5.2: Female Enrolment in Tertiary Programs and in ICT- and Engineering-Related Tertiary Degree Programs, 2021	82

Tables

Table ES1: Policies to Facilitate Technological Change and Mitigate the Negative Effects of Resulting Disruptions	XX
Table 1.1: Summary of the Main Labor Market Supply and Demand Issues in CADR	2
Table 1.2: The Biggest Obstacles Facing Firms	14
Table 3.1: Advantages and Disadvantages of Platform Work for Workers and Firms	42
Table 3.2: Primary Location-Based Platforms in CADR Countries	43
Table 3.3: Most Common Type of Online Gig Tasks in CADR Countries, 2017–23	44
Table 4.1: Examples of Digital Interventions Targeted to Smallholder Farmers in CADR	49
Table 4.1: Imports of Industrial Robots, 2021	60
Table 5.1: Policies to Facilitate Technological Change and Mitigate the Negative Effects of Resulting Disruptions	69
Table 5.2: Drivers of Technology Adoption Among Firms	70
Table 5.3: Main Challenges Cited by SMEs When Using or Trying to Adopt Digital Platforms, 2022	75
Table 5.4: Tools for Identifying In-Demand Skills	77

Abbreviations and Acronyms

ACS	American Community Survey
AI	artificial intelligence
ARG	Argentina
BOL	Bolivia
BRA	Brazil
CADR	Central America and the Dominican Republic
CHL	Chile
COL	Colombia
CRI	Costa Rica
DAI	Digital Adoption Index
DOM	Dominican Republic
ECE	early childhood education
ECLAC	Economic Commission for Latin America and the Caribbean
ECU	Ecuador
FDI	foreign direct investment
GDP	gross domestic product
GNI	gross national income
GPT	generative pretrained transformers
GTI	green task intensity
GSP	global skills partnership
GTM	Guatemala
GVC	global value chains
HND	Honduras
ICT	information and communication technology
IFR	International Federation of Robotics
ILO	International Labour Organization
IPUMS	Integrated Public Use Microdata Series, International
ISCO	International Standard Classification of Occupations
KOR	Republic of Korea
LAC	Latin America and the Caribbean
LFP	labor force participation
MEX	Mexico
NEET	not in education, employment, or training

NIC	Nicaragua
OECD	Organisation for Economic Co-operation and Development
OLI	Online Labor Index
O*NET	Occupational Information Network
PAN	Panama
PERU	Peru
PIAAC	Program for the International Assessment of Adult Competencies
RTI	routine task intensity
SCD	Systematic Country Diagnostics
SEDLAC	Socioeconomic Database for Latin America and the Caribbean
SLV	El Salvador
SME	small and medium-sized enterprise
SOC	Standard Occupational Classification
TVET	technical and vocational education and training
UE	unemployment
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
URY	Uruguay
USA	United States of America
USAID	United States Agency for International Development
VEN	Venezuela
WDI	World Development Indicators
WFH	work from home
WITS	World Integrated Trade Solution
YES	Youth Empowerment Service

Acknowledgements and Data Notes

This report was prepared by Harry Moroz and Mariana Viollaz. Diana Isabel Londoño Aguirre, Guillermo Beylis, Guillermo Caballero Ferreira, Lily Franchini, Luis Laguinge, Maria Del Mar Gomez Ortiz, Marla Hillary Spivack, and Daria Taglioni provided substantial contributions. The team received excellent comments and advice from Marina Bassi, Diego Arias Cabballo, Lourdes Rodriguez Chamussy, Wendy Cunningham, Janibeth Miranda, Miriam Montenegro, Alvaro Gonzalez De Pablo, Truman Packard, Viviana Maria Eugenia Perego, Josefina Posadas, Jaime Saavedra, Alexandria Valerio, Deborah Elisabeth Winkler, and William Wiseman.

Census, American Community Survey (ACS), and Current Population Survey data were obtained from Integrated Public Use Microdata Series, International (IPUMS-International). The authors wish to acknowledge the statistical offices that provided the underlying data. Household and labor force surveys were obtained via the Socioeconomic Database for Latin America and the Caribbean (SEDLAC), as well as from the statistical agencies of individual countries, as follows:

- **Costa Rica:** Encuesta Continua de Empleo
- **Dominican Republic:** Encuesta Nacional de Fuerza de Trabajo and Encuesta Nacional Continua de Fuerza de Trabajo
- **El Salvador:** Encuesta de Hogares de Propósitos Múltiples
- **Guatemala:** Encuesta Nacional de Empleo e Ingresos
- **Honduras:** Encuesta Permanente de Hogares de Propósitos Múltiples
- **Nicaragua:** Encuesta Nacional de Hogares sobre Medición de Nivel de Vida
- **Panama:** Encuesta de Hogares and Encuesta de Mercado Laboral

The team utilized data on green tasks prepared by Julia Granata and Josefina Posadas as described in Granata and Posadas (2022). Data on global value chains (GVCs) were provided by Daria Taglioni as described in Borin, Mancini, and Taglioni (2021). Data on platform workers were provided by Namita Datta as described in Datta and Chen (2023). The data on LinkedIn user profiles was provided by LinkedIn via the Development Data Partnership.

The report uses comparisons to other countries in Central America and the Dominican Republic (CADR), to Latin America and the Caribbean (LAC) and OECD regional averages, and to Korea to benchmark the characteristics of CADR countries. See appendix A for more information on the selection of benchmarks.

Executive Summary

Technological progress has the potential to cause significant disruption in labor markets. Advances first in agricultural and industrial machinery, then computers, and now artificial intelligence (AI) have enabled machines to undertake a growing range of tasks previously done by humans, which puts jobs at risk. However, far from being a purely destructive force, technological progress and automation can also generate employment. Where competition is robust, automation can create jobs as price declines linked to productivity improvements create higher demand. New technologies can also generate entirely new tasks, new types of jobs, and new industries. Information and communication technology (ICT) can facilitate new working arrangements that are beneficial for workers and firms. This means that slow progress towards the future of work could mean missing out on the opportunities created by technological advancements.

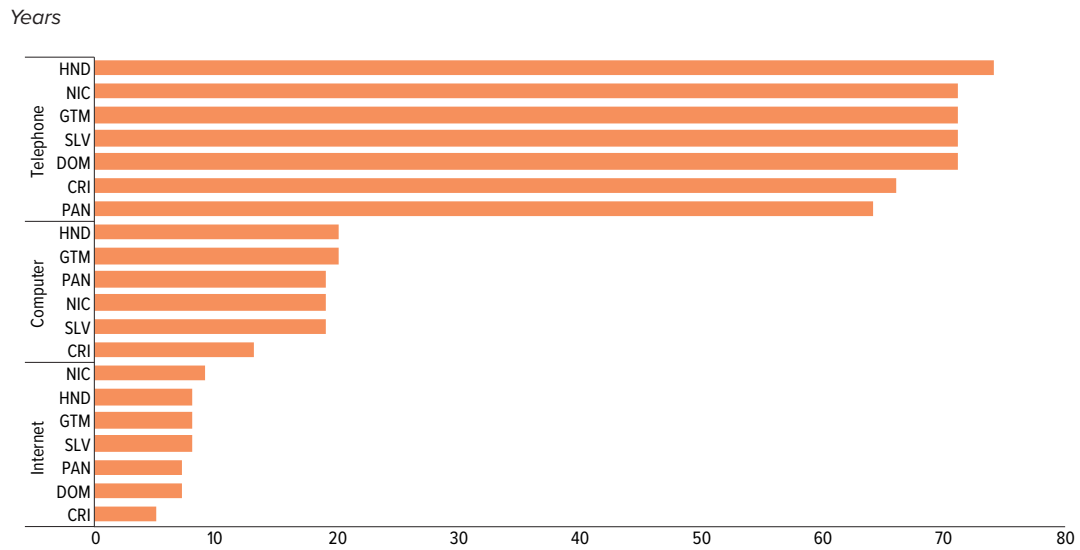
Advanced economies offer a model for how the future of work will look in Central America and the Dominican Republic (CADR), but important differences in development stages mean that the labor market impacts of technological progress are distinct now and are likely to continue to be in the near future. Labor markets in CADR are better characterized by agricultural employment than by robot-assisted manufacturing. This means that applying lessons from technology's impacts on the labor markets of advanced countries requires an assessment of both the technological potential to automate jobs in CADR and the economic potential for new technologies to take hold and cause labor market disruptions. The adoption and diffusion of technology as well as employment structure, skills supply, and globalization will all shape the impact of technological progress on labor markets in the region. Technology adoption abroad is also likely to affect CADR through changes in demand for labor that is embodied in the movement of goods (offshoring), the movement of people (migration), and the movement of services (digital trade in services).

This report examines the impact of computers, robots, AI, and improved ICT at work on labor markets in CADR. The report focuses on these technologies as the most likely to have shaped labor markets in the region in the recent past and the most likely to shape them in the near future. The report first examines how technological progress within the region is shaping what workers do (their tasks) and how they do it (their working arrangements). The report goes beyond the analysis of susceptibility to automation to dissect the factors underlying recent labor market transformations and uncover the extent to which technological change has played a role in these transformations. The report also examines how technological progress outside of the region is shaping labor markets within it by investigating how robot adoption in the United States is affecting the demand for CADR workers in CADR countries and for CADR workers in the United States.

THE LIMITED REACH OF TECHNOLOGY IN CENTRAL AMERICA AND THE DOMINICAN REPUBLIC

The penetration and diffusion of technology are limited in CADR countries. CADR countries rank low on summary measures of technological progress like the World Bank's Digital Adoption Index and the Frontier Technologies Readiness Index compiled by the United Nations Conference on Trade and Development. CADR countries are slower to adopt new technologies, though these lags have shortened with each significant technological advancement (figure ES1). Even when technology is available, however, diffusion is limited. For example, cellphones are prevalent in CADR countries but use of the internet varies significantly across countries in the region. The Dominican Republic and Costa Rica have rates of internet use that approach those of Korea and the United States. In all other CADR countries, in contrast, at least one-third of the population did not use the Internet in 2021.

FIGURE ES1: Lags in Technology Adoption in CADR Countries



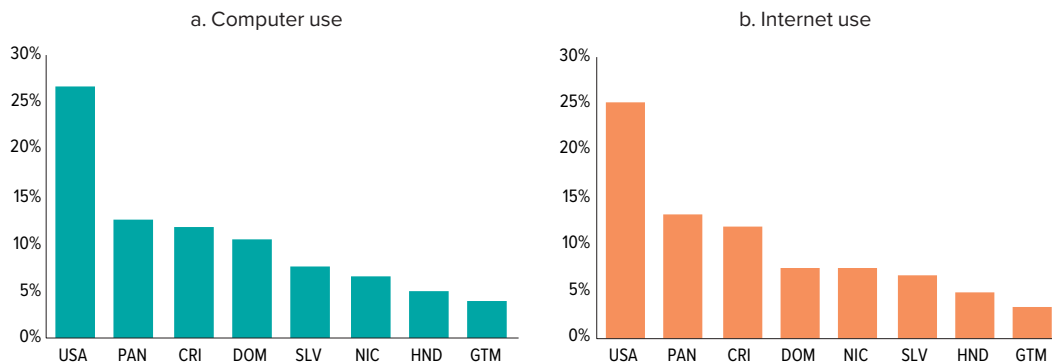
Source: Comin, Hobijn, and Rovito 2008.

Note: Lags are calculated as the years between a benchmark year and the year in which the United States had the same adoption as the CADR country in the benchmark year. Data are not available for computers for the Dominican Republic. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Limited technology uptake is apparent among CADR workers and firms. In the agricultural sector, farm machinery measured in total horsepower per hectare is around 10 percent of the level in the United States in Guatemala, Honduras, and Nicaragua and 50 percent and 66 percent in Costa Rica and Panama, respectively. Less than 15 percent of workers in all CADR countries work in jobs that are intensive in the use of computers or the internet, compared with at least 25 percent in the United States (figure ES2). Data on firms’ use of robots are not available for CADR countries, but trade data on imports of industrial robots provide suggestive evidence that use of robotic technologies is not widespread. Costa Rica and the Dominican Republic led CADR with imports of the equivalent of six robots and one robot for every 100,000 people in 2021, respectively. All other CADR countries imported less than half a robot for every 100,000 people. The United States and Korea, in contrast, imported 13 and 21.

FIGURE ES2: Use of Computers and the Internet at Work, 2021

Percentage of workers in computer- and internet-intensive occupations



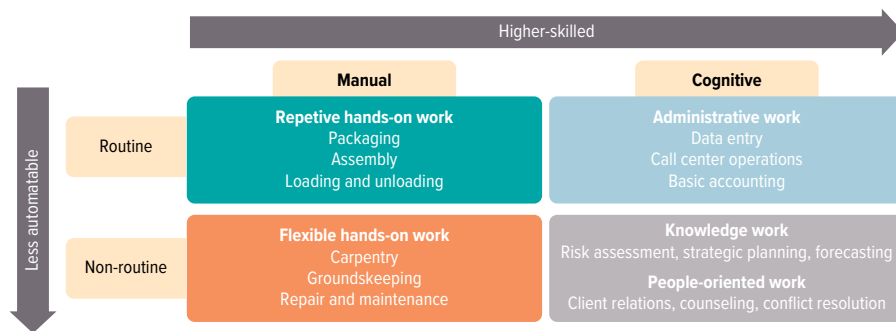
Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The year is 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. Computer- and internet-intensive occupations are defined as occupations in the top 25 percent of computer and internet use at work as defined using PIAAC data from comparator countries. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; USA = United States; SLV = El Salvador.

CADR'S INCOMPLETE TRANSITION TO THE FUTURE OF WORK

Analyzing the intensity of employment in tasks that are more and less susceptible to automation provides evidence of the impact of technology on labor markets. Certain types of tasks—routine ones—are more susceptible to automation by computers and so their presence is associated with less technological impact on the labor market (figure ES3). These routine tasks might be either manual *repetitive hands-on work* like packaging and assembly or cognitive *administrative work* like data entry. Nonroutine tasks, in contrast, are less susceptible to automation by computers and so their presence is associated with a greater impact of technology on the labor market. These nonroutine tasks might be either manual *flexible hands-on work* like groundskeeping and maintenance or cognitive, involving either *knowledge work* like strategic planning or risk assessment, or *people-oriented work* like client relations or counseling.

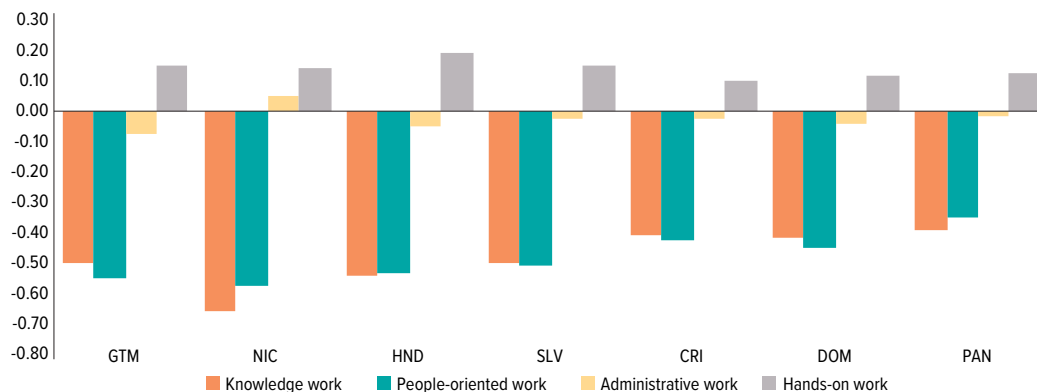
FIGURE ES3: Classifying Tasks by Their Automatability



Consistent with technology's limited adoption in CADR, there is little evidence that computerization has had substantial labor market impacts on most CADR countries. Workers in CADR do jobs that involve much less of the knowledge and people-oriented tasks associated with technological progress than workers in the United States (figure ES4). Though data do not allow for a distinction between routine and nonroutine manual tasks, work in less-skilled hands-on jobs is much more common in CADR. Male, young, less-educated, and rural workers are even more likely to be employed in these more routine, more automatable jobs of the past.

FIGURE ES4: Routine and Nonroutine Task Intensity in CADR Versus the United States, 2021

Standard deviations of tasks intensity from the United States' average



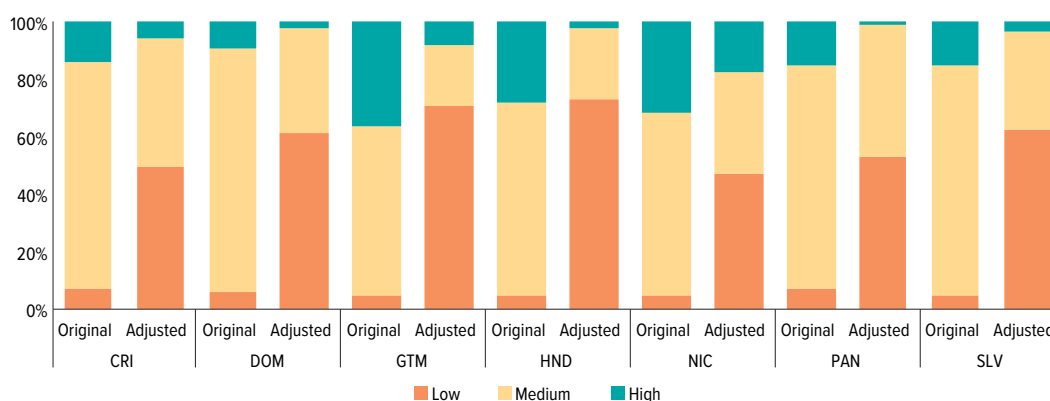
Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The year is 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Impacts from artificial intelligence and robots are also likely to be muted in the short term. Measures of the potential for artificial intelligence and mobile robots¹ to replace jobs in CADR that extend this task analysis seem to show that large numbers of workers are at risk: at least 60 percent of workers in all CADR countries work in jobs where at least some tasks they undertake are likely to disappear or change substantially (figure ES5). However, this potential for automation appears much less dire when small corrections are made for factors that might interrupt the translation of potential labor market impacts of technological progress into actual impacts. When sectors that tend to have low rates of technology use are excluded from the analysis, exposure to displacement by automation technologies declines substantially to at most 46 percent of workers.

FIGURE ES5: Share of Jobs at High Risk of Automation, Original and Adjusted Measures, 2021

Percentage



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017; Frey and Osborne 2017.

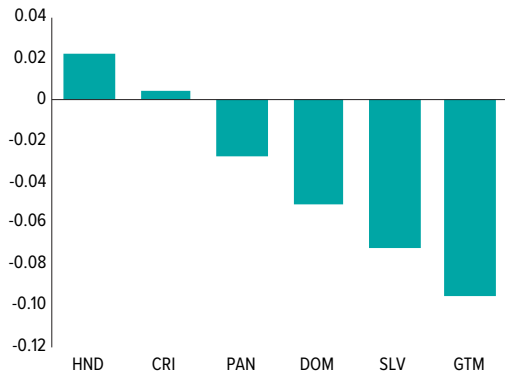
Note: The year is 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. The risk of automation is calculated according to the task-based approach in Arntz, Gregory, and Zierahn (2016) and Egana del Sol et al. (2022) and then adjusted following Weller et al (2019). Low risk is a probability of automation that is 30 percent or less; medium is above 30 but below 70 percent; and high is 70 percent or above. The adjustment assigns a risk of automation equal to zero to workers in low-productivity sectors defined as self-employed workers with less than college education, wage employees and employers in small-size firms, domestic workers, and workers who do not receive a labor income. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Recently, however, there is some evidence in CADR of a shift towards the knowledge- and people-oriented jobs that characterize technological progress. In the last decade, the routine work that characterizes jobs of the past declined in most of the region while the nonroutine knowledge and people-oriented work that characterizes the employment of the future increased (figure ES6). Specifically, jobs became more intensive in knowledge tasks in all CADR countries except Costa Rica and Honduras and in people-oriented tasks in all except Costa Rica, Guatemala, and Honduras. Even with this progress, however, jobs in CADR countries were much more intensive in the routine tasks of the past in 2021 than those in the United States.

¹ Mobile robots use sensors, artificial intelligence, and other technology to maneuver in order to perform nonroutine manual tasks (Frey and Osborne 2017).

FIGURE ES6: Changes in the Routine Intensity of Work, 2011–19

Difference in index of routine task intensity (RTI)

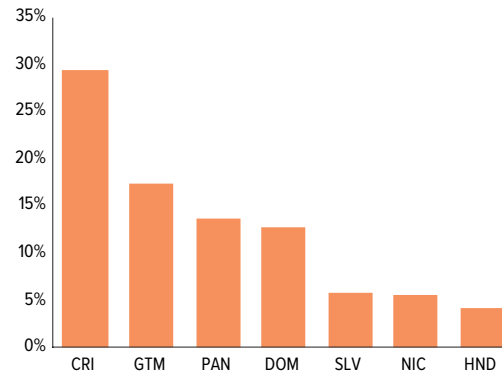


Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The end year is 2018 for Panama. Nicaragua is excluded because of lack of available data. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; PAN = Panama; SLV = El Salvador.

FIGURE ES7: Online Gig Workers, 2022

Percentage of employed population that participates in online gig work activities



Source: Datta and Chen 2023.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

There is also evidence that advancements in ICT are making new forms of work a normal part of economic life in CADR, though their prevalence is varied. During the COVID-19 pandemic, remote and platform work surged. In Costa Rica, for example, remote work increased from 8 percent of employment in 2019 to 18 percent in 2021. Gig work is also increasingly becoming an option for workers in the region. In 2022, more than 10 percent of workers reported doing online gig work in Costa Rica, the Dominican Republic, Guatemala, and Panama (figure ES7). After the pandemic, however, remote work rates declined. In the Dominican Republic, for example, telework fell from 5 percent of workers in 2020 to 1.7 percent in 2022. Despite the high rates of online gig work in some countries, in El Salvador, Honduras, and Nicaragua, only 6 percent or less of workers took on online gig jobs. The gig workers providing taxi and delivery services in the Dominican Republic make up only 0.2 percent of the labor force. There is also evidence that at least at present, platform jobs are accessible primarily to those who face fewer obstacles in the labor market: platform workers tend to be younger, male, and more highly educated.

THE FACTORS BEHIND CADR'S INCOMPLETE TRANSITION

The transition of CADR countries to the future of work has been only partial, despite the existence of the technology to automate many tasks and to enable remote and platform work. Employment is evolving towards nonroutine tasks in CADR, but routine ones still dominate. Remote work surged during the pandemic, but now seems to be diminishing. Platform work is present but makes up a small share of total jobs in some countries. This highlights the importance of analyzing factors beyond the “technological potential” for a job to be automated or performed remotely to understand which types of workers are hired and in which types of capital investments are made.

Employment structure (how employment is distributed across sector), skills, adoption and diffusion of technology, and globalization mediate the impact of technology on jobs. Factors that are key to understanding changes in what work is being done and how work is being done include the adoption and diffusion of technology (Do firms and workers use new technologies?); but also employment structure (Do sectors that use technology dominate?); the supply of skills (Do workers have skills that are complementary to technology?); and globalization (Is the economy open to technological influences?).

Each of these factors plays a role in explaining the evolution of employment in CADR countries.

Examining the relationship between these factors and how intensive a job is in the routine tasks that are associated with jobs of the past shows that each is important in explaining what workers do at work in CADR countries. Across CADR:

- Less agricultural work is associated with employment that is less intensive in routine tasks.
- More education is associated with employment that is less intensive in routine tasks.
- Greater technology use is associated with employment that is less intensive in routine tasks.
- Greater global value chain participation is associated with employment that is more intensive in routine tasks.

Adoption and diffusion of technology is not a primary factor explaining differences in the tasks that workers do in CADR countries. Technology explains around 10 percent of the variation in the routine intensity of employment over time in all CADR countries. This result is consistent with the limited reach of technology in CADR. Instead, worker skills and employment structure are the most important factors.

Worker skills have improved substantially in CADR, but relatively low levels of tertiary education and low educational quality impede uptake of newer technologies. Education levels have improved throughout the CADR region, driven by a decline in workers who have primary education or less and an increase in those who have secondary education. However, education levels in the higher-income CADR countries are low relative to the most developed economies globally and those in the lower-income CADR countries are low relative to the higher-income CADR countries. In Costa Rica, the Dominican Republic, and Panama, around a quarter of workers are tertiary educated versus more than half of workers in Korea and the United States. In the remaining CADR countries, 14 percent or less of workers have tertiary education. Educational quality is also a problem. Even in the best performing country in the region, Costa Rica, less than 60 percent of 15-year-olds meet the minimum proficiency standard on the Programme for International Student Assessment (PISA) in reading and just 40 percent in math. In the poorest performing CADR countries, less than 30 percent and 20 percent do, respectively. This compares with at least three-quarters of students in both subjects in the OECD.

Workers in CADR countries also lag in the kinds of skills needed to accomplish the new tasks associated with new technologies. In the Dominican Republic, firms cite inadequate digital skills as a limitation when trying to fill vacancies. In El Salvador, digital startups report low quality training and education as barriers to hiring talent. Data on technology skills taken from LinkedIn profiles in Costa Rica and Panama show a significant lag in technology skills. Lack of management skills, which are increasingly viewed as a prerequisite to technology adoption, may also be hindering adoption of technologies in CADR. For example, based on data from the World Management Survey, the average management score for firms in Nicaragua is 2.4, the seventh lowest among the 35 countries surveyed.

The prevalence of services sector employment across CADR countries implies less vulnerability to automation, but at the expense of the dominance of low-productivity employment. Most CADR countries are experiencing “premature deindustrialization” in which growth in the services share of employment is happening at lower levels of development and at lower levels of peak manufacturing employment than occurred in advanced countries. Indeed, the industrial share of employment contracted between 1991 and 2019 in all CADR countries except Panama and Honduras. This implies a lower risk of automation—low-paid services are harder to automate because they tend to involve more (nonroutine) hands-on actions and more (nonroutine) people-oriented interactions—but raises concerns about future growth because manufacturing has historically been an accelerator of economic development and a generator of good jobs.

Continued advancements in ICT outside of the region could offer a way forward to improve the productivity of the increasingly dominant services sector. Though globalization has not played a significant role in the evolution of employment in CADR, connections to the global economy have increased in recent decades. Foreign direct investment (FDI) inflows grew from a regionwide average of 1.0 percent of GDP between 1970 and 1989 to 4.5 percent between 2010 and 2022. This is, in part, the result of the entry of CADR countries in manufacturing GVCs, particularly in textile and garments (Dominican Republic, El Salvador, Guatemala, and Nicaragua), automotive (El Salvador, Honduras, and Nicaragua), and medical devices (Costa Rica and the Dominican Republic). Digital technologies are opening new opportunities for small- and medium-sized enterprises (SMEs) in CADR to access new markets and expand their customer and supplier base, including to international markets. Meta and the World Bank's Future of Business Survey of SMEs shows that SMEs across the region use digital tools to facilitate online sales and purchases: more than 40 percent say they use such technologies. Digital platforms in particular seem capable of transformative impacts. Large shares of firms across CADR report that digital platforms had a very or extremely important impact on their business.

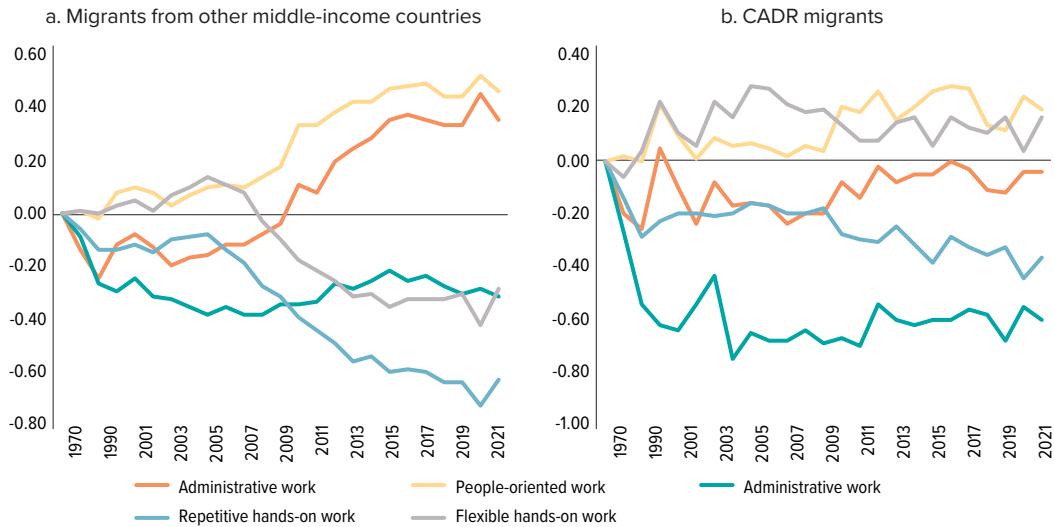
THE IMPORTANCE OF TECHNOLOGICAL CHANGE ABROAD

Changes in the nature of work in CADR countries are being influenced not only by developments within the region but also by how technological progress plays out in developed countries. Technological progress abroad could affect CADR labor markets in several ways. First, automation abroad could drive a process of reshoring in which automation-induced labor savings incentivize companies to bring jobs back for domestic production (or to create new jobs domestically instead of abroad). Second, technological developments in developed countries could alter the demand for migrants from CADR countries. Technological advancements could replace the need for migrant workers, or they could increase and change the kinds of migrant workers demanded, as suggested by recent research demonstrating a link between technological progress and increased demand for manual service workers. Research conducted for this report shows the following impacts of technological progress outside of CADR.

- *Robot adoption in the United States has a negative effect on labor markets in most CADR countries, likely as a result of reduced opportunities for offshoring.* Between 2010 and 2019, robot adoption in the United States is associated with a decline in labor force participation and employment of 0.4 percentage points for workers with medium education in the Dominican Republic and El Salvador. In Costa Rica, the effects of robot adoption are channeled through an increase of 0.2 percentage points in the unemployment rate of low- and medium-educated workers. Honduras is an exception. Robot adoption led to an increase in the labor force participation of medium-educated workers of 0.2 percentage points. This may be linked to the reliance of Honduras's export basket to the United States on raw materials, which may mean that the country benefits when robot adoption leads to expansions in demand.
- *Computerization in the United States has shifted CADR migrants into less-skilled services and construction jobs.* Since 1970, the employment of migrants in the United States from non-CADR, middle-income countries has become much more intensive in knowledge and people-oriented tasks (figure ES8a). The employment of migrants from CADR countries, in contrast, has become somewhat more intensive in flexible hands-on work and people-oriented work, but has not experienced much change in knowledge work (figure ES8b). In sum, technological progress in the United States seems to be pushing CADR workers towards less-skilled services and construction sector jobs where nonroutine manual and interpersonal tasks dominate.

FIGURE ES8: Evolution of the Task Content of Migrants in the United States, 1970–2021

Task index (1970 = 0)



Source: ACS 2000–2021; US Census 1970, 1980, 1990.
 Note: CADR = Central America and the Dominican Republic.

- Robot adoption in the United States had no observable impact on overall migration flows from CADR countries to the United States in the 2000s and 2010s. Overall, migrant flows did not seem to respond to robot adoption in the United States during this period. However, robot adoption in the early 2000s did increase the demand for high-skilled CADR migrants but in low-skilled nonroutine occupations. Between 2000 and 2010, an increase of one robot per thousand industrial workers was associated with a higher employment rate and a lower unemployment rate for high-educated CADR migrants. This seems to be related to an increase in aggregate demand, particularly in food preparation and building and grounds cleaning and maintenance, due to increased productivity associated with robot adoption, as high-skilled CADR workers switched to these lower-skilled occupations. Robot adoption in the United States between 2010 and 2019, however, led to less demand for high-educated CADR migrants. The employment rate of high-educated CADR migrants declined 0.4 percentage points for each additional robot, while the total number of high-educated CADR migrants fell by 53 migrants for each additional robot adopted. This may reflect reduced incentives for high-skilled CADR migrants to migrate.

FACILITATING TECHNOLOGICAL PROGRESS THAT BENEFITS WORKERS

The challenge for policymakers in CADR is to balance policies that enable technological progress and the benefits it brings with policies that mitigate the effects of any ensuing disruptions. Technological progress is a key component of development, allowing for increased productivity, new products and services, and access to new markets. In many cases technological progress goes hand-in-hand with better employment outcomes. CADR countries have not yet experienced significant disruptions from technological progress, nor have they taken full advantage of its potential benefits. While many workers in the region seem to be at risk of losing their jobs to machines, a number of factors related to employment structure, skills, the use of technology, and globalization mean that this risk has not materialized and is unlikely to do so in the near term. However, this also means that the region is not yet benefiting from the potential gains associated with technological progress.

Given the limited reach of technology in CADR countries, supporting technology adoption and diffusion will be key to facilitating CADR countries' continued development. Business advisory and related services can promote technology uptake, improve the management skills that are often a prerequisite of technology adoption, and improve linkages between small businesses and the digital platforms that can open new markets.

From a labor market perspective, two priorities emerge for CADR countries to take advantage of the benefits of technological progress while mitigating the downsides. First, pathways for developing skills complementary to new technologies will be essential. Second, social protection and labor market policies will need to be adapted to new working arrangements on one hand, and to the disruptions associated with technological progress on the other. Within these adaptations lies a short-term opportunity to expand access to social protection by developing partnerships among digital platforms, governments, and service providers.

This will need to be done taking into account the unique circumstances in CADR countries. The region's more developed countries—Costa Rica, Panama, and, in many respects, the Dominican Republic—are generally at a more advanced stage of structural change and technology adoption. This means that different CADR countries have somewhat different priorities (table ES1). The region's less advanced countries need to focus more on building foundational structures and piloting new initiatives for skills building and social protection, while the region's more advanced countries can work to improve the sophistication of existing systems.

TABLE ES1: Policies to Facilitate Technological Change and Mitigate the Negative Effects of Resulting Disruptions

Objective 1: Promote the adoption and diffusion of technology by building firm capabilities		
Building strong foundations	<ul style="list-style-type: none"> • Ensure quality infrastructure (e.g., electricity, internet service, mobile networks) • Promote competition, ensure regulations enable technology adoption and diffusion, and expand access to finance 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Strengthen business advisory and technology extension services, and technology centers to promote technology uptake among firms and improve management capabilities	Utilizing extension services to increase technology uptake in the agricultural sector	Targeting services through assessments of market failures, strength of demand, and risk of overcrowding the market
Promote SME use of digital platforms by increasing digital skills, awareness, and technology uptake	Piloting initiatives that develop digital skills among SMEs	Developing initiatives that help connect SMEs to overseas markets
Objective 2: Strengthen pathways for skills development and deployment		
Building strong foundations	<ul style="list-style-type: none"> • Invest in early childhood education and strengthen basic literacy and numeracy for school-age children 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Develop labor market insight tools to collect, analyze, and disseminate information about the labor market	Introducing or strengthening labor force surveys and utilizing administrative data	Deploying vacancy, skills profiling, and other specialized surveys and exploring novel sources of labor market information (for example, online job postings)
Build foundations-driven, demand-oriented education and training systems that are designed to be lifelong and targeted to workers at greater risk of labor market disruptions	Piloting remedial skills and demand-driven training programs that improve literacy and numeracy and basic digital skills and that fill labor market demand in strategic areas	Identifying areas of growing demand in real time, developing training programs in response, and incorporating other support services into these training programs
Design digitally enabled, fit-for-purpose intermediation programs that focus on overcoming geographic disparities and information problems	Building a public employment services system that is a reliable information source Exploring global skills partnerships (GSPs) to create safe and inclusive migration pathways	Expanding the public employment services system to provide labor market intelligence, career and skills guidance, job matching, and referral services
Objective 3: Adapt social protection and labor market policies to new forms of work		
Building strong foundations	<ul style="list-style-type: none"> • Move away from reliance on traditional employer-employee relationships for financing and providing social protection 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Exploit the potential of platform work	Avoid regulations that lead to further labor market segmentation	In the short term, explore models for expanding access to social protection to platform workers
Monitor potential anti-competitive practices	Develop models of the businesses, characteristics, and anti-competitive potential of digital platforms	Develop more sophisticated analyses of the particular anticompetitive practices of platforms, especially issues related to data

Chapter 1

Jobs in Central America and the Dominican Republic

Labor markets in Central America and the Dominican Republic (CADR) face significant challenges despite improvements in recent years. Structural change is slow in several countries. No matter the stage of structural transformation, all CADR countries are experiencing strong growth in services employment. This will require creating better quality jobs in a sector typically characterized by low-wage, low-productivity work. Indeed, job quality is already a challenge. Lack of access to social protection is the norm and wage growth has been stagnant in many countries. Advancements have been made in education levels, but this human capital is underutilized: low female and youth labor force participation rates mean that a large portion of the region's human capital is not being deployed in the labor market. Large outmigration flows from several CADR countries imply that human capital is better utilized elsewhere. The private sector needs more dynamism to create high-quality jobs. Barriers to entry and firm growth translate into high rates of small and less productive informal firms.

SETTING THE STAGE: LABOR MARKET DYNAMICS AND TECHNOLOGICAL PROGRESS

Understanding how the nature of work will evolve in the coming years in CADR first requires understanding existing labor market dynamics. Much has been written about the potential impact of technological progress on labor markets in developed countries, but less is known about the interplay between technology and jobs in CADR where preexisting labor market challenges may mean a different evolution. Much of the region is characterized by low female labor force participation, high unemployment, limited social protection coverage, low skill levels, and challenging business environments. Understanding these dynamics is important, both because they will help determine the future impact of technological change in the region and because they have affected the impacts of technological changes that have already occurred.

This chapter presents a high-level summary of labor markets in CADR. The chapter is drawn from recent literature on jobs and labor markets in CADR countries supplemented by new analysis. The chapter begins with a discussion of growth and employment dynamics, then moves on to discuss labor supply and labor demand in turn. Table 1.1 summarizes the main labor market issues in CADR countries.

TABLE 1.1: Summary of the Main Labor Market Supply and Demand Issues in CADR

Country	Macroeconomic context	Challenges related to labor supply	Challenges related to labor demand
CRI	<ul style="list-style-type: none"> Strong growth explained by growth in labor productivity Substantial structural transformation 	<ul style="list-style-type: none"> Elevated unemployment (UE) rate Large gender labor force participation (LFP) and UE gap; high youth UE and not in education, employment, or training (NEET) rates, esp. women Skills gaps, particularly in high-value sectors High secondary school dropout rate 	<ul style="list-style-type: none"> High tax wedge raises incentives for informal employment Fragmented dialogue between workers and employers
DOM	<ul style="list-style-type: none"> Strong growth explained by growth in labor productivity Substantial structural transformation 	<ul style="list-style-type: none"> Large gender LFP and UE gap; high NEET rates, esp. women Challenges with education quantity and quality Substantial outmigration 	<ul style="list-style-type: none"> Market concentration, special tax regimes, credit access problems, and unreliable electricity access disrupt firm entry and growth Multiple minimum wages with lagging adjustment create labor market distortions
GTM	<ul style="list-style-type: none"> Slow growth with limited labor productivity growth Structural transformation with smaller fall in agricultural employment 	<ul style="list-style-type: none"> Low overall LFP Large gender LFP gap; high NEET rates, esp. women Challenges with education quantity, esp. rural areas Limited internal mobility Substantial outmigration 	<ul style="list-style-type: none"> Barriers to entry and unfavorable political and governance context create lack of contestability and disincentivize (formal) entry
HND	<ul style="list-style-type: none"> Slow growth with limited labor productivity growth Structural transformation with smaller fall in agricultural employment 	<ul style="list-style-type: none"> Large gender LFP, UE gap; high NEET rates, esp. women Challenges with education quality, particularly technical and vocational education and training (TVET) Labor market mismatches Substantial outmigration 	<ul style="list-style-type: none"> Increases in minimum wage may hamper formal job growth High public sector wage premium creates competition with private sector
NIC	<ul style="list-style-type: none"> Slow growth with limited labor productivity growth Structural transformation with smaller fall in agricultural employment 	<ul style="list-style-type: none"> Large gender and youth LFP gaps; high youth UE; high NEET rates, esp. women Substantial outmigration 	<ul style="list-style-type: none"> Barriers to entry and growth disincentivize formality, leaving most jobs in unproductive micro firms
PAN	<ul style="list-style-type: none"> Strong growth explained by growth in labor productivity Substantial structural transformation 	<ul style="list-style-type: none"> Elevated UE rate Large gender LFP gap; high youth UE, NEET rates, esp. women Challenges with education quality create skills gaps High secondary school dropout rate 	<ul style="list-style-type: none"> Challenge to shift to knowledge-driven growth model; low investment in R&D and ineffective diffusion of knowledge affect innovation Unequal access to infrastructure
SLV	<ul style="list-style-type: none"> Slow growth with limited labor productivity growth Structural transformation 	<ul style="list-style-type: none"> Low overall LFP rate Large gender LFP gap; high NEET rates, esp. rural women Labor market mismatches High public sector wages distort skilled labor Substantial outmigration, esp. higher-skilled 	<ul style="list-style-type: none"> High minimum wages, tax wedge and rigid regulations discourage formality and reduce productivity Crime disincentivizes formality and firm growth and reduces profitability Lack of technology use by small firms constrains productivity

Sources: IFC 2023 and OECD 2017c for Costa Rica; Abdullaev and Estevão 2013, OECD 2022a, USAID 2020, and Winkler and Montenegro 2021, for the Dominican Republic; Banegas and Winkler 2020 for El Salvador; Eberhard-Ruiz 2021 and USAID 2017a for Guatemala; Michel and Walker 2019 and USAID 2017b for Honduras; Castro-Leal and Porras-Mendoza 2020 and World Bank 2012b for Nicaragua; OECD 2017a for Panama; Bashir, Gindling, and Oviedo 2012; Ulku and Zaorak 2021; and World Bank 2022b for the Central America and the Dominican Republic (CADR) region as a whole. Note: CRI = Costa Rica; DOM = Dominican Republic; esp. = especially; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; R&D = research and development; SLV = El Salvador.

GROWTH AND EMPLOYMENT DYNAMICS

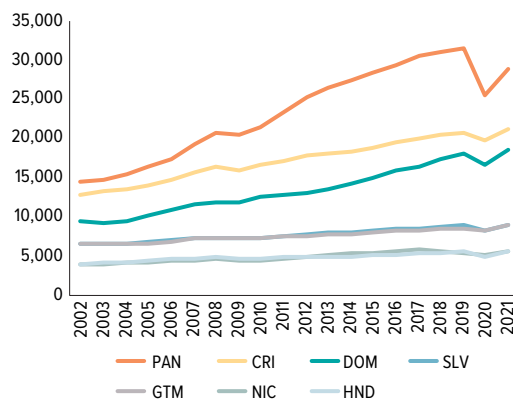
Costa Rica, the Dominican Republic, and Panama are CADR's highest-income, highest-productivity countries. El Salvador, Guatemala, Honduras, and Nicaragua, in contrast, have been relatively stagnant in the last two decades with only modest productivity improvements. Deindustrialization characterizes employment in the region: employment has shifted strongly out of agriculture and is now concentrated in the services sector.

Economic Growth

CADR includes countries at diverse levels of economic development. The region's sole high-income country, Panama, has a gross domestic product (GDP) per capita that is five times higher than that of Nicaragua and Honduras, the region's least developed countries (figure 1.1). The region's higher-income countries grew more during the last two decades than the lower-income ones (figure 1.2). After beginning the period with a similar GDP per capita to that of Panama, Costa Rica grew more slowly than its southern neighbor, while the Dominican Republic caught up to Costa Rica. El Salvador, Guatemala, Honduras, and Nicaragua all grew slowly with no substantial catch-up growth.

FIGURE 1.1: GDP Per Capita, 2002–21

Purchasing Power Parity, constant 2017 international \$

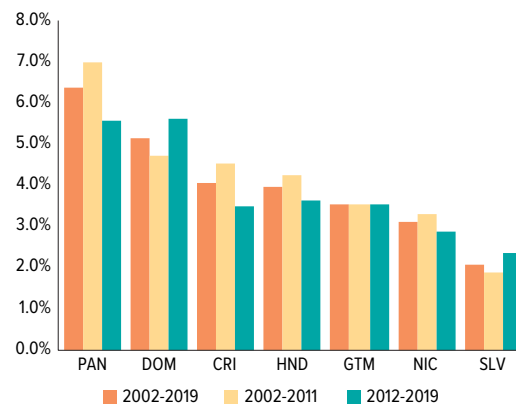


Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GDP = gross domestic product; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 1.2: GDP Growth, 2002–19

Percentage average annual growth



Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GDP = gross domestic product; GTM = Guatemala; HND = Honduras; PAN = Panama; NIC = Nicaragua; SLV = El Salvador.

Labor productivity has driven growth in the region's higher-income countries. CADR has a substantial productivity gap with comparators (Ulku and Zaourak 2021). Previous analyses decomposing economic growth into changes in labor productivity and in demographic and employment trends reveal two sets of countries. Increasing labor productivity has been the main growth driver in Costa Rica, the Dominican Republic, and Panama, explaining about 80 percent of per capita value-added growth between 2000 and around 2017 (Banegas and Winkler 2020; Castro-Leal and Porrás-Mendoza 2020; Winkler and Montenegro 2021). In El Salvador, Guatemala, Honduras, and Nicaragua, in contrast, economic growth during this period was slow and mostly driven by changes in demographic factors rather than labor productivity improvements (Banegas and Winkler 2020; Castro-Leal and Porrás-Mendoza 2020; Eberhard-Ruiz 2021; Michel and Walker 2019).

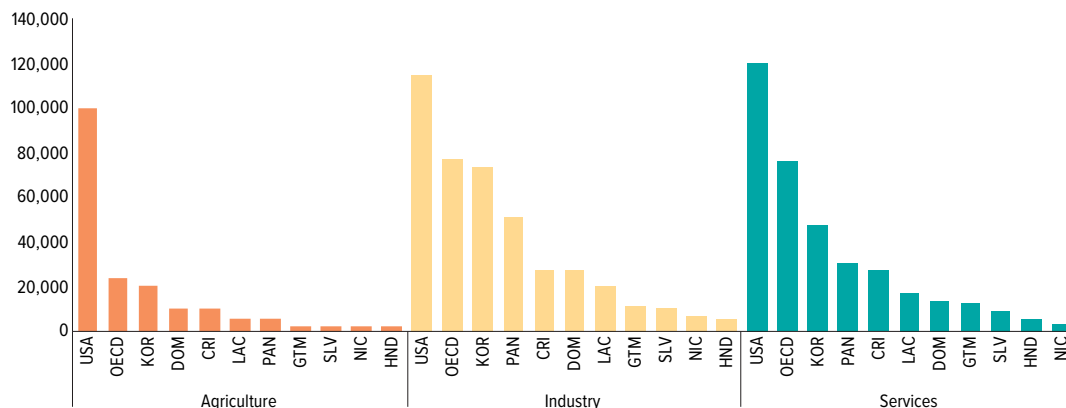
Productivity

The relatively insignificant role of labor productivity in explaining growth in many CADR countries indicates challenges for longer-term economic development. Productivity growth is the main engine of sustained economic progress. While favorable demographic and employment trends can yield periods of economic growth, improvements in labor productivity are necessary for sustained convergence with advanced economies.

Costa Rica, the Dominican Republic, and Panama stand out as the leaders in productivity in CADR. Productivity, proxied as value added per worker, is highest in Costa Rica, the Dominican Republic, and Panama, though still well below the levels in aspirational benchmarks Korea, the Organisation for Economic Co-operation and Development (OECD), and the United States (figure 1.3). Productivity differences across countries are starkest in the industrial sector where Panama's productivity is nearly double that of Costa Rica and the Dominican Republic, which themselves have industrial productivity that is at least twice that of the region's remaining countries. Cross-country differences in services sector productivity are also significant, though only two main groups—Costa Rica and Panama, on one hand, and the region's other countries, on the other—stand out. Differences are less stark in the agricultural sector.

FIGURE 1.3: Labor Productivity Across Sectors, 2019

Value added per worker, constant 2015 US\$



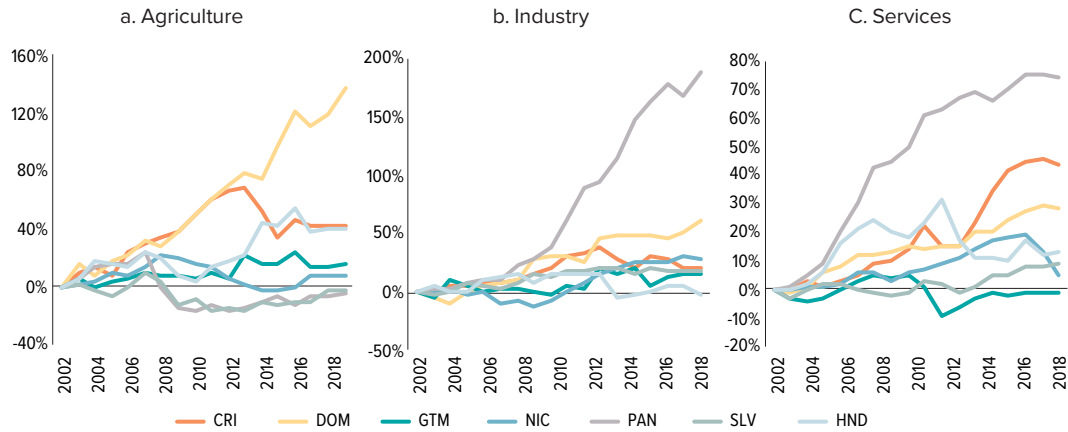
Source: World Development Indicators data, World Bank.

Note: Data for the industrial sector for the Republic of Korea are for 2015. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador; USA = United States of America.

Productivity growth has been minimal in most CADR countries. Since 2002, agricultural productivity has grown substantially in the Dominican Republic (figure 1.4a). Productivity growth has also been significant in Costa Rica and Honduras, though agricultural productivity has fallen relative to 2002 levels in Costa Rica in recent years. Agricultural productivity is lower than 2002 levels in El Salvador and Panama, and growth has been minimal in Guatemala and Nicaragua. Panama stands out for the rapid increase in its industrial productivity, which was nearly triple the 2002 level in 2019 (figure 1.4b). The Dominican Republic is another standout with industrial productivity growth of 62 percent. Panama again stands out for a substantial increase in services productivity, along with Costa Rica and the Dominican Republic (figure 1.4c).

FIGURE 1.4: Labor Productivity Growth Across Sectors, 2002–19

Change in value added per worker, percent, base year = 2002



Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

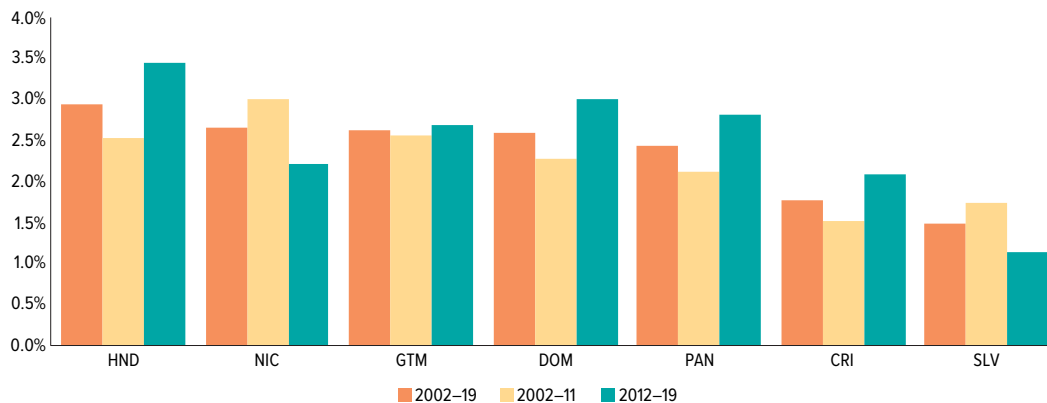
Employment

Despite modest economic growth, CADR countries did generate new jobs in the last two decades.

Employment growth between 2002 and 2021 was highest in Honduras (2.5 percent), Nicaragua (2.4 percent), and Guatemala (2.3 percent), in part reflecting the lower contribution of labor productivity to economic growth in these countries (figure 1.5). Across the region, employment growth was lower in the 2010s than in the 2000s.

FIGURE 1.5: Employment Growth, 2002–19

Percentage average annual growth



Source: World Development Indicators data, World Bank.

Note: The period 2012–21 omits 2020, which was significantly affected by the COVID-19 pandemic. CRI = Costa Rica; DOM = Dominica; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Employment has shifted out of agriculture in CADR countries. The canonical path of economic development known as structural transformation anticipates employment first shifting from (low-productivity) agriculture to (higher-productivity) industry and then from industry to (lower-productivity) services as industrial productivity increases. Consistent with this model, agricultural employment has

declined in all CADR countries over the longer term. Though available irregularly for the last 60 years, census data show a substantial decline in agricultural employment (figure 1.6). This decline continued between 1991 and 2019, the period during which comparable survey data is available (figure 1.7). Still, smaller declines in agricultural employment in Guatemala, Nicaragua, and Honduras mean that nearly a third of employment remains in low-productivity agriculture.

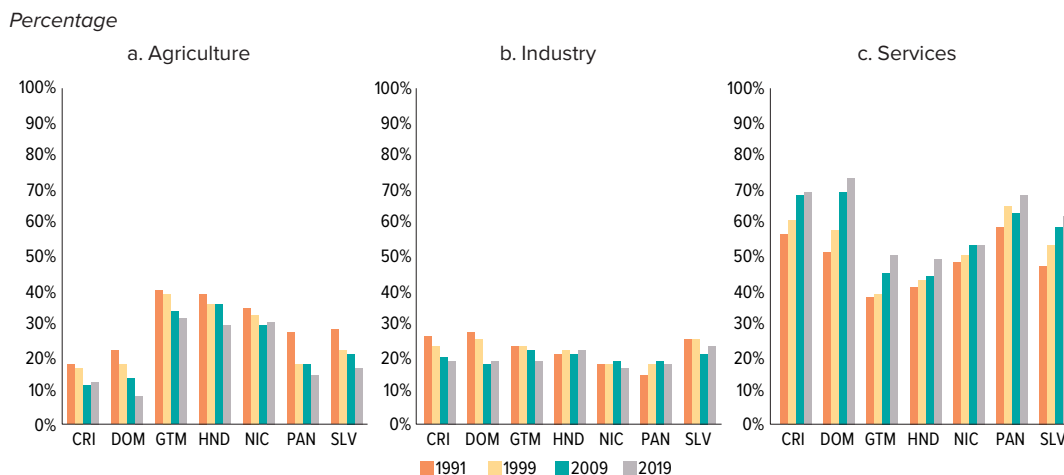
FIGURE 1.6: Change in Employment Share by Sector, 1960–2010



Source: [Minnesota Population Center 2020](#).

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

FIGURE 1.7: Employment Share by Sector, 1991–2019



Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

CADR countries are deindustrializing. Deindustrialization—the shift of employment away from industry and towards services—is a common phenomenon in advanced economies (see the United States in figure 1.6) and considered to be the final stage of the structural transformation process. However, recent evidence suggests that in developing countries in general and in Latin America in particular, the growth in the services share of employment is happening at lower levels of development and at lower levels of

peak manufacturing employment (Rodrik 2016).² This seems to be the case in CADR countries where, at odds with the typical model of structural transformation, employment has not shifted strongly into industry. Over the long term, gains in the industrial share of employment have been modest and in the three most recent decades, this share actually shrank or plateaued in all CADR countries except Panama (figures 1.6 and 1.7). In services, in contrast, employment has grown substantially in both the longer term and in the three most recent decades.

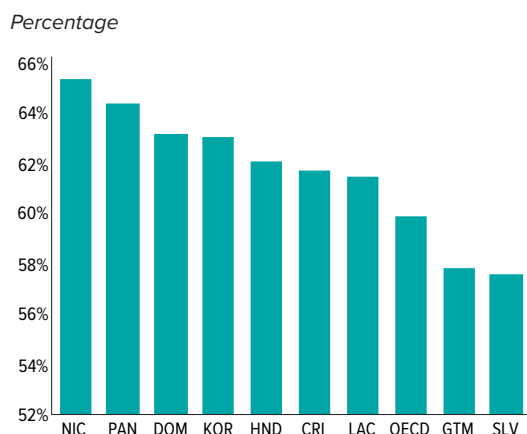
LABOR SUPPLY

CADR countries face substantial challenges developing and deploying human capital in productive employment. Low education levels combined with evidence of low educational quality raise concerns about how well current and future workers will be able to complement and facilitate technological progress and respond to changes in work resulting from technological progress. At the same time, low labor force participation and high unemployment rates in some countries, particularly for women and young people, combined with high levels of informality (proxied by access to social protection) and self-employment, suggest that CADR countries struggle to deploy human capital.

Labor Force Participation and Employment

Labor force participation rates have generally improved in CADR countries in the last two decades, with a few exceptions. Between 2002 and 2011, most countries in the region had labor force participation rates below the Latin American and the Caribbean (LAC) average. This trend began to change around 2010: Costa Rica, the Dominican Republic, Honduras, Nicaragua, and Panama all had higher participation rates in the 2012–19 period prior to the COVID-19 pandemic. In contrast, labor force participation rates declined during this period in El Salvador and Guatemala, leaving these as the only CADR countries with lower labor force participation rates in 2021 than the LAC average (figure 1.8). All CADR countries experienced declines in participation in 2020 as a result of the pandemic and some of them remained below prepandemic levels in 2021.

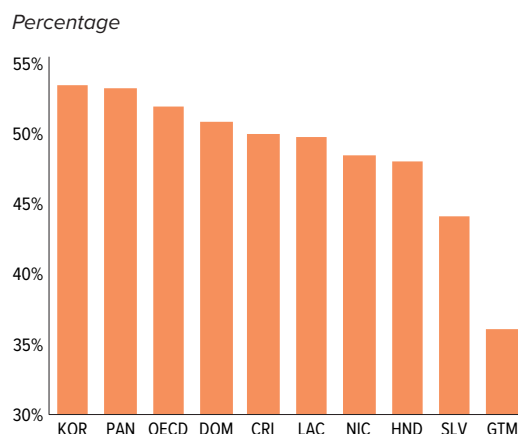
FIGURE 1.8: Labor Force Participation Rate, 2021



Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.9: Female Labor Force Participation Rate, 2021



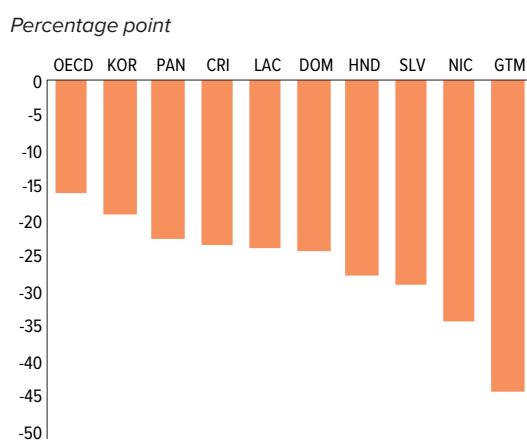
Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

² The same is observed for sector value-added, though the phenomenon is more apparent for employment (Beylis et al. 2020). See also Felipe, Mehta, and Rhee (2019).

Women continue to participate in CADR labor markets at much lower rates than men. Female labor force participation rates in Guatemala (36 percent) and El Salvador (44 percent) are low relative to both other CADR countries and to the LAC regional average (50 percent) (figure 1.9). These are also the only two countries where the female labor force participation rate declined between 2002 and 2021. The gap between female and male labor force participation rates is large in all CADR countries (figure 1.10). Low female labor force participation rates are associated with penalties arising from having children, being married, and inadequate availability of formal wage employment, which themselves are linked to gender norms and legal barriers (Almeida and Viollaz 2022; Eberhard-Ruiz 2021; Michel and Walker 2019). Other factors include receipt of remittances and teenage pregnancy (Sousa and García-Suaza 2018; Winkler and Montenegro 2021).

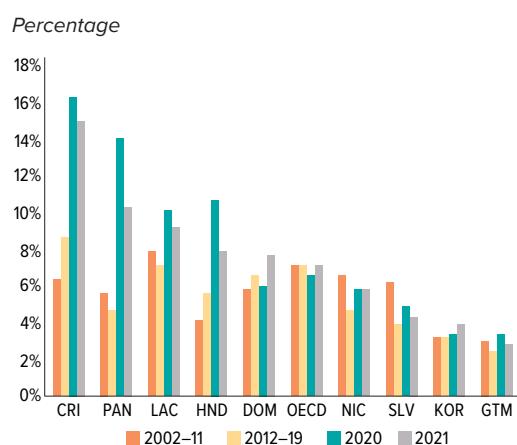
FIGURE 1.10: Female-Male Gap in Labor Force Participation Rate, 2021



Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.11: Unemployment Rate, 2002–21



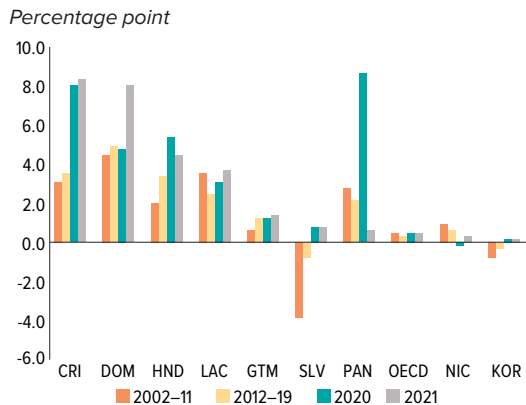
Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

During the last two decades, unemployment rates were low in CADR countries relative to the LAC average. Between 2002 and 2019, every CADR country's average unemployment rate was below LAC's (figure 1.11). Unemployment spiked during the pandemic in all CADR countries except the Dominican Republic and remained elevated in 2021 in most countries. The gender gap in unemployment is largest in Costa Rica, the Dominican Republic, and Honduras (figure 1.12). Female labor force participation increased substantially during the last two decades in these countries, suggesting that women sought work in greater numbers but faced challenges accessing employment.

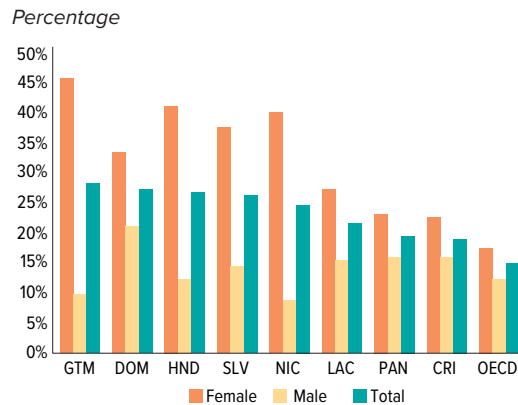
Young people struggle to utilize their human capital in CADR labor markets. Young people have both lower labor force participation rates and higher unemployment rates than older people in all CADR countries. For example, the age gap in the unemployment rate ranges from 2 percentage points in Guatemala and Honduras to more than 25 percentage points in Costa Rica, Nicaragua, and Panama. The youth unemployment rate is also more volatile and susceptible to shocks. For example, young people suffered a larger unemployment spike due to the COVID-19 pandemic. Rates of being outside of education and training in addition to outside of the labor force (NEET rates) are also high in most countries (figure 1.13). Young women are more likely to be disengaged from these activities with double-digit gaps between women and men in all CADR countries except Costa Rica and Panama.

FIGURE 1.12: Female-Male Gap in Unemployment Rate, 2002–21



Source: World Development Indicators data, World Bank.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.13: Young People in NEET Status, 2021

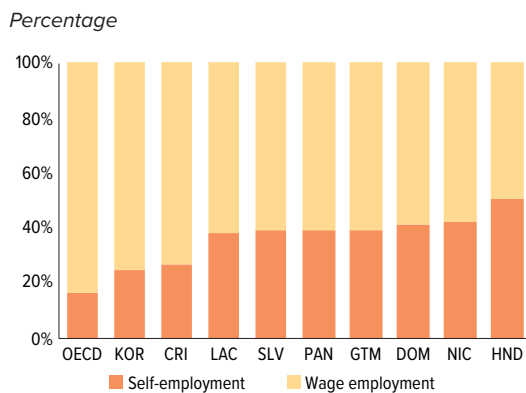


Source: World Development Indicators data, World Bank.
 Note: Data is for 2019 for Guatemala and Honduras and 2014 for Nicaragua. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; LAC = Latin America and the Caribbean; NEET = not in education, employment, or training; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

Job Quality

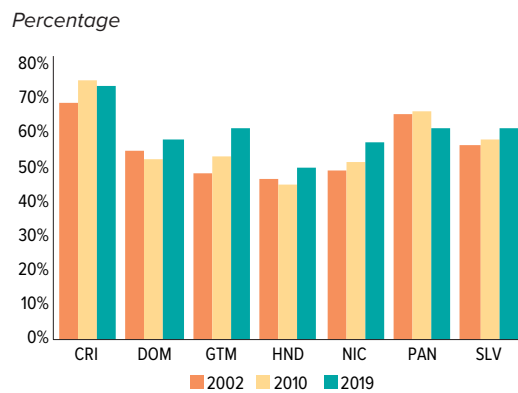
Self-employment represents a large share of all jobs in most CADR countries. Wage employment is less common than in the OECD and Korea in all CADR countries and is less common than the LAC average in all except Costa Rica (figure 1.14). Self-employment is most common in Honduras where half of workers are self-employed. Despite relatively low levels, wage employment increased in most CADR countries in the last two decades, though these increases were uneven within and across countries (figure 1.15). Men are more concentrated than women in self-employment in the region’s higher-income countries. The relationship reverses in El Salvador, Guatemala, Honduras, and Nicaragua. These trends generally hold over time, though the increase in self-employment in Panama in recent years has been driven by an increasing share of self-employed women.

FIGURE 1.14: Employment Share by Wage and Self-Employment, 2019



Source: World Development Indicators data, World Bank.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.15: Employment Share by Wage Employment, 2002–19

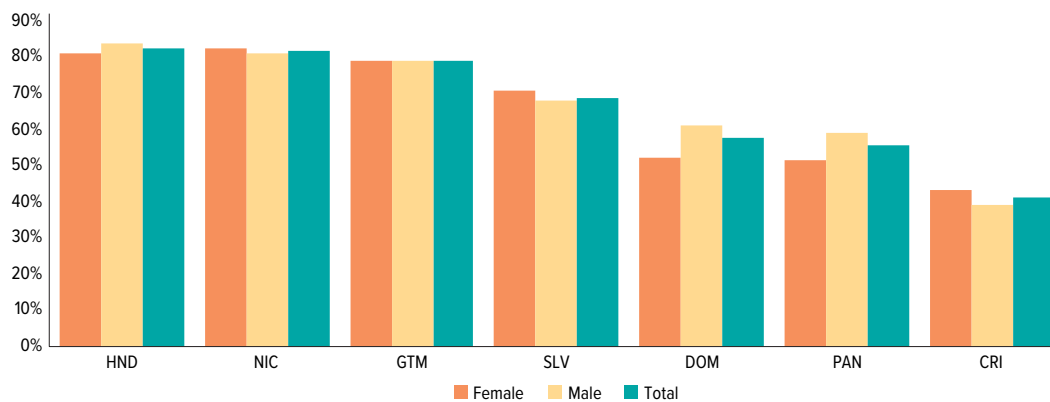


Source: World Development Indicators data, World Bank.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Informality is common in CADR with rates are as high as 80 percent in Honduras and Nicaragua (figure 1.16). The International Labour Organization’s (ILO) definition of informal workers, which includes workers not receiving social protection as well as own-account and family workers, is used as a proxy measure for job quality. Informal employment represents less than half of jobs only in Costa Rica, though even there informality is high by international standards and informal workers struggle to shift to formal jobs (OECD 2017c). Women have higher informality rates in Costa Rica and El Salvador while men have higher rates in the Dominican Republic, Honduras, and Panama.

FIGURE 1.16: Informality Rate, 2021

Percentage



Source: ILOSTAT.

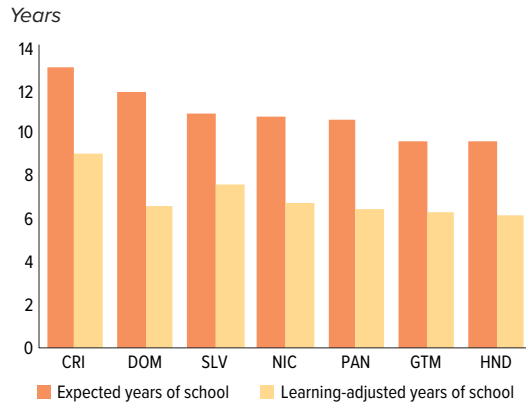
Note: The years are 2012 for Nicaragua, 2017 for Honduras, and 2019 for Guatemala. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Wages have been stagnant outside of the CADR region’s higher-income countries. Analysis of hourly wages reveals two groups of countries. First, Costa Rica and Panama have experienced wage growth in recent years and have hourly wages above the LAC average. Second, the Dominican Republic, El Salvador, and Honduras have stagnant hourly wages that are below the regional average. Women’s hourly earnings are higher than men’s in Costa Rica, Guatemala, and Nicaragua while they are lower in the Dominican Republic, El Salvador, Honduras, and Panama (Urquidi and Chalup 2023). This pattern persists once characteristics like education and occupation are controlled for.

Skills

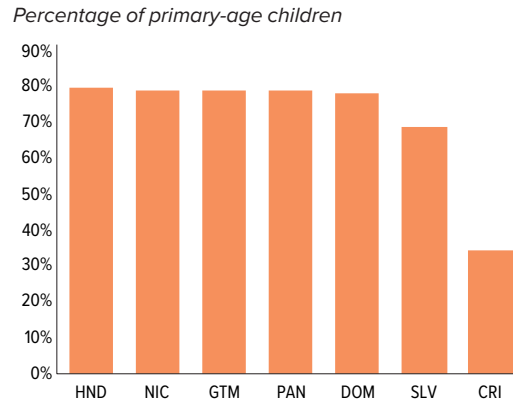
Improvements in education quantity in CADR are complicated by continued challenges related to quality. CADR countries have made significant progress in schooling attainment. Data from the 2020 Human Capital Index show that across the region children can expect to complete on average 11 years of schooling (figure 1.17). Even in the poorest performing countries in the region (Guatemala and Honduras) the average child can still expect to complete nine years of school, indicating that they remain in school through the end of basic education. However, learning outcomes are low across the region (World Bank 2022b; 2023b). Adjusting years of schooling for the quality of learning shows that children can only expect to receive on average seven years of education. Learning poverty rates, the share of children who are out of school or who cannot read a basic text by ten, are nearly 80 percent in every country with the exception of Costa Rica and El Salvador (figure 1.18). When children fail to master basic skills early in school, it can be difficult for them to build more advanced skills later, undermining the benefits of additional years spent in the classroom (Belafi, Hwa, and Kaffenberger 2020).

FIGURE 1.17: Schooling and Learning-Adjusted Schooling, 2019



Source: World Bank Human Capital Index.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

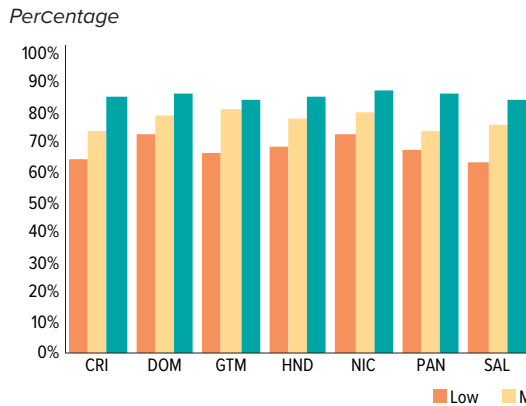
FIGURE 1.18: Learning Poverty, 2019



Source: World Development Indicators data, World Bank.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

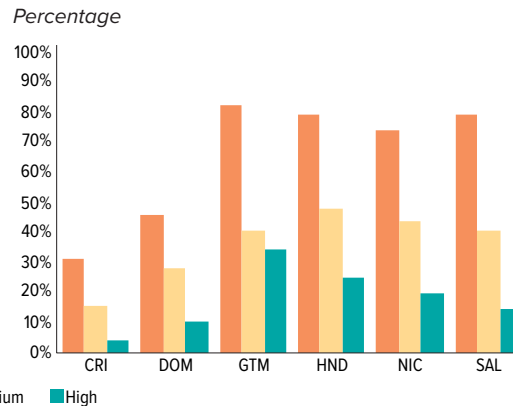
More education is associated with better labor market outcomes and higher-quality jobs, translating into better employment prospects in all CADR countries (figures 1.19 and 1.20). However, informality rates among the most educated are still high—above a quarter of workers—in Guatemala and Honduras.

FIGURE 1.19: Employment Rate by Education, 2021



Source: SEDLAC (CEDLAS and The World Bank).
 Note: The years are 2014 for Guatemala and Nicaragua and 2019 for Honduras. Low is 8 years or less of formal education, medium is between 9 and 13, and high is more than 13. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

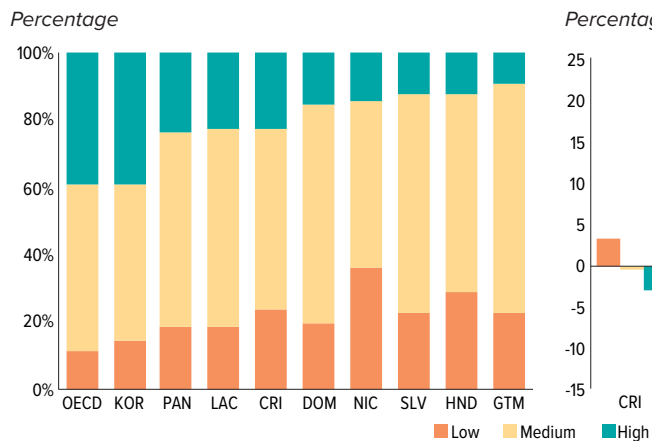
FIGURE 1.20: Informality Rate by Education, 2021



Source: SEDLAC (CEDLAS and The World Bank).
 Note: The years are 2014 for Guatemala and Nicaragua and 2019 for Honduras. Low is 8 years or less of formal education, medium is between 9 and 13, and high is more than 13. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; SLV = El Salvador.

High-skilled employment is limited in CADR countries. Even the region’s higher-income countries have high-skilled employment shares that are well below the OECD average (figure 1.21). Instead, low- and mid-skilled jobs dominate, representing at least half of employment in all CADR countries. During the last decade when comparable data is available, there has been little growth in high-skilled jobs as a share of total employment while mid-skilled jobs have increased (figure 1.22). In all CADR countries, women have a higher share of employment in high-skilled occupations compared to men and, in most countries, are less concentrated in mid- and low-skilled jobs.

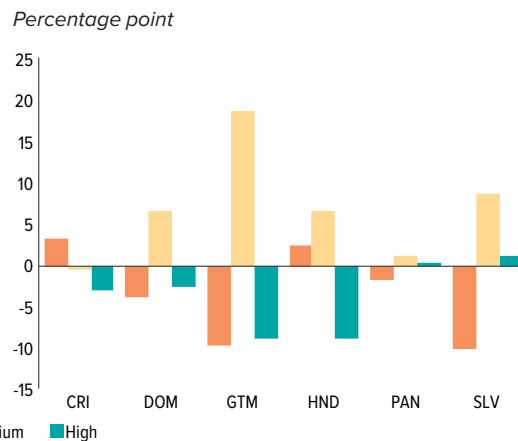
FIGURE 1.21: Employment Share by Skill Level, 2021



Source: ILOSTAT.

Note: Data are for 2019 for Guatemala, 2020 for Honduras, and 2014 for Nicaragua. Low skill is elementary occupations. Medium skill is clerical, service, and sales workers; skilled agricultural and trades workers; and plant and machine operators, and assemblers. High skill is managers, professionals, and technicians. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; LAC = Latin America and the Caribbean; NIC = Nicaragua; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.22: Change in Employment Share by Skill Level, 2011-21



Source: ILOSTAT.

Note: Nicaragua is omitted because of lack of data. The end year is 2019 for Guatemala and 2020 for Honduras. Low skill is elementary occupations. Medium skill is clerical, service, and sales workers; skilled agricultural and trades workers; and plant and machine operators, and assemblers. High skill is managers, professionals, and technicians. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; PAN = Panama; SLV = El Salvador.

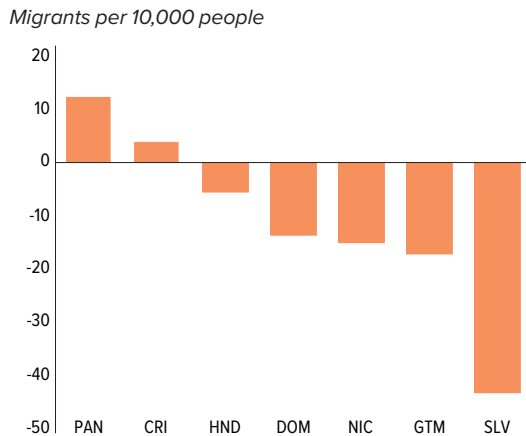
Migration

Outmigration is a significant phenomenon in several CADR countries. Most CADR countries send more migrants abroad than they receive (figure 1.23). On net, El Salvador sends the most people abroad as a share of its population: 43 of every 10,000 people are outmigrants. The number of migrants abroad has increased since 1990 for all CADR countries except Panama (figure 1.24). Four CADR countries—the Dominican Republic, El Salvador, Guatemala, and Honduras—have 1 million or more migrants abroad. The United States is the most common destination for all CADR migrants except for those from Nicaragua (figure 1.25). Other common destinations for CADR migrants are Canada, Mexico, and Spain outside of the region. Inside the region, higher-income CADR countries attract more CADR migrants and more migrants overall.³ Remittance inflows are very large in several CADR countries at around one-fifth or more of GDP in El Salvador, Guatemala, Honduras, Nicaragua (figure 1.26).

CADR migrants move for a multitude of reasons with a number of important consequences for the region's labor markets. Migration from CADR countries is driven by a range of elements (World Bank 2022f; Voorend, Alvarado, and Oviedo 2021; OECD 2018b). These include “push” factors like lack of economic opportunities, natural hazards, and violence domestically and “pull” factors such as better economic opportunities and improved access to services in destination countries. Outmigration has complex labor market effects, particularly in countries that send large numbers of migrants. Outmigrants from the region's sending countries tend to be more skilled than nonmigrants (Del Carmen and Sousa 2018; Winkler and Montenegro 2021; World Bank 2022f). This raises concerns that investments in human capital at home are benefiting labor markets abroad and potentially creating skills shortages. Remittances can also affect labor supply decisions, particularly for women, by raising reservation wages and disincentivizing labor market participation (Michel and Walker 2019; Sousa and García-Souza 2018; Winkler and Montenegro 2021). At the same time, outmigration can, at times, raise wages at home by reducing competition for jobs (Gagnon 2011).

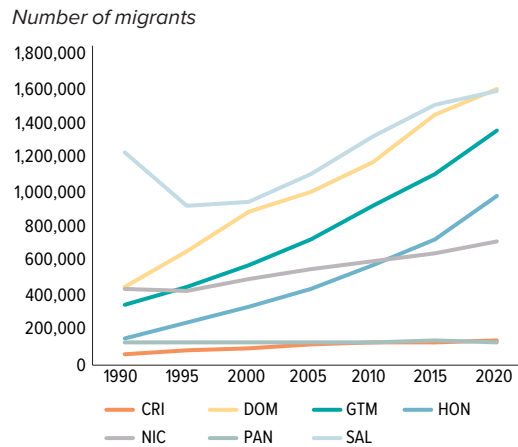
3 This report does not focus on CADR countries as destinations for migrants. For discussion of this topic, see Blyde (2020) and Voorend, Alvarado, and Oviedo (2021) for Costa Rica; Hiller and Chatruc (2023) and OECD (2018) for the Dominican Republic; and Hausmann, Espinoza, and Santos (2017) and OECD (2017c) for Panama.

FIGURE 1.23: Net Migration Rate, 2021



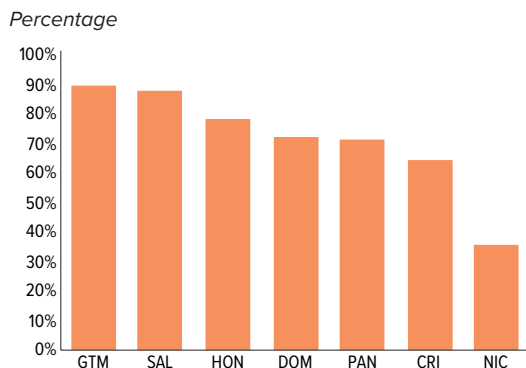
Source: World Development Indicators data, World Bank.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 1.24: Migrants from CADR countries, 1990–2020



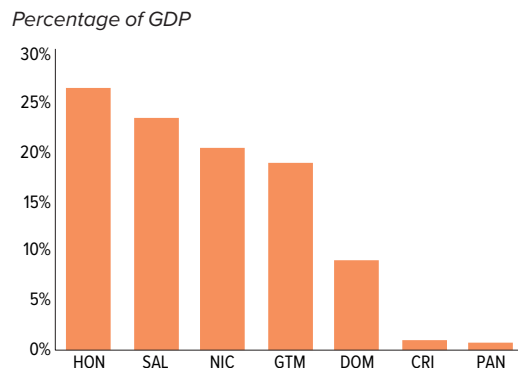
Source: United Nations.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 1.25: Share of CADR Outmigrants in the United States, 2020



Source: United Nations.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 1.26: Remittance Inflows, 2022



Source: World Bank-KNOMAD.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GDP = gross domestic product; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = EL Salvador.

LABOR DEMAND

Competition from the informal sector is a common obstacle facing firms across the CADR region.

The World Bank Enterprise Surveys offer insight into the main challenges for firm operations (table 1.2). Informality is a common challenge: more than 10 percent of firms cite the practices of the informal sector, which could be a source of unfair competition, as their biggest obstacle in all CADR countries except the Dominican Republic. Other issues are common to subsets of countries. Crime, corruption, or political instability are top issues cited by firms in the Dominican Republic, Guatemala, and Panama. An inadequately educated workforce is a top concern in higher-income Costa Rica and Panama, as well as in El Salvador and Nicaragua. The Dominican Republic is the only country in which firms frequently report an infrastructure concern: access to electricity.

TABLE 1.2: The Biggest Obstacles Facing Firms

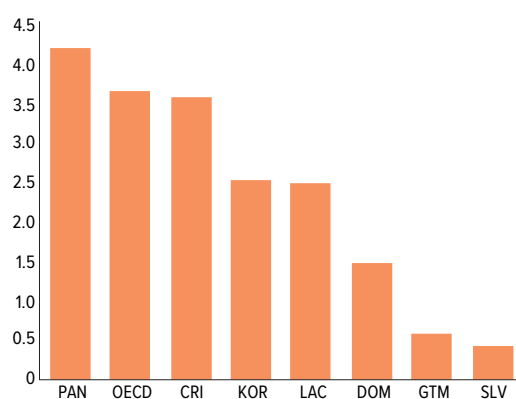
Country	Biggest obstacles (Percentage of firms)
Costa Rica	Access to finance (26%), practices of the informal sector (23%), inadequately educated workforce (13%)
Dominican Republic	Corruption (19%), electricity (15%), tax rates (11%)
El Salvador	Access to finance (22%), practices of the informal sector (19%), inadequately educated workforce (12%), business licensing (11%)
Guatemala	Corruption (23%), political instability (21%), practices of the informal sector (17%), crime, theft, and disorder (11%)
Honduras	Access to finance (18%), practices of the informal sector (16%), tax rates (11%)
Nicaragua	Practices of the informal sector (27%), access to finance (12%), inadequately educated workforce (12%), customs and trade regulations (11%)
Panama	Corruption (33%), practices of the informal sector (14%), inadequately educated workforce (14%)

Source: World Bank Enterprise Surveys 2010, 2016, 2017, 2023.

Note: Obstacles shown are those that at least 10 percent of firms cite as their biggest obstacle. The years are 2010 for Costa Rica and Panama; 2016 for the Dominican Republic, Honduras, and Nicaragua; 2017 for Guatemala; and 2023 for El Salvador.

FIGURE 1.27: New Business Density, 2020

New registrations per 1,000 working age population

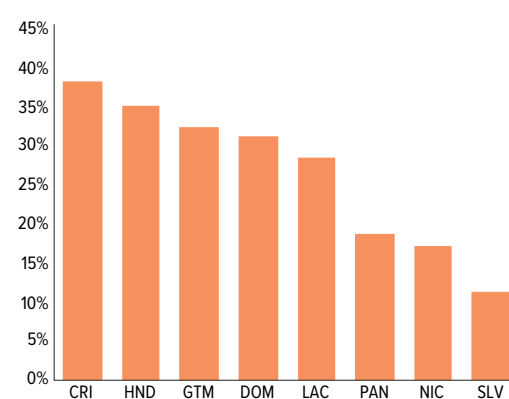


Source: World Development Indicators data, World Bank.

Note: Data are 2016 for Korea and 2018 for the OECD and the Dominican Republic. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; KOR = Korea; LAC = Latin America and the Caribbean; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

FIGURE 1.28: Firms Choosing Inadequate Education as Biggest Obstacle, 2016

Percentage of firms



Source: World Bank Enterprise Surveys 2010, 2016, 2017, 2023.

Note: Data are 2010 for Costa Rica and Panama; 2017 for Guatemala; and 2023 for El Salvador. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; LAC = Latin America and the Caribbean; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Recent labor market assessments and survey data from the region identify idiosyncratic challenges facing labor market demand in different CADR countries, but challenges for firms to enter the market, survive, and grow are common across countries. With the exceptions of Costa Rica and Panama, all CADR countries have new business entry rates well below the regional average and far below the rates of OECD countries and high-income Korea (figure 1.27). In the Dominican Republic, older, less productive firms dominate employment (Winkler and Montenegro 2021). In El Salvador and Nicaragua, small unproductive firms are responsible for most employment but struggle to grow (Banegas and Winkler 2020; Castro-Leal and Porras-Mendoza 2020). Across the region, firms that do enter tend to be informal and face high

formalization costs, while formal firms tend to be older and less productive and may develop market power that restricts entry (Eberhard-Ruiz 2021; OECD 2022a; Winkler and Montenegro 2021). The result is that most job creation occurs in the informal sector, where jobs are lower quality and less productive.

Challenges finding workers with the right skills are also common. A higher share of firms in Costa Rica, Honduras, Guatemala, and the Dominican Republic report an inadequately educated workforce as a major constraint compared with the LAC average (figure 1.28). Nearly half of employers reported difficulties finding new employees in 2019 in the Dominican Republic (USAID 2020). Labor market assessments done by USAID find skills constraints to be an important obstacle facing growth industries in the Dominican Republic, El Salvador, and Honduras (USAID 2017b, 2017c, and 2020). Even where firms are less likely to report inadequate education as a constraint, skills issues arise. For instance, lack of skills is less frequently cited as a barrier in El Salvador, though skills mismatch appears to undermine labor market demand (Banegas and Winkler 2020).

Chapter 2

The Labor Market Impacts of Technological Progress

This chapter defines the analytical framework used in the report. Technological progress holds great possibilities for growth, including growth that creates jobs. However, what people do at work (their tasks) and how they do it (their working arrangements) are almost certain to change as new technologies are adopted. Advanced economies offer a model for how the future of work will look in CADR, but important differences in development stages mean that the labor market impacts of technological progress are likely to be distinct now and in the near future. Employment structure, skills supply, the adoption and diffusion of technology, and globalization will all shape the impact of technological progress on labor markets in the region. Technology adoption abroad is likely to have its own impacts through changes in demand for labor that is embodied in the movement of goods (offshoring), the movement of people (migration), and the movement of services (digital trade in services).

SETTING THE STAGE: THE HISTORY OF THE FUTURE OF WORK

The kinds of jobs that people do have changed substantially over time. Many jobs that sound commonplace now—network engineer, internet developer, web designer—appeared only in the 1990s (Lin 2011). In fact, the majority of jobs done in the United States in 2018 did not exist in 1940 (Autor et al. 2022). Substantial changes have also occurred in what it means to do a certain job. Between 1950 and 2000, most—88 percent—of the changes in tasks in the United States’ labor market occurred *within* occupations and job titles (Atalay et al. 2020). That is, the work done by a manager, a machinist, or a cashier has evolved.⁴

Technological progress lies behind many of these changes. These labor market evolutions are closely linked to the adoption of computers, ICT, and other technological developments (Lin 2011; Atalay et al. 2018). This means that the future of work has arrived, at least in the most advanced economies.

The future of work seems to be more distant in other countries, including in CADR. As Chapter 1 showed, labor markets in CADR are better characterized by agricultural employment than by robot-assisted manufacturing. This means that learning lessons from technology’s impacts on the labor markets of the most advanced countries of the world requires understanding not only the technological potential to automate jobs in CADR but assessing the economic potential for new technologies to take hold and cause significant labor market disruptions. This chapter lays out a framework for understanding the potential labor market impacts of technological progress on CADR’s labor markets and the factors and channels that will determine whether and how these impacts emerge.

⁴ For further discussion of within-occupation changes in tasks, see Autor, Levy, and Murnane (2003), Michaels, Ruach, and Redding (2019), Ross (2017), and Michaels, Ruach, and Redding (2019) for the United States; Akcomak, Kok, and Romagosa (2016) for the United Kingdom; and Bachmann et al. (2022), Spitz-Oener (2006), and Koomen and Backes-Gellner (2022), and Bachmann et al. (2022) for Germany.

TECHNOLOGY'S LABOR MARKET IMPACTS: CHANGES IN WHAT WORKERS DO AND HOW THEY DO IT

Ongoing advancements in technology have prompted concern about widespread job displacement but also raised hopes for improvements in productivity and new innovations that could spur job creation.

Technological progress has the potential to cause significant disruption in labor markets. Advances first in agricultural and industrial machinery, then computers, and now AI have enabled machines to undertake a growing range of tasks previously done by humans, which puts jobs at risk. However, far from being a purely destructive force, technological progress and automation can also generate employment. Where markets are competitive, automation can create jobs as price declines linked to productivity improvements create higher demand (box 2.1). New technologies can also generate entirely new tasks, new types of jobs, and new industries. ICT can facilitate new types of working arrangements that are beneficial for both workers and firms. This creates concern that slow progress towards the future of work could mean missing out on the opportunities created by technological advancements.⁵

BOX 2.1: Competitive Markets and Technology Adoption

Competitive markets are a crucial ingredient for benefiting from technology adoption. The expansions in output that can result from technological improvements that increase productivity and that can result in job creation depend, in part, on how well prices respond to the lower costs linked to technology (Dutz, Almeida, and Packard 2018). Firms are more likely to respond with lower costs, leading to higher demand and output, when markets are competitive. A virtuous cycle can be created, as more competition is also linked to greater technology adoption. However, many markets in LAC are characterized by limited competition and the operation of cartels that undermine competitive pressures and so productivity as well (Licetti et al. 2021). Overly regulated product markets characterize Central America generally (Cirera, Cunha, and Lee 2022). In El Salvador and Honduras, taxes and subsidies as well as market concentration result in low competition. Policies that can help enhance the competitive environment include those that lower barriers to external trade, that facilitate domestic competition by avoiding regulatory distortions on firm entry and exit, and that increase access to finance.

Note: LAC = Latin America and the Caribbean.

No matter the ultimate impact on employment levels, technological progress is altering what people do at work and how they work. The deployment of technology in the workplace has two impacts on work. First, technology can add, eliminate, or change the tasks that employers demand and the skills that workers need to undertake these tasks.⁶ Second, technology can change how work is organized. To understand these two impacts, take the example of telephone operators.⁷ In the middle of the twentieth century, telephone operators physically routed telephone calls by inserting plugs into jacks. Computerization of switchboards eliminated the need for operators to undertake certain tasks—for example, manual switching—and as a result, changed the kinds of skills required for the job, with

5 Acemoglu and Restrepo (2019) formalizes these different potential labor market effects of technology as the *displacement effect* of (automation) technologies that substitute labor with capital, the *reinstatement effect* of (nonautomation) technologies that create new tasks with a comparative advantage for labor, and the *productivity effect* of (automation and nonautomation) technologies that permits more flexible allocation of tasks to factors of production. The first reduces the labor share of value added and the second increases the labor share of value added and labor demand and results in a positive productivity effect. The nature of the productivity effect determines the reinstatement effect's impact on labor demand. See also Acemoglu and Restrepo (2018). Agrawal, Gans, and Goldfarb (2019) undertake a similar exercise focused specifically on AI. Brynjolfsson and Mitchell (2017) define a set of "nontechnological factors" that mediate the labor market impacts of technology.

6 This perspective on tasks and skills follows Acemoglu and Autor (2011).

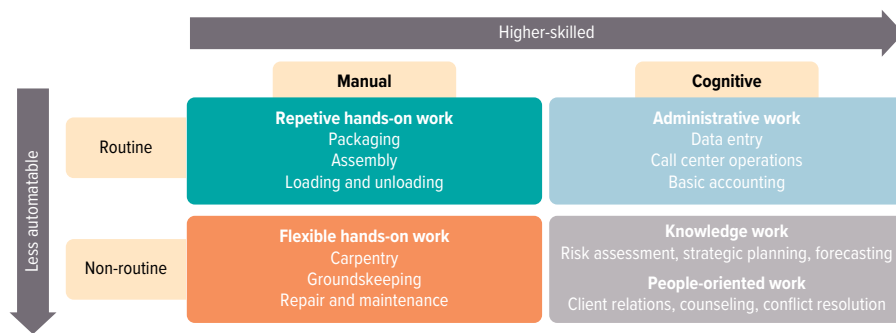
7 This example elaborates on the discussion of telephone operators in Bresnahan (1999).

interpersonal skills—communicating effectively with callers—becoming more important. Computerization also led to a substantial decline in the number of telephone operators. For example, in the United States, the number of operators fell from around 400,000 in the 1960s to around 4,000 in 2022. At the same time, the organization of telephone operators shifted, as computerization allowed for decentralization from a telephone company to individual businesses with in-house operators, some of which have now been replaced by voice-enabled chatbots. Notably, in the United States, current telephone operators experienced negative employment effects but future cohorts of the young women who were the most common telephone operators were not impacted but rather shifted to comparable jobs as typists and servers as demand increased in these areas (Feigenbaum and Gross 2022).

In a first stage of digitally enabled automation, computers facilitated the automation of routine tasks.

Certain types of tasks—routine ones—are more susceptible to automation by computers (Acemoglu and Autor 2011; Autor, Levy, and Murnane 2003). These routine tasks might be either cognitive (that is, involving thinking or analysis) or manual (that is, involving physical labor) but are suitable for automation because they “follow explicit programmed rules” and “can be exhaustively specified with programmed instructions and performed by machines.” Routine manual tasks can be thought of as repetitive hands-on work like packaging and assembly that requires recurring actions in circumstances that do not change much (figure 2.1). Routine cognitive tasks consist of administrative work like data entry that do not involve much problem solving or critical thinking. Nonroutine tasks, in contrast, “cannot at present be described in terms of a set of programmable rules” and so are less susceptible to automation (Autor, Levy, and Murnane 2003). Again, these could be higher-skilled cognitive or lower-skilled manual tasks. Nonroutine manual tasks involve flexible hands-on work like groundskeeping and maintenance that requires physical labor in varying settings. Nonroutine cognitive tasks may be either analytical, involving knowledge work like strategic planning or risk assessment, or interpersonal, involving people-oriented work like client relations or counseling. This model of routine-biased technological change predicts that as the costs of computing decline, repetitive hands-on and administrative jobs—that is, jobs that involve lots of routine manual and routine cognitive tasks—will decline as well.⁸

FIGURE 2.1: Classifying Tasks by Their Automatability



A second stage of digitally enabled automation raises concerns about displacement of the nonroutine tasks once thought safe from automation.

This second stage, driven by AI and mobile robotics⁹, has the potential to automate nonroutine tasks including high-skilled knowledge work like forecasting and high-skilled people-oriented work like counseling (Brynjolfsson and Mitchell 2017). For instance, the latest iteration of chatbots like ChatGPT allows users to make requests in natural language. A user might ask for

8 Routine-biased technological change is a more sophisticated version of skill-biased technological change. Skill-biased technological change posits that technological change augments the productivity (and wages) of high-skilled workers relative to less-skilled workers and so favors higher-skilled employment growth (Mondolo 2021; Katz and Murphy 1992; Sebastian and Biagi 2018).
 9 Mobile robots use sensors, artificial intelligence, and other technology to maneuver in order to perform nonroutine manual tasks (Frey and Osborne 2017).

programming code, courteous written invitations, or a short essay on an historical event and receive a rapid, plausible response. Automation of these tasks need not involve the explicit programmed rules that constrain automation under the traditional routine-biased task model. To acknowledge the expansion in computer capacity to undertake more complex tasks, Frey and Osborne (2017) created a new framework to evaluate the impact of technological progress in which only “engineering bottlenecks to computerization” hold back automation. These bottlenecks are tasks involving perception and manipulation (that robots struggle to undertake) and tasks involving creative and social intelligence (that computers struggle to undertake).

AI and mobile robotics seem to make most occupations susceptible to automation of at least some of their tasks. Research on the susceptibility of employment to automation finds that only 14 percent of employment is at high risk of automation in the OECD (Nedelkoska and Quintini 2018).¹⁰ Still, an additional 32 percent of jobs are at medium risk, meaning that they involve some tasks that will likely disappear because of automation. More recent literature focused specifically on AI emphasizes the disruption that AI is likely to bring *within* jobs.¹¹ For instance, Brynjolfsson, Mitchell, and Rock (2023) finds that nearly every occupation in the United States has some tasks that are suitable for machine learning, though no occupation consists of only these activities. Looking specifically at the subset of machine learning large language models called generative pretrained transformers (GPTs) of the type that underpins ChatGPT, Eloundou et al. (2023) estimates that about 80 percent of the workforce in the United States could have at least 10 percent of their tasks affected by GPTs. In short, the content of specific jobs is likely to change substantially because of AI and other new technological developments, even if entire jobs do not disappear.

Alongside these developments in digitally enabled automation, continued improvements in ICT are transforming how work is organized. Firms arise because they organize tasks that would otherwise be expensive to arrange using separate contracts (Coase 1937). Organizing production, supply chains, and workers via a firm’s physical infrastructure and internal organizational structure may involve lower transaction costs than coordinating remote workers or contracting work out. For example, jobs that involve teamwork, jobs that are difficult to monitor, and jobs that are intensive in manual tasks involve significant transaction costs that may make remote provision or contracting challenging (Mas and Pallais 2020).¹² However, technology lowers these transaction costs, in turn reshaping the boundaries of the firm. Moreover, the cost of these technologies themselves has generally been declining in recent decades making them more attractive (Oettinger 2011).

Two transformations in working arrangements are emerging. The *World Development Report 2019: The Changing Nature of Work* outlines how technology is remaking firms.¹³ First, improved ICT is reshaping the geographic boundaries of the firm by facilitating remote work. Jobs can be done outside of big cities and developed countries in places where labor and other costs are cheaper. Online labor markets for contract workers are already dominated by exchanges between developed and developing countries in which firms in the former employ workers in the latter (Agrawal et al. 2015). Second, the improved technology associated with platform work is reshaping the functional boundaries of the firm. Firms are increasingly able to contract tasks outside, including for tasks like software design or marketing that were previously done internally. Overall, investments in ICT are linked to less vertical integration, smaller firms, and greater reliance on (offshore) markets for purchase of services (Abramovsky and Griffith 2006; Brynjolfsson et al. 1989; Hitt 1999).

10 Frey and Osborne (2017) estimate that nearly half of employment in the United States is at high risk of automation. Results for other developed countries following the Frey and Osborne (2017) occupation-based methodology include 42 percent of employment in Canada (Lamb 2016); 35 percent in the United Kingdom (Deloitte 2014); and 33 percent in Singapore (CSF 2015). However, Frey and Osborne (2017)’s focus on occupations fails to account for differences in the automatability of tasks within occupations. Nedelkoska and Quintini (2018) addresses this concern. See also Arntz, Gregory, and Zierahn (2016) and Pouliakas (2018). The McKinsey Global Institute, the World Economist Forum, and PwC have also produced frequently cited measures of automatability using alternative methodologies (Manyika 2017a, 2017b; WEF 2018; PwC 2018).

11 For the analysis of AI generally, see Felten, Raj, and Seamans (2018); Felten, Raj, and Seamans (2021); Grace et al. (2018); Gries and Naudé (2022); Kogan et al. (2021); Lassébie and Quintini (2022); Martínez-Plumed et al. (2020); Meindl, Frank, and Mendonça (2021); Tolan et al. (2021); and Webb (2020). For analysis of machine learning specifically, see Brynjolfsson and Mitchell (2017) and Brynjolfsson, Mitchell, and Rock (2018, 2023). For analysis of generative pretrained transformers, a type of large language model, see Eloundou et al. (2023) and Felton, Raj, and Seamans (2023).

12 Remote work can also have negative externalities on other workers (Mas and Pallais 2020).

13 See also “How Technology Is Redrawing the Boundaries of the Firm,” *The Economist*, January 8, 2023.

TECHNOLOGY'S LABOR MARKET IMPACTS: THE EVIDENCE FROM ADVANCED ECONOMIES

In advanced economies, there is evidence of both job losses and jobs gains from these waves of technological progress. The process of routine-biased technological change described above is associated with job loss as automation replaces jobs and job gains as price declines linked to lower capital costs induce additional product demand and, in turn, additional labor demand (Autor 2022; Montobbio et al. 2022; Gregory, Salomons, and Zierahn 2022). A recent review of the empirical literature uncovers several themes (Montobbio et al. 2022).¹⁴ First, a set of studies finds that technological change has been associated with job loss in some areas, particularly in traditional manufacturing in the case of process innovations, but job gains in others, particularly in high-tech and knowledge-intensive industries where product innovations are more frequent. Second, recent research on the impact of robots finds that firms adopting robots tend to increase employment, but primarily by expanding at the expense of smaller and less innovative firms. This explains in part why, at the aggregate level, some studies find negative impacts of robots on employment (for example, Acemoglu and Restrepo 2020) while others find no negative impacts (for example, Graetz and Michaels 2018). Again, where negative impacts are found, they tend to be present in manufacturing. Third and finally, the firm and its level of innovation plays an important role in mediating the impacts of technological change. In general, more innovative firms that invest in new technologies tend to increase employment (Bessen, Denk, and Meng 2022; Hirvonen, Stenhammer, and Tuhkuri 2022).

The labor market impacts of technological change are felt most by less-skilled workers. Across different technologies and different measures of technological progress, high-skilled workers are found to benefit from technological change while less-skilled workers are found to lose out (Hötte, Somers, and Theodorakopoulos 2023). For instance, in many but not all developed countries, routine-biased technological change has led to employment polarization, which is a hollowing out of middle-skill jobs.¹⁵ Computers replace (low- and mid-skilled) jobs intensive in routine cognitive and manual tasks, complement (high-skilled) jobs intensive in more advanced nonroutine cognitive (analytical and interpersonal) tasks like problem solving and coordination, and in some countries, increase (low-skilled services) jobs intensive in basic nonroutine manual and cognitive tasks like dexterity and interpersonal communication (Autor and Dorn 2013; Autor et al. 2022; Autor, Levy, and Murnane 2003). While other factors, such as offshoring that moves routine (industrial) jobs abroad, have played a role, automation has generally been found to be dominant (Autor and Dorn 2013; Goos, Manning, and Salomons 2009; Goos, Manning, and Salomons 2014; Michaels, Natraj, and Van Reenen 2014).¹⁶ Inequality impacts are expected, given the larger impact on less-skilled workers (Berg, Buffie, and Zanna 2018; IMF 2018). Workers in routine jobs in the United States have lost wages, which is linked to increased wage inequality (Acemoglu and Restrepo 2022; Bachmann, Cim, and Green 2019; Cortes 2016; Ross 2017). The negative wage effects of robots in the United States are primarily concentrated at the bottom and middle of the wage distribution (Acemoglu and Restrepo 2020). The distribution of skills across geographies has implications for regional equity as well (box 2.2).

¹⁴ Mondolo (2021) and Hötte, Somers, and Theodorakopoulos (2023) are also recent literature reviews of the links between technological change and labor markets.

¹⁵ Employment polarization is found in the United States (Autor and Dorn 2013; Autor, Katz, and Kearney 2006, 2008); Canada (Green and Sand 2015); West Germany (Dustmann, Ludstock, and Schönberg 2009; Spitz-Oener 2006); the United Kingdom (Goos and Manning 2007); and Europe (Goos, Manning, and Salomons 2009, 2014; OECD 2017b; Oesch and Menés 2011). Employment polarization may lead to wage polarization in the case of additional demand for low-wage workers or additional wage inequality, for example, if displaced middle-skilled workers shift to lower-skilled jobs (Autor 2022). Findings of wage polarization are generally restricted to the 1990s in the United States (Autor and Dorn 2013; Autor, Katz, and Kearney 2008; Green and Sand 2015). Wage polarization is not found in Canada and Germany (Antonczyk, DeLeire, and Fitzenberger 2018; Dustmann, Ludstock, and Schönberg 2009; Green and Sand 2015; Koomen and Backes-Gellner 2022).

¹⁶ For additional evidence linking technological change to routine and nonroutine tasks, see Akerman, Gaarder, and Mogstad (2015); de Vries et al. (2020); Gaggl and Wright (2017); Michaels, Natraj, and Van Reenen (2014); and Spitz-Oener (2006).

BOX 2.2: Spatial Differences in the Labor Market Impacts of Technological Progress

Automation may benefit larger cities. In the United States, larger cities tend to be more specialized in the kinds of managerial and technical tasks that are less likely to be automated than smaller cities, which are more likely to experience disruption from automation (Frank et al. 2018). Indeed, the computer revolution in the United States shifted jobs to cities specialized in analytical and interactive skills, which tend to be present in larger cities (Berger and Frey 2016).

However, changes in working arrangements could work in the opposite direction, benefiting smaller cities to the detriment of larger ones. The kinds of jobs that are more suitable to remote provision tend to be concentrated in cities, meaning that more remote working possibilities could mean a shift away from the biggest cities. During the COVID-19 pandemic, for example, business services workers in very dense United States cities were more likely to work from elsewhere than workers in less dense cities (Althoff et al. 2022). This had knock-on effects for consumer services workers who rely on spending by business services workers to support their jobs (Althoff et al. 2022; Barrero, Bloom, and Davis 2021). Additionally, platform work can offer income-generating opportunities where jobs are lacking, as long as good digital infrastructure and digital devices are available. Recent World Bank research on online gig workers shows that around two-thirds of these workers in Latin America and the Caribbean are in small cities and towns (Datta, Namita and Chen 2023).

However, the latest advancements in AI may have different impacts across the skills distribution, including benefiting less-skilled workers. AI-linked technological changes may have more disruptive effects among high-skilled occupations. Recent research estimating the exposure of tasks to disruption by AI and machine learning generally finds that exposure is higher in higher-skilled, higher-wage occupations (Eloundou et al. 2023; Felten, Raj, and Seamans 2023; Meindl, Frank, and Mendonça 2020; Tolan et al. 2021; Webb 2020).¹⁷ Industries likely to be impacted include information processing, legal services, and securities and investments (Eloundou et al. 2023; Felten, Raj, and Seamans 2023). These sectors are typically associated with high-skilled knowledge work. Notably, recent research suggests that AI assistants increase the productivity of *less-skilled* workers within occupations, in effect substituting for worker education and experience (Agrawal, Gans, and Goldfarb 2023). This has been found in the case of customer support agents, taxi drivers, software developers, and college-educated workers completing writing tasks (Brynjolfsson, Li, and Raymond 2023; Kanazawa et al. 2022; Noy and Zhang 2023; Peng et al. 2023).

Other distributional impacts tend to be context specific. For instance, exposure to ICT in Europe between 2010 and 2018 was beneficial for young and prime-aged workers but bad for older women, while exposure to robots had adverse impacts on prime-aged men (Albinowski and Lewandowski 2022). Robot adoption in the United States has larger negative wage and employment effects on men than on women (Acemoglu and Restrepo 2020). Recent research shows that women who were initially more exposed to automation than men in the United States shifted to high-skill, high-wage occupations more than men (Cortés et al. 2023).

¹⁷ Brynjolfsson, Mitchell, and Rock (2023) find that both low- and high-wage jobs are suitable for machine learning but show a negative correlation between suitability and wage.

TECHNOLOGY'S LABOR MARKET IMPACTS: THE VIEW OUTSIDE OF ADVANCED ECONOMIES

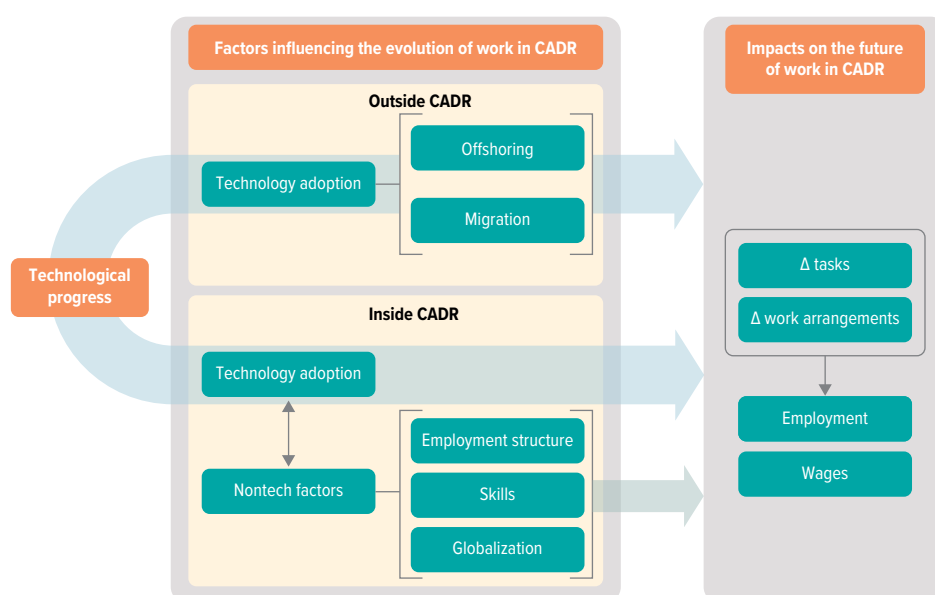
The applicability of this model of how technology impacts labor markets to CADR depends on several factors. Each of the technologies described above is available around the world. As a result, labor markets everywhere are susceptible to similar disruptions from technological progress. In fact, the relatively large share of less-skilled labor in developing countries means that a larger population may be at risk (Schlogl and Sumner 2018). However, several key factors beyond the existence of a technology determine its ultimate impact on labor markets. These factors include the adoption and diffusion of technology (Do people and firms use new technologies?) as well as employment structure (Do sectors that use technology dominate?), the supply of skills (Are there workers with skills that are complementary to technology?), and globalization (Is the economy open to technological influences?). Labor markets in developing countries are also susceptible to technological progress outside of their borders, which could occur even if technological progress is concentrated in just a few advanced economies, or even in a few superstar firms (Korinek, Schindler, and Stiglitz 2021). Technology adoption abroad may alter the demand for labor from developing countries that is embodied in the movement of goods (offshoring), the movement of people (migration), and the movement of services (digital trade in services).

Evidence of the impact of technological progress on employment in developing countries is mixed so far. In many parts of the world, declining computing costs have led to a decline in occupations intensive in routine manual and cognitive tasks (World Bank 2016). However, most developing countries do not show signs of the employment polarization that characterizes the United States and Western Europe (Maloney and Molina 2016; Maloney and Molina 2019; Martins-Neto et al. 2021). In Latin America there is evidence of growth in high-skilled jobs and loss of low-skilled jobs but not of the hollowing out of middle-skilled jobs except in Brazil and Mexico (Busso and Hincapié 2017; Maloney and Molina 2019; Messina and Silva 2018; Messina and Silva 2021). This is more consistent with skill-biased technological change (technology benefiting more highly skilled workers) than routine-biased technological change. Several recent studies have found evidence of a negative link between robots and employment in developing countries. Robots have been linked to lower employment and wages in China and more negative employment effects in developing than developed economies (Carbonero, Ernst, and Weber 2020; Giuntella and Wang 2019; Giuntella, Lu, and Wang 2022). In China, these effects are concentrated among less-skilled workers and are larger for male, prime-age, and older workers (Giuntella, Lu, and Wang 2022). However, positive impacts have been found in Indonesia and in cross-country research focusing on manufacturing operators and assemblers (Cali and Presidente 2021; Maloney and Molina 2019).

Results focused on technology generally have been more positive. Most firms in the 11 primarily developing economies surveyed by the World Bank's Firm-Level Adoption of Technology Survey report maintaining the same number of workers after adopting more sophisticated technologies (Cirera, Comin, and Cruz 2022). These firms also tend to generate more jobs and may even increase their share of unskilled workers. Cross-country research on adoption of digital technologies in the manufacturing sectors of 88 developing countries finds that adoption is labor augmenting (Cusolito, Lederman, and Peña 2020). Focusing on four countries in Latin America and the Caribbean, Dutz, Almeida, and Packard (2018) find that technological development leads to job growth, including of low-skilled workers, particularly when skills complementary to technology are in abundance. In Costa Rica, product innovation and process innovation are found to be linked to employment growth (Monge-Gonzalez et al. 2011).

The remainder of this report looks at the impact of adopting computers, robots, AI, and improved ICT at work on labor markets in CADR.¹⁸ The report focuses on these technologies as the most likely to shape labor markets in the region in the near future. It looks at technological progress both within and outside of the region. It first examines how technological progress within the region is shaping what workers do (their tasks) and how they do it (their working arrangements). The report goes beyond the typical analysis of susceptibility to automation to dissect the factors underlying recent labor market transformations and uncover the extent to which technological change has played a role. It also examines how technological progress outside of the region is shaping labor markets within it by investigating how robot adoption in the United States is affecting the demand for CADR workers working in CADR countries (by changing incentives for offshoring) and for those working in the United States (by changing demand for migrants). Figure 2.2 depicts the analytical framework described in the previous paragraphs.

FIGURE 2.2: The Labor Market Impacts of Technological Change in CADR



Note: CADR = Central America and the Dominican Republic.

¹⁸ Despite the focus on these three types of technology, previous waves of technological change like agricultural and industrial mechanization remain relevant in the region, particularly because the shift to nonfarm work expected from agricultural mechanization and improved agricultural inputs has been limited in several countries in CADR (FAO 2022). The report also focuses specifically on technologies that are used at work. Despite this, a broad set of home, health, and other technologies have important labor market impacts, particularly for women. Improved internet access has been shown to increase labor force participation and employment rates in developing countries (Chiplunkar and Goldberg 2022; Hjort and Poulsen 2019). Home appliances and contraception are linked to increased female labor force participation in Guatemala and other Latin American countries (Almeida and Viollaz 2022; Cubas 2016; Gasparini and Marchionni 2015). Similar results are found for developed countries. For the impact of home technologies, see Dettling (2017), Cavalcanti and Tavares (2008), Coen-Pirani, León, and Lugauer (2010), and Greenwood, Seshadri, and Yorukoglu (2005). For health technologies, see Bailey (2006), Albanesi and Olivetti (2016), and Goldin and Katz (2002).

Chapter 3

Technological Progress and Labor Market Transformation in CADR Countries

This chapter describes the impacts of technology on labor markets in CADR that are observable to date. Over the longer term, there is little evidence that technological progress has shifted employment away from the occupations that are most susceptible to automation, though trends towards the knowledge and people-oriented work that is less automatable are apparent in the last decade. Even with these shifts, employment in El Salvador, Guatemala, Honduras, and Nicaragua is much more intensive in routine, automatable tasks than other CADR countries and the United States. A large share of employment in every CADR country seems to be at risk of disruption from AI and robots, but this share is much lower once sectors with little technological penetration are excluded. Changes in working arrangements are apparent in CADR, but their extent is limited.

SETTING THE STAGE: TECHNOLOGICAL PROGRESS AND ITS EMPLOYMENT IMPACTS

Evidence from advanced economies shows labor markets in flux, but how technology is affecting labor markets in CADR is less certain. In advanced economies, technological progress is generating increased demand for cognitive and socioemotional skills, advanced technical skills, and digital skills. Automation is reducing the demand for workers to perform routine and even some knowledge and people-oriented nonroutine tasks. Working arrangements are shifting as digitization creates opportunities for people to work from home and to find work on job platforms. COVID-19 accelerated some of these trends, particularly the shift to new types of working arrangements. However, evidence for these trends is scarcer for CADR. This chapter looks at how tasks and working arrangements are changing in the region.

CHANGES IN TASKS

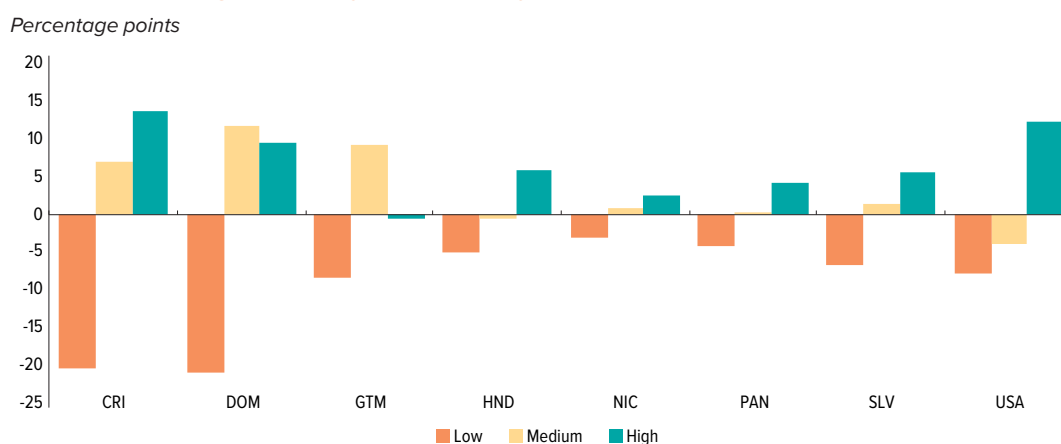
Certain types of tasks are more susceptible to disruption by computers, AI, and robots. Evidence of the impact of technological progress on labor markets can be observed in how occupations and tasks of different types evolve over time. Changes in tasks are observable in changes in occupational shares over time, as well as by breaking down occupations into different types of tasks that are more and less likely to be automated. This can be done for both computers, which automate routine tasks, and for AI and robots, which automate both routine and nonroutine tasks.

Changes in Tasks: Computerization

Long-term changes in occupations in CADR countries do not show signs of decline in jobs associated with routine, automatable tasks. The first wave of digitally enabled automation described in Chapter 2 involves rules-driven computers that are well suited to take on the routine repetitive hands-on and administrative work previously done by workers. Looking at census data for CADR countries permits

analysis of long-term employment shifts that may be related to technological change, though this can only be done for broad occupational categories. The data do not show evidence of a decline in the jobs most associated with routine, automatable tasks between the 1980s and the 2000s. For instance, employment generally increased for plant and machine operators and assemblers, an occupation typically considered to be intensive in routine tasks. Declines in crafts and related trades workers, another occupation typically considered to be routine-intensive, were observed in Costa Rica and El Salvador, but in none of the other CADR countries. Ordering occupations by their average skill level, proxied by average years of education in 1980, shows that no CADR country saw a substantial decrease in employment among mid-skilled occupations (figure 3.1). That is, unlike in advanced economies, changes in occupations in CADR countries during the last 30 years do not show signs of employment polarization. Instead, shifts in employment patterns are more consistent with so-called skill-biased technological change: employment changes were increasing in skill level.

FIGURE 3.1: Change in Employment Share by Skill Level, circa 1980s to circa 2000s



Source: [Minnesota Population Center 2020](#).

Note: The periods are 1984 to 2011 for Costa Rica, 1981 to 2010 for the Dominican Republic, 1981 to 2002 for Guatemala, 1988 to 2011 for Honduras, 1995 to 2005 for Nicaragua, 1980 to 2010 for Panama, 1992 to 2007 for El Salvador, and 1980 to 2010 for the United States. Occupations at the one International Standard Classification of Occupations (ISCO) one-digit ISCO-08 level are ranked by average years of education circa 1980 and combined into low (the three occupations with the lowest average years of education), high (the three occupations with the highest average years of education), and medium (the remaining occupations) skill levels. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

In more recent years, there is evidence of a shift away from the routine tasks that are easier to automate. Evidence from LAC shows that there has been a shift away from routine tasks and towards nonroutine ones across the region (Beylis et al. 2020; Gasparini et al. 2021). A similar pattern is evident in CADR countries. The routine task intensity (RTI) score measures how intensive employment is in routine tasks.¹⁹ The measure is standardized with respect to the value of the United States to allow for cross-country comparisons. The RTI shows that employment in all CADR countries except Costa Rica and Honduras became less intensive in routine tasks in the previous decade (figure 3.2a).

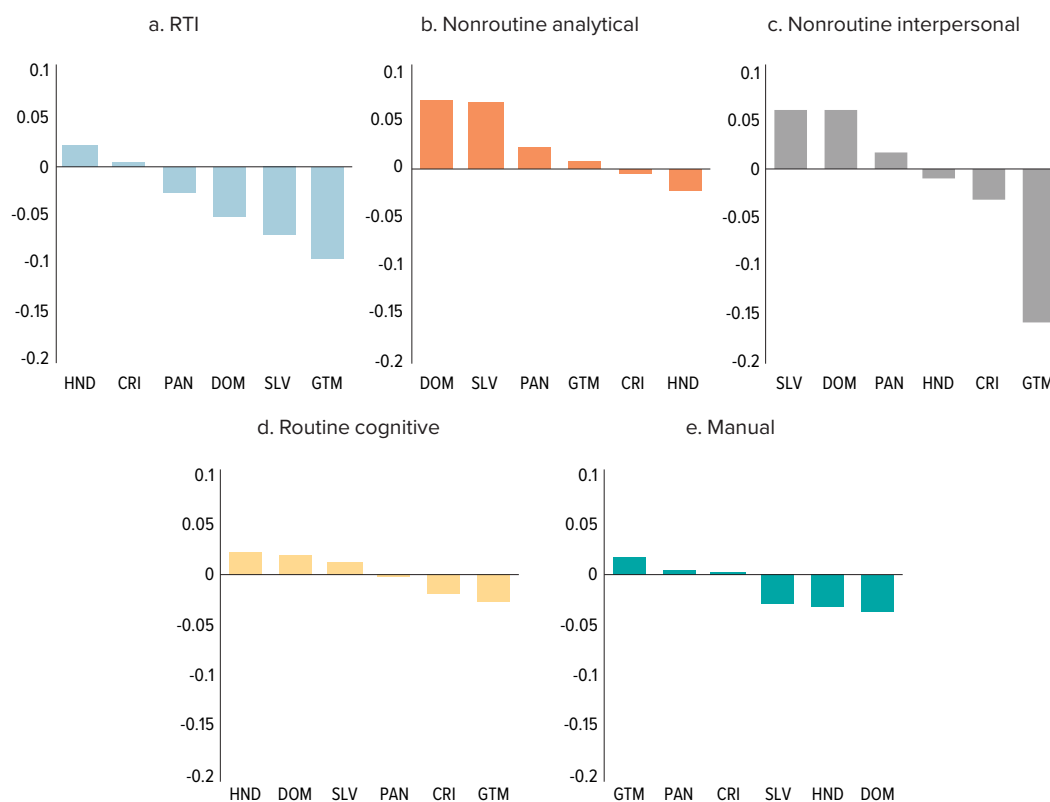
Employment became more intensive in knowledge and people-oriented tasks in many CADR countries. The routine intensity of occupations measured by the RTI can be broken down into different types of tasks: nonroutine analytical (knowledge work), nonroutine interpersonal (people-oriented work), and routine cognitive (administrative work) tasks. During the last decade, jobs became more intensive in nonroutine analytical tasks in all CADR countries except Costa Rica and Honduras and in nonroutine interpersonal tasks in all except Costa Rica, Guatemala, and Honduras (figure 3.2b and figure 3.2c). Routine cognitive

¹⁹ The RTI is constructed from data on tasks from the Program for the International Assessment of Adult Competencies (PIACC) and data on employment levels. See appendix B for a detailed description of the methodology to calculate the RTI.

tasks became more prevalent in three of the six countries with data available, though these increases were relatively small and were outweighed by the growing intensity of the nonroutine tasks (figure 3.2d). Manual tasks, which are not directly incorporated into the RTI because of the inability to distinguish routine from nonroutine ones in the available data, experienced relatively small changes (figure 3.2e).²⁰

FIGURE 3.2: Changes in the Routine Intensity of Work, 2011–19

Difference in RTI and task indexes



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

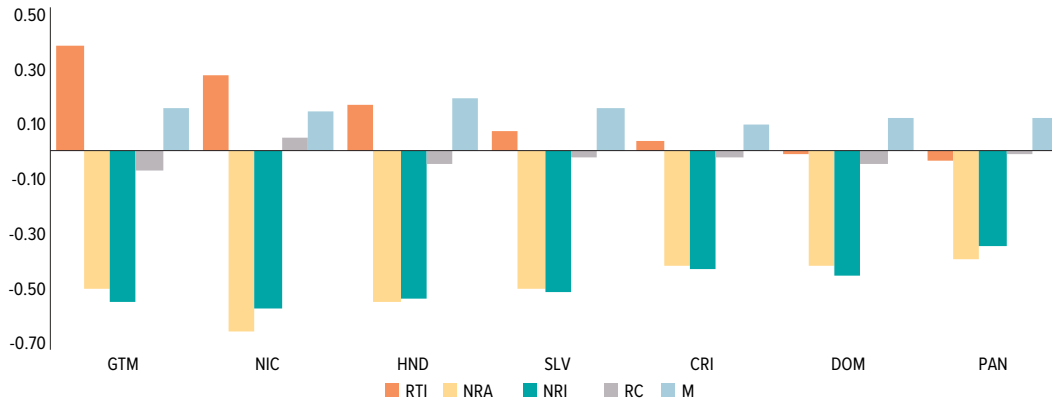
Note: The end year is 2018 for Panama. Nicaragua is excluded because of lack of available data. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; PAN = Panama; RTI = routine task intensity; SLV = El Salvador.

Despite these recent shifts, employment in the region remains intensive in routine work, particularly in CADR’s less developed countries. The RTI shows that employment in El Salvador, Guatemala, Honduras, and Nicaragua is much more intensive in routine tasks than employment in the United States as well as that in the other CADR countries (figure 3.3). While differences in the intensity of routine cognitive tasks (administrative work) are small across countries, all CADR countries show a much lower prevalence of nonroutine analytical and interpersonal tasks (knowledge and people-oriented work) than the United States, with particularly large differences in El Salvador, Guatemala, Honduras, and Nicaragua. In these four countries, the size of the differences and the size of the workforce in nonroutine-intensive employment means a much higher RTI and more routine employment overall. Manual tasks are more prevalent than in the United States in all CADR countries.

²⁰ These results are generally consistent with previous studies that include CADR countries (Banegas and Winkler 2020; Winkler and Montenegro 2021; World Bank 2022b). See appendix B for a comparison.

FIGURE 3.3: RTI and Task Intensity of CADR Countries, 2021

Standard deviations from the United States' average



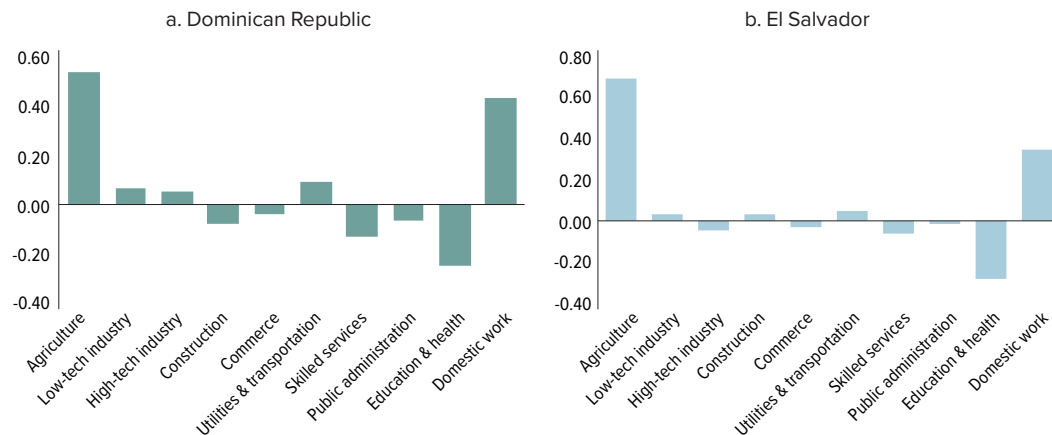
Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras, 2018 for Panama, and 2014 for Nicaragua. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; M = manual; NIC = Nicaragua; NRA = nonroutine analytical; NRI = nonroutine interpersonal; PAN = Panama; RD = routine cognitive; RTI = routine task intensity; SLV = El Salvador.

Jobs with routine tasks are most common in agriculture and domestic work and less common in education and health. In all CADR countries with data available, agriculture and domestic work have the highest RTI (figure 3.4a–f). Employment in these sectors tends to be less intensive in nonroutine cognitive tasks. On the other extreme, employment in education and health is less routine. Public administration is also among the least routine intensive sectors, especially in Nicaragua and Panama.²¹

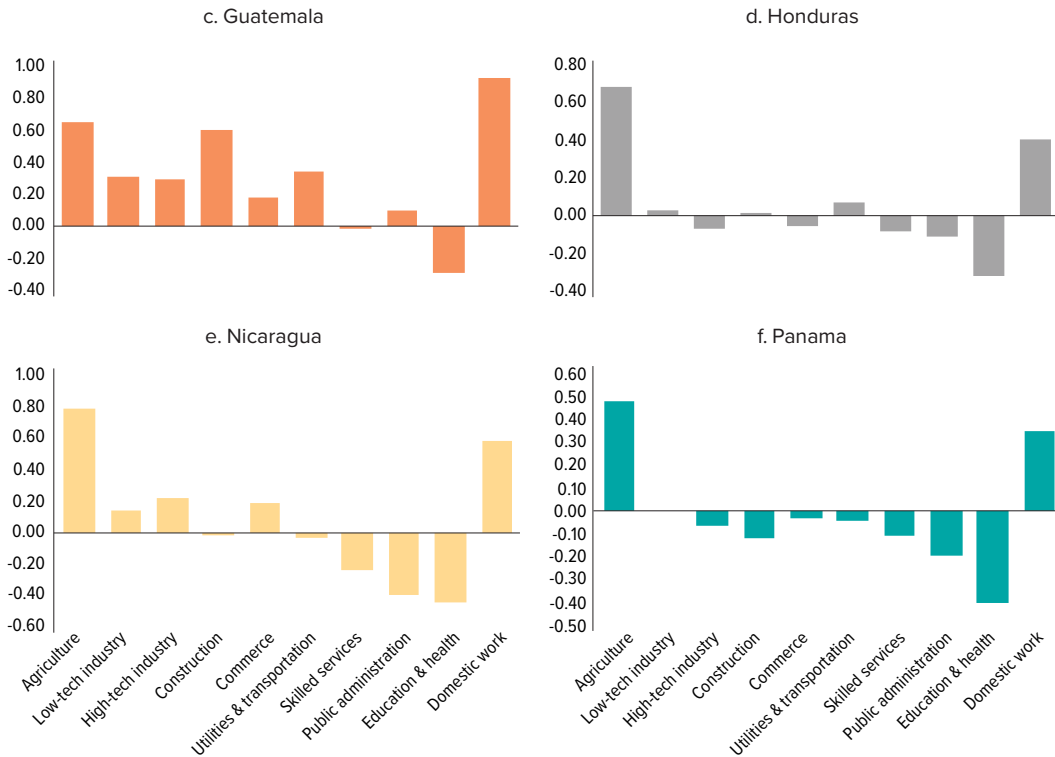
FIGURE 3.4: RTI by Economic Sector, 2021

Standard deviations from the United States' average



21 In general, these patterns are consistent with previous findings for other LAC countries (Gasparini et al. 2021).

FIGURE 3.4: RTI by Economic Sector, 2021 (continued)



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.
 Note: The year is 2019 for Guatemala and Honduras, 2018 for Panama, and 2014 for Nicaragua. Sector is not available for Costa Rica. RTI = routine task intensity.

Male, young, less-educated, and rural workers tend to be employed in more routine-intensive jobs.

When looking at the sociodemographic characteristics of workers, some consistent patterns emerge. Men, young workers, and those in rural areas are more likely to be employed in jobs that are more routine intensive (figure 3.5a–c). Workers with low and medium levels of education are employed in jobs that are more routine intensive than more highly educated workers (figure 3.5d).²² The disaggregation by type of employment, in contrast, does not show a consistent pattern across countries (figure 3.5e).

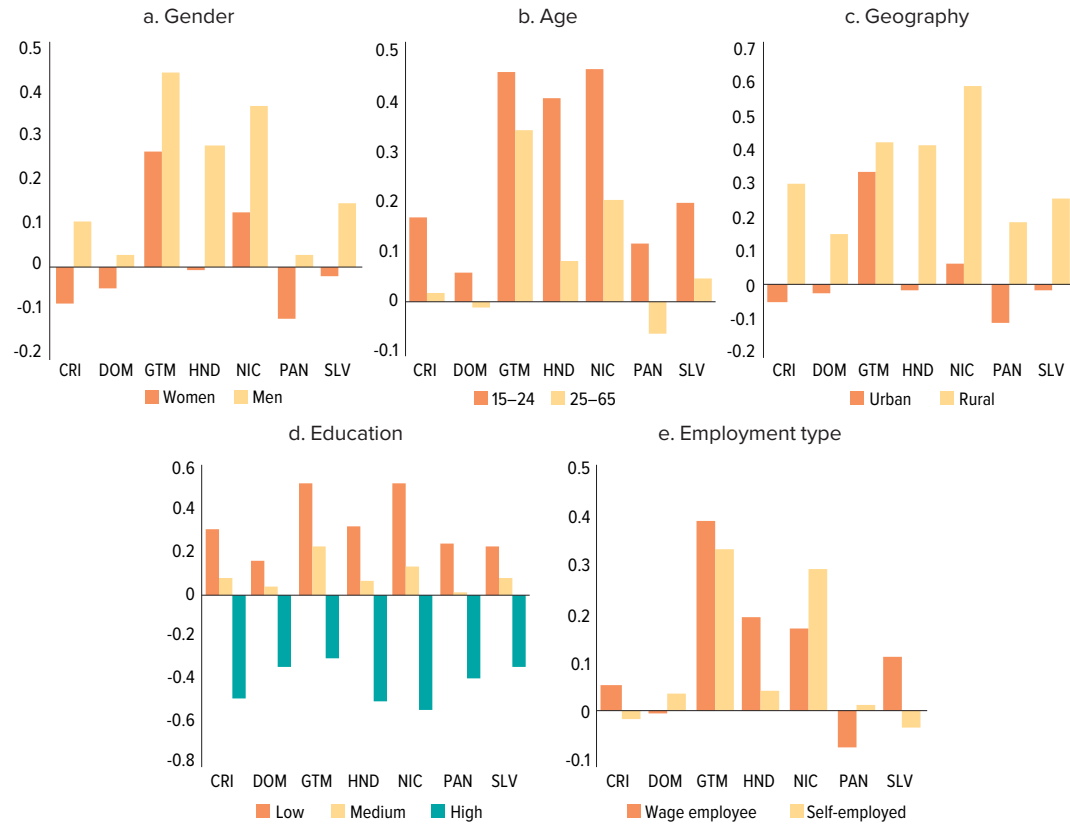
Jobs that are intensive in nonroutine tasks have higher returns.

Regression estimates show that nonroutine analytical and interpersonal tasks (knowledge and people-oriented work) contribute positively to hourly wages in all CADR countries (figure 3.6a–b).²³ This finding is in line with previous literature for developed and developing countries (Saltiel 2020; Autor and Handel 2013). The expected increase in hourly wages from an increase of half a standard deviation in the RTI ranges from 21 percent in El Salvador to 35 percent in Nicaragua for nonroutine analytical tasks and from 23 percent in the Dominican Republic to 36 percent in Honduras for nonroutine interpersonal tasks. The returns to routine cognitive tasks (administrative work) are not statistically significant (and so are not shown). Manual tasks, in contrast, have negative returns in all countries except the Dominican Republic where the expected change in hourly wages is very close to zero and not statistically significant (figure 3.6c).²⁴

22 This pattern is consistent with previous evidence for Argentina, Brazil, Chile, Colombia, Mexico, and Peru (Gasparini et al 2021).
 23 This finding is in line with previous literature for developed and developing countries (Saltiel 2020; Autor and Handel 2013).
 24 The finding on returns to manual tasks differs from Saltiel (2020), which finds a positive return to manual tasks in a set of nine low- and middle-income countries using STEP data. Saltiel (2020) uses variation at the individual level, while we use variation at the occupation level.

FIGURE 3.5: RTI by Sociodemographic Characteristics, 2021

Standard deviations from the United States' average

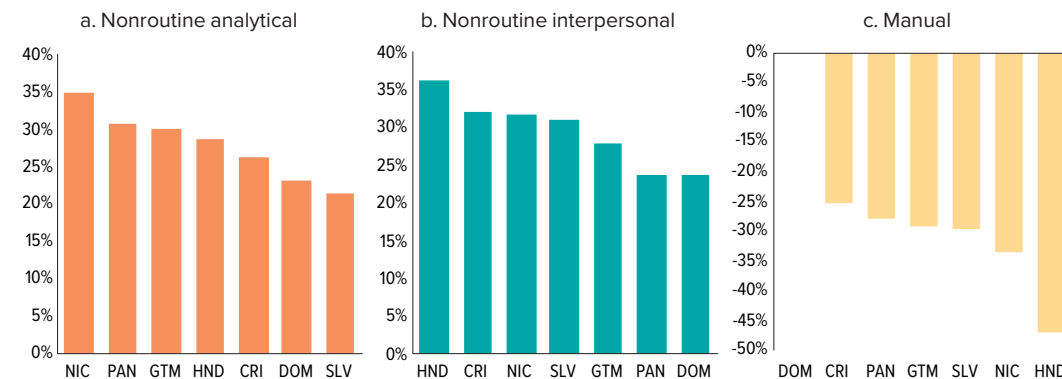


Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The year is 2019 for Guatemala and Honduras, 2018 for Panama, and 2014 for Nicaragua. Low education is less than 9 years of school, medium is between 9 and 13 years, and high is 14 or more. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; RTI = routine task intensity; SLV = El Salvador.

FIGURE 3.6: Returns to Routine and Nonroutine Tasks, 2010s

Percentage change in hourly wages from a 0.5 SD change in the task measure



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

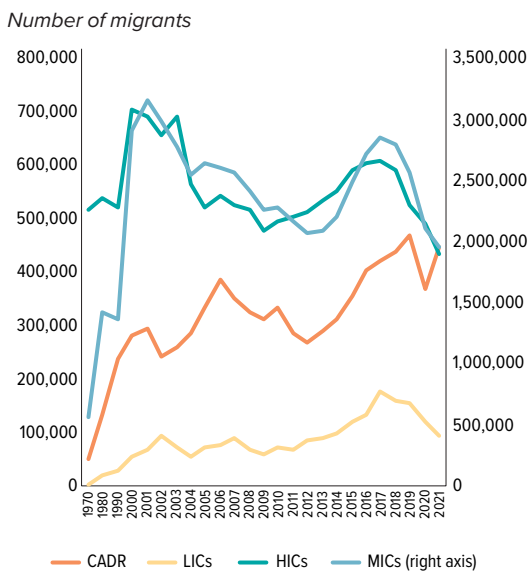
Note: Models are estimated by ordinary least squares (OLS) controlling for gender, age and its square, indicators for educational level, and year fixed effects. Each bar shows the expected percentage change in hourly wages due to a change in the task measure equal to 0.5 standard deviations of the corresponding task measure in each country. All models include years with comparable data for each country: 2011 to 2021 for Costa Rica; 2017 to 2021 for the Dominican Republic; 2013 to 2021 for El Salvador; 2010 to 2015 and 2017 to 2019 for Guatemala; 2015 to 2019 for Honduras; 2010 to 2012 for Nicaragua; and 2011 to 2014, 2016, and 2018 for Panama. Robust standard errors are clustered at the country and International Standard Classification of Occupations (ISCO) two-digit occupation level. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SD = standard deviation; SLV = El Salvador.

Computerization and CADR Workers in the United States

The importance of CADR migration means that some CADR workers are exposed to the impacts of technology on labor markets in advanced economies, particularly in the United States. Chapter 1 briefly introduced the substantial role that migration, especially to the United States, plays for CADR countries. This means that some CADR workers have been a part of the significant transformation of labor markets described in Chapter 2. This section looks specifically at whether CADR workers in the United States have experienced the same kinds of labor market impacts as other migrant groups and as nonmigrant United States workers.

Migration to the United States from CADR countries has risen over time and CADR migrants now make up about 15 percent of all recent migrants to the United States. Between 1970 and 2000, there was a sharp increase in migrants to the United States from all countries including CADR countries (figure 3.7). Since the 2000s, migration from low-income countries generally increased until 2017, after which migration declined, while migration from middle- and high-income countries declined during most of this period. Migration from CADR countries, in contrast, increased sharply throughout the entire 2010s, and except for a COVID-19-related drop in 2020, did not experience a decline after 2017 as occurred in every other country group. In 2021, there were nearly 450,000 migrants from CADR in the United States who had arrived in the last three years and around 1.3 million who had arrived in the last decade.²⁵ This represents about 15 percent of total migrants of both types in the United States. CADR migrants make up about 0.2 percent of the working age population versus 0.04 percent for migrants from low-income countries, 0.9 percent for other middle-income countries, and 0.2 percent for other high-income countries.

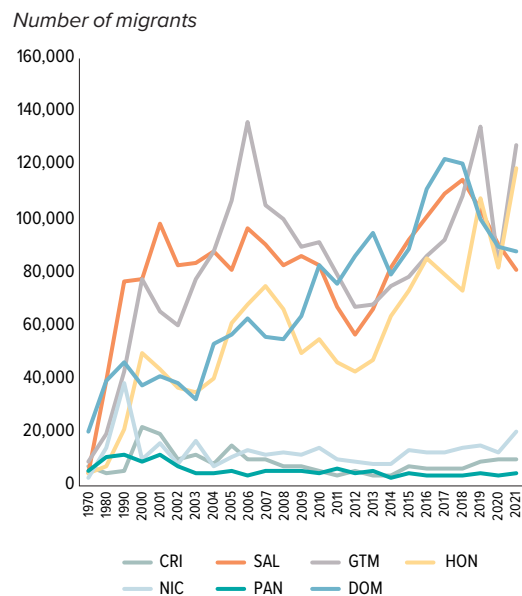
FIGURE 3.7: Three-Year migrants in the United States, 1970–2021



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.

Note: CADR = Central America and the Dominican Republic; HICs is high-income countries; LICs = lower-income countries; MICs is middle-income countries.

FIGURE 3.8: Three-Year CADR Migrants in the United States, 1970–2021



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.

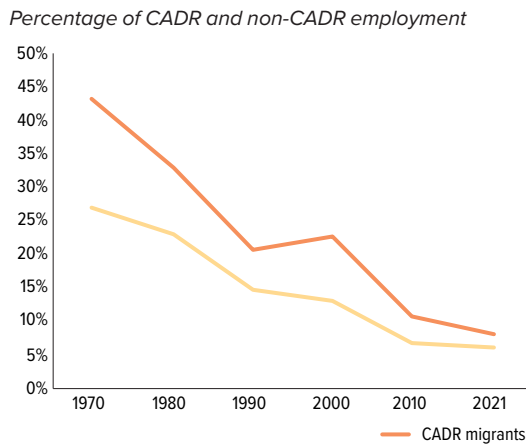
Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

25 The remainder of the analysis will focus on three-year migrants, as trends are very similar between the two groups.

The Dominican Republic, El Salvador, Guatemala, and Honduras are the main senders of migrants to the United States among CADR countries. These four countries have been responsible for more than 90 percent of the migrants from CADR countries since the early 2000s. During this period, migration from all four countries generally increased (figure 3.8). Migrants from CADR countries are younger than those from other countries (30 versus the mid-30s). Nearly half are women. Most have less than secondary education. This educational pattern has been fairly stable over time, though the share of migrants with secondary education has increased slightly. In contrast, the skill level of migrants from other countries has increased substantially over time: at least 30 percent of migrants from low-, middle-, and high-income countries have tertiary education versus 13 percent in CADR countries.

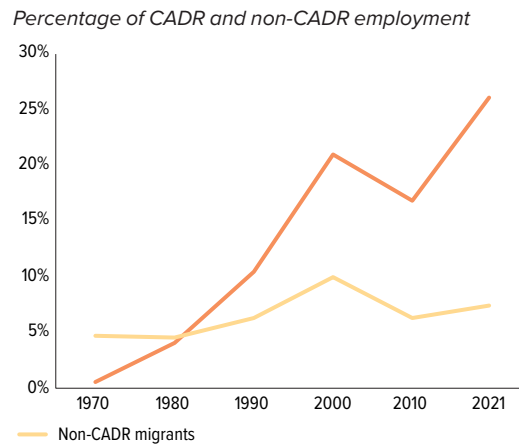
Migrants from CADR and non-CADR countries have shifted out of jobs that involve routine tasks. During the last 50 years, migrants from CADR countries have been concentrated in just a few less-skilled occupations.²⁶ Migrants from non-CADR countries are less concentrated and have substantial shares of workers in high-skilled jobs.²⁷ Employment in manufacturing jobs declined precipitously for CADR migrants in the last 50 years from nearly 50 percent of employment in 1970 to 8 percent in 2021, consistent with the automation of routine manual tasks (repetitive hands-on work) (figure 3.9). This decline also occurred among non-CADR migrants, but manufacturing jobs made up a much smaller share of their jobs in 1970, meaning that the overall shift was less drastic. Employment in office and administrative support jobs, which are intensive in routine cognitive tasks, also declined for both CADR and non-CADR migrants.

FIGURE 3.9: Employment of Three-Year Migrants in Manufacturing Jobs in the United States, 1970–2021



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.
Note: CADR = Central America and the Dominican Republic.

FIGURE 3.10: Employment of Three-Year Migrants in Construction Jobs in the United States, 1970–2021



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.
Note: CADR = Central America and the Dominican Republic.

CADR migrants shifted into jobs intensive in nonroutine manual tasks while non-CADR migrants shifted into higher-skilled knowledge jobs. Employment in construction occupations, which are intensive in nonroutine manual tasks, increased sharply among CADR migrants and is now the top occupational group by employment share (figure 3.10). In contrast, there has been little change in employment in construction among non-CADR migrants. Employment also increased for CADR migrants in several other occupations intensive in nonroutine manual tasks including food preparation and serving, building and grounds cleaning, and transportation and material moving. Non-CADR migrants generally saw more

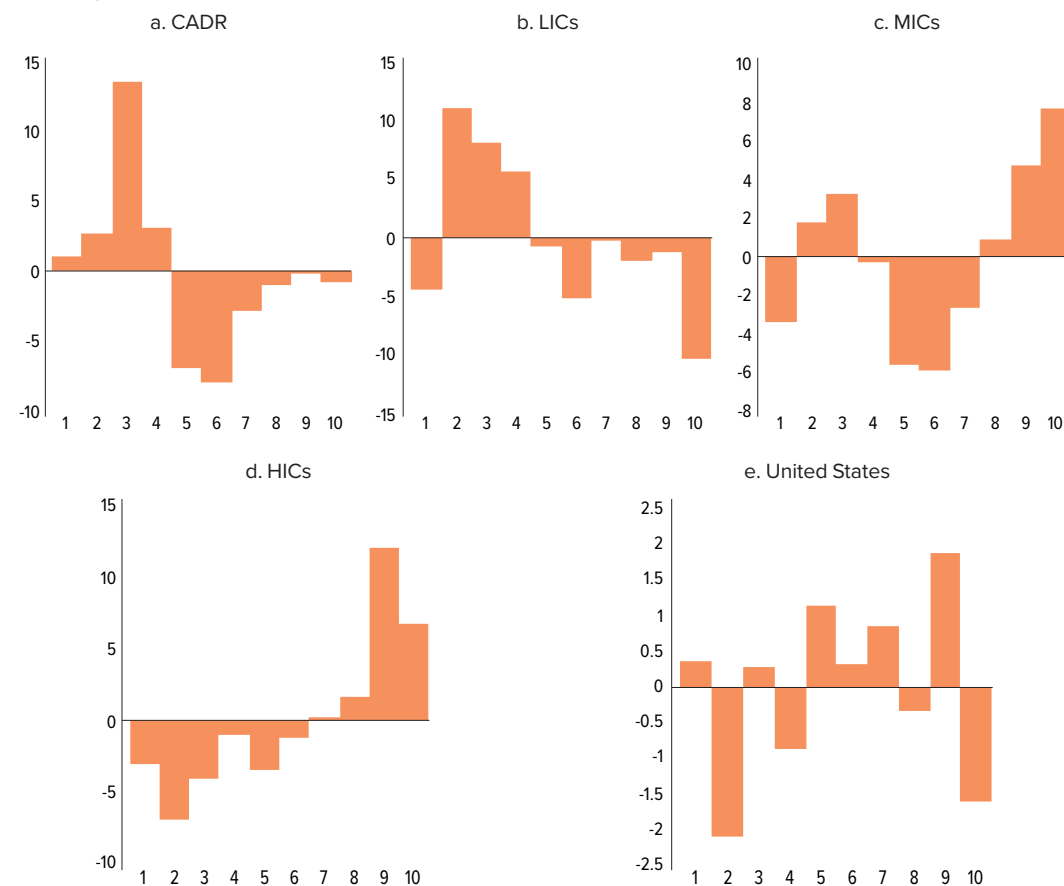
26 These occupations have made up 5 percent or more of employment at least once during this period. These are food preparation and serving, building and grounds cleaning, sales, office and administrative support, construction, production, and transportation and material moving.
27 These include management, computer and mathematics, and education jobs.

-muted employment increases in these occupations while experiencing employment growth in higher-skilled occupations as well, including in management, computers and mathematics, and education.

CADR migrants contributed to the expansion in low-skilled employment observed in the United States in the last several decades—one side of employment polarization in the United States—but did not contribute to the expansion in high-skilled employment—the other side of polarization. CADR migrants have shifted strongly from middle- to low-skilled jobs, unlike the pattern observed for migrants from other middle- and high-income countries and for nonmigrant US workers (figure 3.11a–e). In fact, CADR migrants and migrants from lower-income countries are responsible for much of the increase in low-skilled employment observed in the United States in recent decades. This is consistent with recent research showing that offshoring and automation in the United States has increased demand for low-skilled services that are intensive in nonroutine manual tasks (Mandelman and Zlate 2022). Migrants from other middle- and high-income countries, on the other hand, have benefited from the same complementarity between technology and skills that nonmigrant United States workers have enjoyed. The importance of CADR migrants and of migrants from low-income countries is such that the picture of routine-biased technological change becomes much murkier for nonmigrant US workers (figure 3.11e).

FIGURE 3.11: Change in Employment Share by Skill Level of Three-Year Migrants and United States Nonmigrants in the United States, 1980–2021

Percentage points



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.

Note: Employment shares are calculated for each occupation and year and then ordered in 1 percent bins by mean occupational wage. These bins are then summed to 10 percent bins. CADR = Central America and the Dominican Republic; HICs = high-income countries; LICs = lower-income countries; MICs = middle-income countries.

Overall, employment of CADR migrants is evolving away from routine tasks and becoming somewhat more intensive in the flexible hands-on and people-oriented work common in construction and services. The task-based measures of routine and nonroutine employment described earlier in the chapter provide a summary picture of the changing composition of the employment of CADR workers in the United States. Since 1970, the employment of nonmigrant US workers and migrants from middle- and high-income countries has become more intensive in nonroutine interpersonal and nonroutine analytical tasks (knowledge and people-oriented work) and less intensive in routine cognitive and manual and nonroutine manual tasks (administrative, repetitive hands-on, and flexible hands-on work) (figure 3.12c–e). The employment of migrants from CADR countries (and from low-income countries), in contrast, has become *more* intensive in nonroutine manual tasks (flexible hands-on work) (figure 3.12a–b). In sum, technological progress in the United States seems to be pushing CADR workers towards less-skilled services and construction sector jobs where nonroutine manual and interpersonal tasks dominate.

FIGURE 3.12: Evolution of the Task Content of Three-Year Migrants in the United States, 1970–2021



Sources: ACS 2000–2021; US Census 1970, 1980, 1990.

Note: CADR = Central America and the Dominican Republic; HICs = high-income countries; LICs = lower-income countries; MICs = middle-income countries; NR = nonroutine; R = routine.

Patterns are similar across gender and country of origin with a few notable exceptions. The increase in nonroutine manual tasks is only apparent for male migrants from CADR: women have only experienced an increase in the intensity of employment in nonroutine interpersonal tasks (figure 3.13a–b). This is consistent with the growth in construction employment among CADR workers being heavily biased towards men.

Focusing on the four CADR countries with the most migrants in the United States, employment has become more intensive in nonroutine interpersonal tasks among migrants from all of them and in nonroutine manual tasks among migrants from all except the Dominican Republic (figure 3.13c–f). Nonroutine analytical skills have become more important for migrants from El Salvador, while routine manual skills have become more important for migrants from Guatemala. In the case of El Salvador, these changes relate to growth in occupations like education and training, management, and business, and a related increase in migrants with tertiary education. Guatemala shows nearly the opposite picture: employment increased in construction occupations while the educational level of migrants from Guatemala declined.

FIGURE 3.13: Evolution of the Task Content of Three-Year CADR Migrants by Gender in the United States, 1970–2021

Task index (1970 = 0)

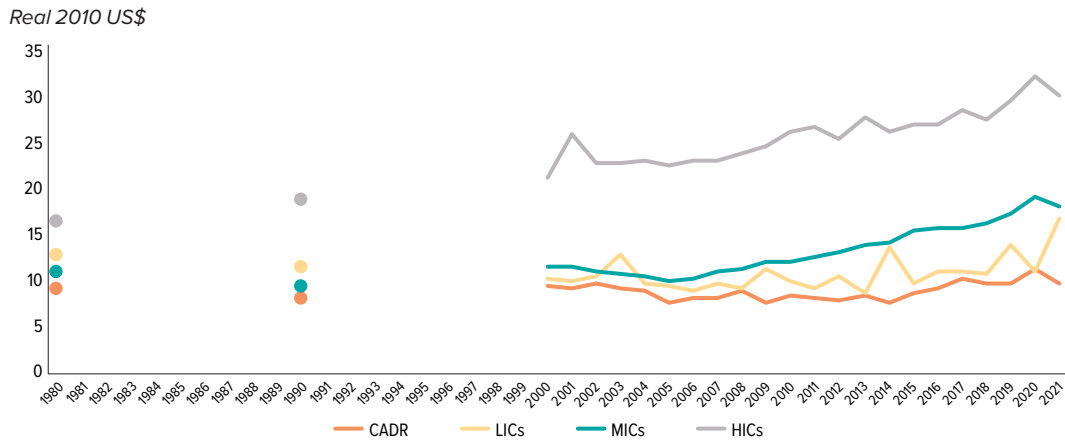


Sources: ACS 2000–2021; US Census 1970, 1980, 1990.

Note: NR = nonroutine; R = routine.

Wages of CADR migrants have barely increased since 1970. The growing predominance of CADR migrants in low-skilled (low-paid) occupations is apparent in the lack of wage growth of this group (figure 3.14). Real wages have grown 12 percent for CADR migrants since 1970 and only 3 percent since 1990. This contrasts with growth of 62 percent, 55 percent, and 41 percent for migrants from low-, middle-, and high-income countries, respectively. This suggests that on one hand, technological progress in the United States has created additional employment opportunities for CADR migrants. On the other hand, these opportunities are in less-skilled jobs, and the growing supply of comparable low-skilled CADR workers may have increased competition, depressing wage growth.

FIGURE 3.14: Average Hourly Wage of Three-Year Migrants in the United States, 1980–2021

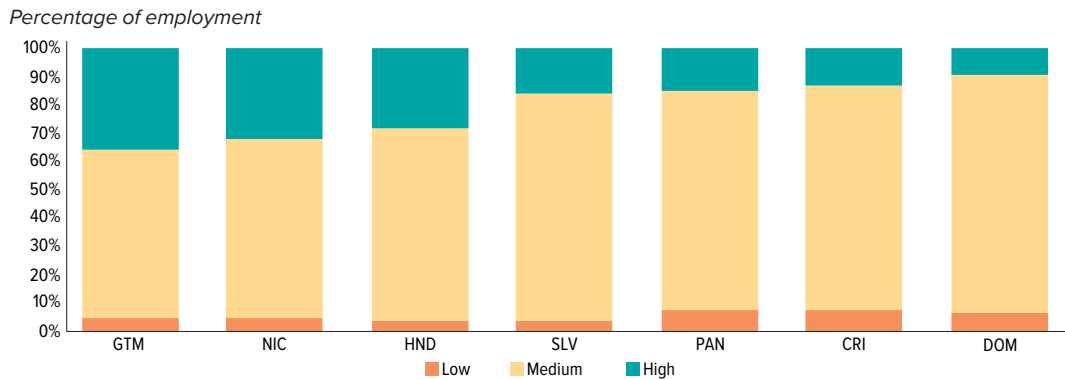


Sources: ACS 2000–2021; US Census 1970, 1980, 1990.
 Note: CADR = Central America and the Dominican Republic; HICs = high-income countries; LICs = lower-income countries; MICs = middle-income countries.

Changes in Tasks: Artificial Intelligence and Mobile Robotics

Estimates of the *susceptibility* of employment to the latest technological developments suggest that a substantial share of jobs is at risk of disruption. The second wave of digitally enabled automation described in chapter 2 involves AI and robots that are capable of doing both routine and nonroutine tasks. Because these technologies are nascent, research in this area tends to involve prospective measures of what AI and robots could do. These measures are calculated in a similar manner to those used to identify the routine and nonroutine tasks suitable for computerization. Tasks are identified that AI and robots are unlikely to be able to carry out, enabling an estimation of the share of workers doing tasks that are likely to be automated. Using this approach, between 9 and 36 percent of workers are at high risk of automation in CADR countries (figure 3.15).²⁸ However, nearly all workers in all CADR countries are at least at medium risk, meaning that some tasks they undertake are likely to disappear or change substantially. This contrasts with the OECD where 14 percent of jobs are at high risk and 46 percent are at least at medium risk.

FIGURE 3.15: Susceptibility of the Workforce to Automation, 2021



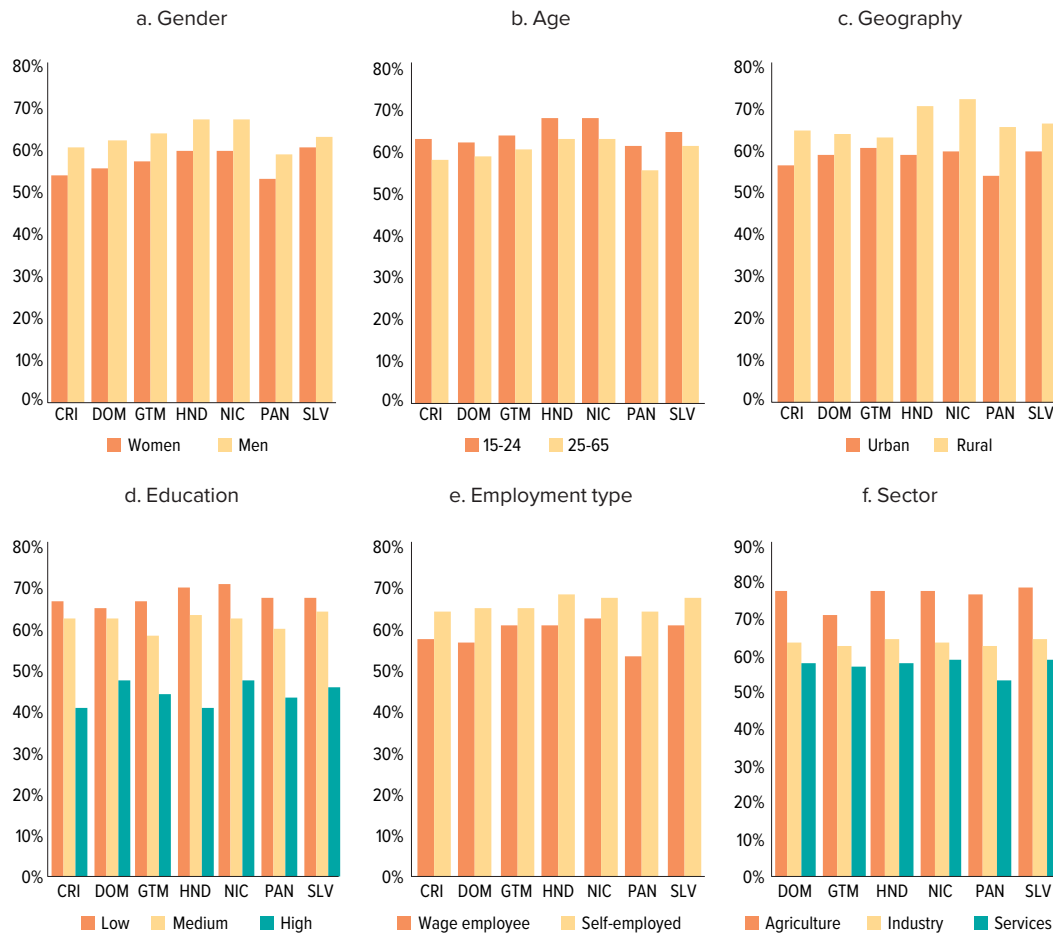
Sources: Frey and Osborne 2017; SEDLAC (CEDLAS and The World Bank); PIAAC 2017.
 Note: The years are 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. The risk of automation is calculated according to the task-based approach in Arntz, Gregory, and Zierahn (2016) and Egana del Sol et al. (2022). Low risk is a probability of automation that is 30 percent or less; medium is above 30 but below 70 percent; and high is 70 percent or above. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

28 See appendix C for a detailed description of the methodology to calculate the probability of automation.

Male, young, less-educated, and rural workers have a higher risk of automation. In all CADR countries, the occupations where women, adult, and urban workers are employed and the tasks they perform at work result in a lower average risk of automation compared to men, younger, and rural workers (figure 3.16a–c). The average risk of automation declines with education and is lower for wage employees than self-employed workers (figure 3.16d–e). The services sector has the lowest risk of automation among economic sectors while agriculture has the highest (figure 3.16f).

FIGURE 3.16: Probability of Automation by Sociodemographic Characteristics, 2021

Percentage average probability



Sources: Frey and Osborne 2017; SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

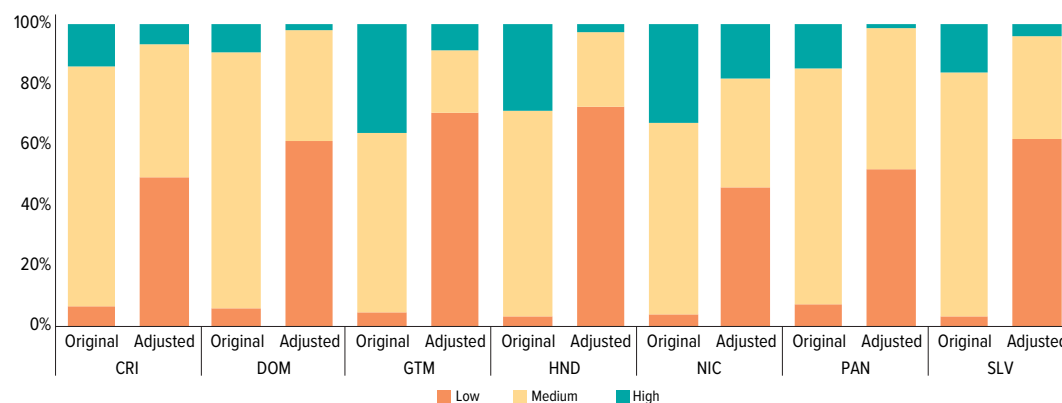
Note: The years are 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. The risk of automation is calculated according to the task-based approach in Arntz, Gregory, and Zierahn (2016) and Egana del Sol et al. (2022). Low risk is a probability of automation that is 30 percent or less; medium is above 30 but below 70 percent; and high is 70 percent or above. Low education is less than 9 years of school, medium is between 9 and 13 years, and high is 14 or more. Data on sector is not available for Costa Rica. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

However, the susceptibility of employment to automation in CADR countries is much less dire when small corrections are made for factors that might interrupt the translation of potential labor market impacts of technological progress into actual impacts. As described in chapter 1, CADR countries are characterized by high rates of informal employment and high rates of self-employment. These large informal and self-employed workforces reflect private sectors that have less mature organizational structures. These sectors also tend to be less capital-intensive and so less affected by technological

advancement (Weller, Gontero, and Campbell 2019). When workers in these sectors are excluded from measures of the probability of automation, exposure to displacement by automation technologies declines substantially (figure 3.17).²⁹ The share of workers at low risk of automation rises from single digits in the original measure to about half in all countries.

FIGURE 3.17: Share of Jobs at High Risk of Automation, Original and Adjusted Measures, 2021

Percentage



Sources: Frey and Osborne 2017; SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras; 2018 for Panama; and 2014 for Nicaragua. The risk of automation is calculated according to the task-based approach in Arntz, Gregory, and Zierahn (2016) and Egana del Sol et al. (2022) and then adjusted following Weller et al (2019). Low risk is a probability of automation that is 30 percent or less; medium is above 30 but below 70 percent; and high is 70 percent or above. The adjustment assigns a risk of automation equal to zero to workers in low-productivity sectors defined as self-employed workers with less than college education, wage employees and employers in small firms, domestic workers, and workers who do not receive a labor income. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

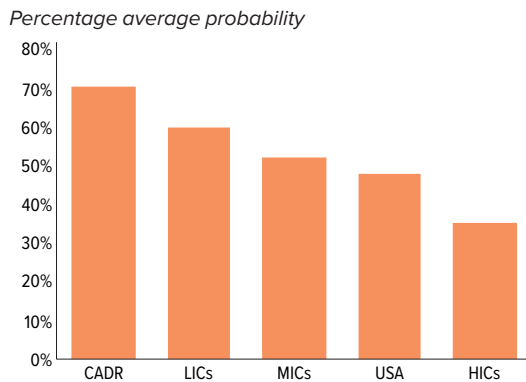
Artificial Intelligence, Mobile Robotics, and CADR Workers in the United States

CADR migrants in the United States are at greater risk of automatability than nonmigrants and migrants from other country groups, but at much lower risk from the latest advances in artificial intelligence. The average probability of automation is around 70 percent for migrants from CADR countries, the highest among all migrant groups and substantially higher than the risk of US nonmigrant workers (figure 3.18).³⁰ This suggests that CADR migrants will likely continue experiencing labor market disruptions of the kind they have experienced in the last several decades in the United States. However, CADR migrants are unlikely to be as affected by the latest advances in AI. The exposure of CADR migrants to GPTs like ChatGPT is lower than that of other migrants and of nonmigrants. Unlike automatability in general, the share of the median CADR worker’s tasks that are exposed to GPTs is relatively low—16 percent for CADR migrants versus 44 percent for US workers—as is the share of workers in occupations with at least 10 or 50 percent of their tasks exposed to GPTs (figure 3.19). The low-skill bias of CADR migrants is likely to mean more labor market disruptions from certain AI and mobile robotics, but relatively less from GPTs.

²⁹ See appendix C for a detailed description of the methodology to calculate this alternative measure of the probability of automation.

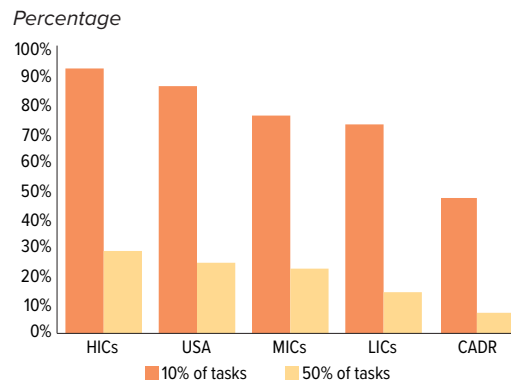
³⁰ The probability of automation calculated here is the occupation-based measure proposed in Frey and Osborne (2017). The task-based methodology for estimating automation probabilities cannot be used because of the small sample sizes of migrants in the Program for the International Assessment of Adult Competencies (PIAAC) data that is typically used for this analysis.

FIGURE 3.18: Average Probability of Automation, 2021



Sources: ACS 2021; Frey and Osborne 2017.
 Note: CADR = Central America and the Dominican Republic; HICs = high-income countries; LICs = lower-income countries; MICs = middle-income countries; USA = United States of America.

FIGURE 3.19: Share of Workers with at Least 10 and 50 Percent of Tasks Exposed to GPTs, 2021



Sources: ACS 2021; Eloundou et al. 2023.
 Note: CADR = Central America and the Dominican Republic; HICs = high-income countries; LICs = lower-income countries; MICs = middle-income countries; USA = United States of America.

CHANGES IN WORKING ARRANGEMENTS

ICT is changing how firms organize workers. Workers within a firm are increasingly able to do their jobs at a distance (remote work). At the same time, firms are increasingly able to look to workers outside of the firm to do tasks at a distance (platform work).

Changes in Working Arrangements: Remote Work

Remote work creates both challenges and opportunities for labor markets. Studies show that remote work can be associated with higher productivity (Bloom et al. 2015; Choudhury, Foroughi, and Larson 2020; Mas and Pallais 2020). However, productivity may decline due to loss of information and knowledge spillovers from face-to-face interactions, increased interruptions, challenges accomplishing certain tasks from home, and poor telecommunications (Atkin, Schoar, and Shinde 2023; Behrens, Kichko, and Thisse 2021; Gibbs, Mengel, and Siemroth 2023). For workers, one of the primary benefits of remote work is the flexibility it offers. Indeed, workers tend to value the flexibility of working from home in particular, relative to other forms of job flexibility (for example, in work schedules) (Mas and Pallais 2017). This flexibility also seems to have cushioned many workers from the worst labor market impacts of the pandemic. Overall, jobs with more potential to be done remotely were associated with less job and income loss (Garrote Sanchez et al. 2021).³¹ On the other hand, less-educated and lower-income workers are less likely to work in jobs that can be done remotely, meaning these benefits are generally available only to those who are already better off (Garrote Sanchez et al. 2021; Mongey, Pilossoph, and Wingerg 2020).

The potential for remote work is low in CADR countries. Estimates of remote work potential can be created by assessing whether a worker’s tasks can be done at home (Dingel and Neiman 2020). Tasks like use of email increase the likelihood that a job can be done at home while tasks like working outdoors decrease the likelihood.³² Remote work potential in CADR countries is calculated using task data from Program for the International Assessment of Adult Competencies (PIAAC) surveys and the United States as a benchmark.³³ In all CADR countries, jobs are less amenable to working from home than the average

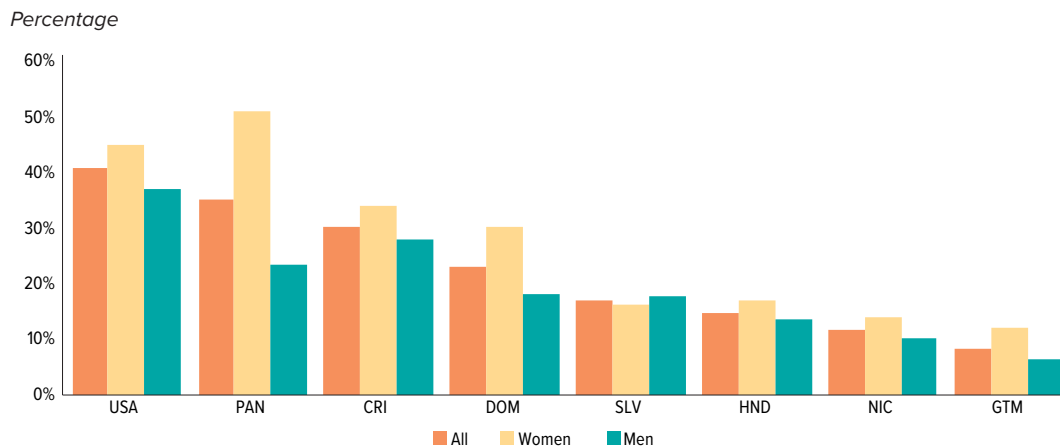
31 See also Adams-Prassl et al. (2020), Mongey, Pilossoph, and Wingerg (2020), and Montenegro et al. (2022) for the United States; Guven, Sotirakopoulos, and Ulker (2020) for Australia; Hatayama, Viollaz, and Winkler (2023) for Chile.

32 Other approaches are also possible, such as surveying workers about the share of tasks that can be done at home. See, for instance, Adams-Prassl et al. (2022).

33 See appendix D for a detailed description of the methodology to calculate remote work potential.

job in the United States.³⁴ While in the United States around 40 percent of work could potentially be done from home, rates are less than 30 percent in all CADR countries except Panama and Costa Rica (figure 3.20). Amenability to working from home in the region generally decreases with income level consistent with the international literature (Gottlieb, Grobovšek, and Poschke 2020). In all countries except El Salvador, women have better chances of working from home than men.

FIGURE 3.20: Share of Workers in Jobs with High Amenability to Working from Home, 2021



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras, 2014 for Nicaragua, and 2018 for Panama. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

Individuals with jobs that can be done remotely in CADR countries tend to be better off. Work-from-home potential increases with education. High-skilled occupations—managers, professionals, and technicians—have higher work-from-home potential than lower-skilled occupations such as skilled agricultural workers, plant and machine operators and assemblers, and crafts and related trades workers. This is consistent with existing literature showing that in both developed and developing countries, workers who can work from home tend to be less economically vulnerable. Across countries, these workers tend to be more highly educated and better paid and to be wage, formal, permanent, and urban workers.³⁵

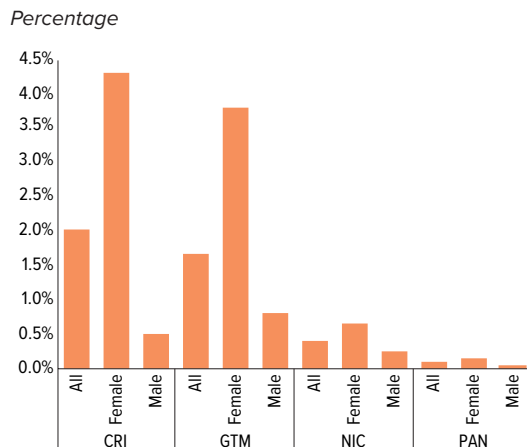
Prior to the COVID-19 pandemic, actual rates of working from home were very low in CADR countries among wage workers but higher among self-employed workers. Data from household and labor force surveys show that before the pandemic 7 percent of workers worked from home in Guatemala (2019), 8 percent in Costa Rica (2019), 9 percent in Panama (2019), and 15 percent in Nicaragua (2012), the four countries where data is available on both wage and self-employed workers. The vast majority of these were self-employed workers: rates of working from home among wage workers were 2 percent or less in all three countries with data available (figure 3.21). Rates were 20 percent or more in all CADR countries with data on self-employed workers (figure 3.22). This pattern is similar to that observed in the rest of the world: the ILO estimates that before the pandemic 8 percent of the global workforce worked from home, most in self-employment (ILO 2021a).³⁶ Across all CADR countries and both employment types, women are more likely than men to work remotely.

³⁴ These results are similar to those of other like studies. See appendix D for a description of these results.

³⁵ See also Dingel and Neiman (2020) and Mongey, Pilossoph, and Wingerg (2020) for the United States; Adams-Prassl et al. (2022) for the United States and the United Kingdom; and Lekfuangfu et al. (2020) for Thailand. Regarding age and gender, the evidence is not conclusive and depends on the country analyzed. Young workers in Mexico and India are less likely to work from home than adult workers (Garrote Sanchez 2021), but the opposite relationship has been reported for a set of 10 low- and middle-income countries (Hatayama, Viollaz, and Winkler 2023). Women have more possibilities of working from home in the same set of 10 low- and middle-income countries (Gottlieb et al. 2021; Hatayama, Viollaz, and Winkler 2023), but there is no gender difference for a set of 11 large Latin American cities (Berniell and Fernandez 2021).

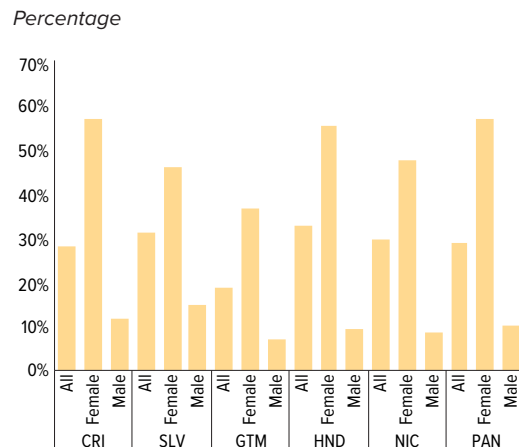
³⁶ In the United States, around 6 percent of workers worked primarily from home in 2019 (Mas and Pallais 2020; Oettinger 2011). Fifteen percent of workers in the European Union reported working from home sometimes or usually in 2018 (Alipour, Falck, and Schüller 2020). Data from five LAC countries show that between 5 and 8 percent of workers worked from home just before the pandemic (Maurizio 2021).

FIGURE 3.21: Share of Wage Workers Working from Home Prior to the Pandemic, 2019



Sources: SEDLAC (CEDLAS and The World Bank).
 Note: The years are 2012 for Nicaragua and 2018 for Panama. Data is unavailable for the other CADR countries. CRI = Costa Rica; GTM = Guatemala; NIC = Nicaragua; PAN = Panama.

FIGURE 3.22: Share of Self-Employed Working from Home Prior to the Pandemic, 2019



Sources: SEDLAC (CEDLAS and The World Bank).
 Note: The years are 2012 for Nicaragua and 2018 for Panama. Data is not available for the Dominican Republic. CRI = Costa Rica; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

The higher rates of remote work among self-employed workers are evidence of a less-developed organization of work, rather than a shift enabled by improvements in ICT. Self-employed workers working at home in less-developed countries tend to be artisans, self-employed business owners, or industrial home-based workers like seamstresses (ILO 2021a). The higher actual work-from-home rates of self-employed workers in CADR relative to wage workers contrast with the potential measure of working from home, which predicts higher rates among wage workers because of their tendency to do office work that can be done from home when facilitated by ICT.

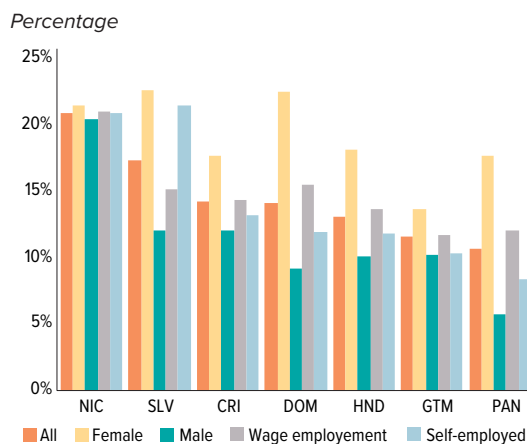
Household and labor force survey data show that the COVID-19 pandemic led to a spike in remote work in CADR's more developed countries. The ILO estimates that during the pandemic, working from home increased from around 8 percent of the global workforce to 17 percent, ranging from 14 percent of workers in low- and lower-middle-income countries to 25 percent in high-income countries (ILO 2021a). A similar increase is observable in Costa Rica: the percentage of workers working from home increased from 8 percent in 2019 to 13 percent in 2020 and 18 percent in 2021.³⁷ The rate jumped from 2 percent in 2019 to 14 percent in 2021 for wage workers but only from 28 percent to 30 percent for self-employed workers. The increases were highest among the most educated. Panama experienced a small increase in remote work of 2 percentage points between 2019 and 2021. Notably, the increase was larger for self-employed workers (2.2 percentage points) than for wage workers (0.4 percentage points), though workers with higher levels of education experienced all of the increase. In El Salvador, the only other CADR country with prepandemic and postpandemic data, work-from-home rates did not change during the pandemic, though data is only available for self-employed workers.

COVID-19-related surveys provide evidence of a regionwide increase in remote work during the pandemic, including among wage workers. The World Bank and United Nations Development Programme's High-Frequency Phone Surveys show higher rates of working from home during the pandemic relative to the rates observed from other data sources prior to the pandemic (figure 3.23). The share of workers working at least half of their total hours from home between May and July of 2021 ranged

37 Gottlieb et al. (2021) estimates that 10.8 percent of urban workers worked from home in Costa Rica in the second quarter of 2020. Maurizio (2021) reports an increase from 8 to 22 percent between the pre-pandemic level and the peak in mid-2020.

from 11 to 21 percent versus a range of 7 to 15 percent prior to the pandemic.³⁸ In contrast to what was found prior to the pandemic, work-from-home rates were higher for wage workers than self-employed workers in Costa Rica, the Dominican Republic, Guatemala, Honduras, and Panama. This provides some evidence that the pandemic resulted in an increase in remote work among wage workers, though this is speculative without comparable data from before the pandemic. Working from home arrangements during the pandemic were more common for women.

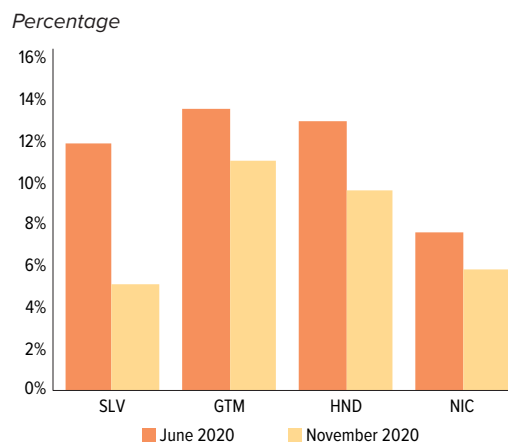
FIGURE 3.23: Share of Workers Working from Home During the Pandemic, 2021



Source: High-Frequency Phone Surveys 2021.

Note: CRI = Costa Rica; DOM = Dominican Republic; NIC = Nicaragua; GTM = Guatemala; HND = Honduras; PAN = Panama; SLV = El Salvador.

FIGURE 3.24: Share of Workers Working from Home During the Pandemic, 2020



Source: COVID-19 Business Pulse Surveys 2020.

Note: GTM = Guatemala; HND = Honduras; NIC = Nicaragua; SLV = El Salvador.

The persistence of the COVID-19–related spike in remote work is uncertain but preliminary evidence suggests it was temporary. It is not yet possible to examine the persistence of these trends for long after the pandemic. In developed countries, there is some evidence of an immediate decline in remote work after the pandemic followed by stabilization at a higher level than prepandemic. In the United States, for example, remote work rates increased from 8 percent prior to the pandemic to a high of around 60 percent during the pandemic before stabilizing at around 30 percent of paid full days in 2022 (Barrero, Bloom, and Davis 2021; Dalton and Groen 2022). In CADR countries, there are signs that the spike will not persist. Firm-level data from the World Bank’s COVID-19 Business Pulse Surveys show declines in work-from-home rates among employees between June and November of 2020 during the pandemic (figure 3.24). In the Dominican Republic, a question about telework added to the labor force survey in 2020 shows that rates declined from 5.0 percent of workers in 2020 to 2.4 percent in 2021 and 1.7 percent in 2022.

Changes in Working Arrangements: Platform Work

Similar to remote work, platform work involves a mix of opportunities and challenges (table 3.1). Workers can combine platform work with other paid and unpaid work. People with restricted mobility can access online jobs and people living in areas with limited economic opportunities can access a larger, even global, market for jobs (Datta and Chen 2023). Barriers to entry can be low with only limited assets and skills required for certain types of platform jobs. At the same time, workers spend a significant amount of (unpaid) time looking for work, taking qualification tests, and writing reviews, and lack the certainty in

³⁸ The High-Frequency Phone Surveys asks how many of a worker’s hours were worked “remotely or virtually” while the labor force and household surveys ask about the location of work or where a job is generally done.

earnings that workers often value (Mas and Pallais 2021). Because many platforms operate internationally, competition for jobs is strong and platform workers can be exposed to international shocks. Even the limited skills requirements can be prohibitive for some people: most platform jobs require a minimum level of digital skills, and many require knowledge of English. The legal status of platform work is often disputed, and platform workers generally lack access to social protection, workplace protections, and training. At the same time, firms see significant advantages in the ability to organize tasks flexibly, scale their workforces up and down more easily in response to shocks, and avoid the costs associated with permanent workers. However, they also face challenges in balancing flexibility and the benefits of collaboration-based innovation that is harder to generate when tasks are atomized.

TABLE 3.1: Advantages and Disadvantages of Platform Work for Workers and Firms

	Advantages	Disadvantages
Workers	<p>Flexibility in time and location of work</p> <ul style="list-style-type: none"> Workers can combine platform work with unpaid and other paid work. <p>Barriers to entry may be lower</p> <ul style="list-style-type: none"> Formal qualifications and certifications may not be needed. 	<p>Insufficient and unpaid work</p> <ul style="list-style-type: none"> Looking for tasks, taking qualification tests, researching clients, writing reviews can take one-third of working time. <p>Volatile and low earnings</p> <ul style="list-style-type: none"> Monopsony and powerful intermediaries in two-sided market <p>Lack of benefits of standard employment</p> <ul style="list-style-type: none"> Social protection, workplace protections, training limited <p>Algorithmic management</p> <ul style="list-style-type: none"> Workers subject to client approval and reputation scores with limited recourse
Firms	<p>Flexibility in task organization</p> <ul style="list-style-type: none"> Can organize workers by project or task <p>Rapid shock response</p> <ul style="list-style-type: none"> Ability to scale workforce up and down Ability to manage uncertainty <p>Cost savings</p> <ul style="list-style-type: none"> Avoid costs of permanent workers 	<p>Challenges developing firm-specific human capital</p> <ul style="list-style-type: none"> Fewer opportunities for the development of firm-specific skills

Sources: ILO 2021b; Oyer 2020; Wood 2019.

The same improvements in ICT that are facilitating remote work are also contributing to the rise of platform work. Platform work connects workers and consumers via online platforms for work performed either online and remotely (for example, image tagging through services like Amazon Turk or freelancing through Upwork) or offline at a physical location (for example, transportation or delivery services through Uber or Deliveroo). The work is typically paid on a piece-rate basis. Online work is less established in LAC than location-based work, though it has grown more prevalent in recent years including during the COVID-19 pandemic when downloads of online platform work apps increased in many countries (IDB 2021b). The number of platforms globally increased from the 10s in the 2000s to nearly 800 in 2020 with at least 15 based in LAC (ILO 2021b).

Location-based platforms have become common in certain sectors in CADR, though the number of location-based platform workers is uncertain. Globally, location-based platform workers typically work across five sectors: transportation, delivery, home services, domestic work, and care services (ILO 2021b). Only two of these sectors, transportation and delivery, are common in CADR (table 3.2). Platforms in these sectors include both global ones like Uber (United States) and locally founded ones like Urban (Guatemala), Delivery RD (Dominican Republic, later acquired by PedidosYa), and Sampopo (Honduras). The industry in the region is characterized by frequent entry and exit of new domestic and international firms. Successful domestic firms are also often acquired by international ones. The large international platforms like Uber and Didi tend to dominate but are typically only present in major cities. Estimates of

the number of location-based platform workers in CADR countries, as in most countries, are generally unavailable. One estimate for the Dominican Republic suggests that 0.2 percent of the labor force works as a location-based gig worker (Garcia and Javier 2020).

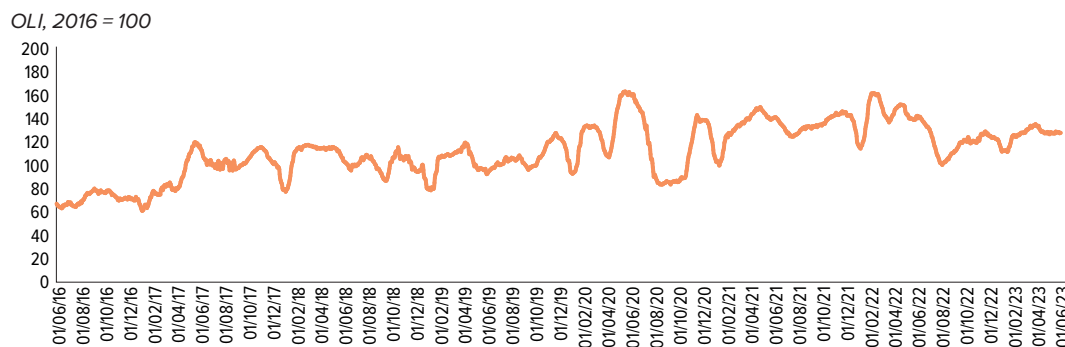
TABLE 3.2: Primary Location-Based Platforms in CADR Countries

Country	Location-based taxi	Location-based food delivery
CRI	Uber, Didi, InDrive	Uber, UberEats, PedidosYa, DidiFood, Rappi
DOM	Uber, Didi, InDrive	Uber Eats, Indriver, PedidosYa, Delivery RD (PedidosYa), Komida!
GTM	Uber, InDrive Urban, Picap	PedidosYa, UberEats
HND	InDrive, Uber, Bolt	PedidosYa, Sampopo
NIC	Picap	UberEats, PedidosYa
PAN	Uber, Didi, InDrive, Wageen	UberEats, PedidosYa
SLV	Uber, InDrive, Bolt	PedidosYa, UberEats

Sources: Garcia and Javier 2020; Sensor Tower 2023.

The demand for online gig work has grown globally. Employers increasingly look abroad for workers because of challenges finding skills locally, high labor costs, or lack of room and equipment (Agrawal et al. 2015). Much of the demand for gig workers comes from developed countries and is concentrated on several large platforms. Infrastructure is in place to support firms outsourcing tasks rather than jobs. For instance, ModSquad manages contract workers around the world who provide digital engagement services to firms worldwide.³⁹ However, local and regional platforms have emerged in developing countries typically in response to demand for workers with specific linguistic or cultural knowledge (Datta and Chen 2023). The Online Labor Index (OLI) compiled by Oxford University and the ILO measures tasks posted on the largest online labor platforms. The OLI shows that demand, proxied by task postings, increased about 50 percent between mid-2016 and mid-2023 (figure 3.25). The United States represents one-third of global demand; India, the United Kingdom, and the United States represent half. Notably, online gig work is sourced globally, meaning workers in CADR are able to access this growing demand. While demand in CADR is generally much lower as a share of the global market, local platforms do exist, including El Salvador–based SoyFreelancer.⁴⁰

FIGURE 3.25: Global Demand for Online Gig Work, 2016–23



Source: Online Labor Index 2023.

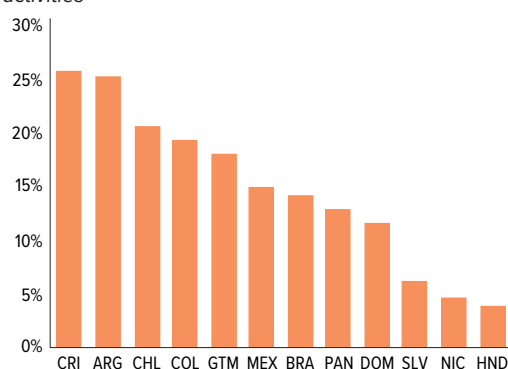
39 See “How Technology is Redrawing the Boundaries of the Firm” in *The Economist*, January 8, 2023.

40 The OLI shows that demand for online gig work is low in CADR: Panama had the largest share of the global market at .08 percent, followed by the Dominican Republic and Costa Rica at .05 percent each.

Workers from all CADR countries participate in online gig work, though they represent a small share of the global online gig workforce. A survey undertaken for a recent World Bank report on online gig work shows that around one-quarter of the labor force in Costa Rica participates in online gig work (figure 3.26). Between 10 and 20 percent of the labor force does in the Dominican Republic, Guatemala, and Panama. Six percent or less does in El Salvador, Honduras, and Nicaragua. Workers in different CADR countries specialize in different types of online gig work (table 3.3). Based on a measure of the workers active on the largest online labor platforms, the OLI shows that Costa Rica again stands out. Online gig workers in Costa Rica are significant providers of online sales and marketing tasks, representing 1.5 percent of global workers, making it the seventh-largest supplier globally.

FIGURE 3.26: Online Gig Workers, 2022

Percentage of labor force that participates in gig work activities



Source: Datta and Chen 2023.

Note: ARG = Argentina; BRA = Brazil; CHL = Chile; CRI = Costa Rica; COL = Colombia; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; MEX = Mexico; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

TABLE 3.3: Most Common Type of Online Gig Tasks in CADR Countries, 2017–23

Country	Occupation
CRI	Sales and marketing support
DOM	Creative and multimedia
GTM	Sales and marketing support
HND	Creative and multimedia
NIC	Creative and multimedia
PAN	Software development and technology
SLV	Software development and technology

Source: [Online Labor Index](#) 2023.

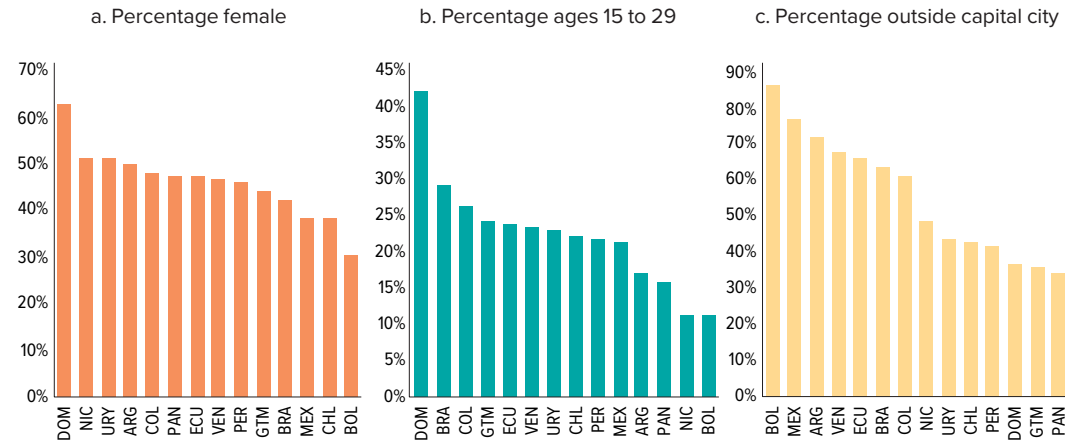
Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Location- and online-based platform workers tend to be younger, male, and more highly educated. Platform workers are a heterogenous group, but global research and research on LAC including in several CADR countries shows several commonalities (Azuara, González, and Keller 2019; ECLAC and ILO 2021b; Fernandez and Benavides 2020; Garcia and Javier 2020; ILO 2021b; Madariaga et al. 2019). Platform workers skew young and male, particularly in developing countries. They also tend to live in urban areas and to be more highly educated, again particularly in developing countries. Many platform workers undertake gig work as a second job. Online-based platform workers tend to be more highly skilled than location-based platform workers.

However, there are differences in these characteristics across CADR countries. A recent World Bank survey of Workana freelancers generally supports these findings but highlights differences across countries. For example, women represent two-thirds of freelancers in the Dominican Republic, the highest share of any country surveyed, and more than half in Nicaragua (figure 3.27a). The majority are younger than 40 in all countries surveyed, but younger workers between the ages of 15 and 29 are more common in the Dominican Republic and Guatemala (figure 3.27b). Finally, online-based platform work is much less common outside capital cities in the four CADR countries surveyed (figure 3.27c). Both online- and location-based platform workers tend to lack access to social protection and other workplace protections. A recent World Bank survey of freelancers on El Salvador’s SoyFreelancer found that only one-third contributed to a government retirement savings scheme. Security is a particular concern for location-based women platform workers (and women customers). Some local firms such as Urban from Guatemala offer a separate platform available only to women drivers and riders to address this concern.

FIGURE 3.27: Characteristics of Workana Freelancers, 2022

Percentage of freelancers



Source: Datta and Chen 2023.

Note: ARG = Argentina; BOL = Bolivia; BRA is Brazil; CHL = Chile; COL = Colombia; DOM = Dominican Republic; ECU = Ecuador; GTM = Guatemala; MEX is Mexico; NIC = Nicaragua; PAN = Panama; PER = Peru; URY = Uruguay; VEN = Venezuela.

Changing Working Arrangements and CADR Workers in the United States

Platform work is attractive to migrants. Low entry barriers and limited job alternatives can make platform work attractive to migrants, who may lack the necessary work documentation and start-up capital for self-employment activities. Recent ILO research shows that 17 percent of online-based platform workers are migrants with a higher proportion in developed countries, while 15 percent of app-based delivery workers and 1 percent of app-based taxi workers are migrants (ILO 2021b).

Migrants from LAC, including most CADR countries, make up about 10 percent of platform workers in the United States. The May 2017 supplement of the United States Current Population Survey includes questions about platform work that provide some insight to the prevalence of platform work among CADR migrants. About one-quarter of the 1.6 million platform workers in the United States in 2017 were migrants. Nearly 150,000 (10 percent) were from LAC. The number of observations for workers from CADR is very small, so any inferences must be drawn with substantial care, but the survey suggests that around 10 percent of all migrant platform workers were from CADR, lower than CADR’s share of total migrants in the United States.

Chapter 4

Barriers to and Enablers of the Future of Work in CADR Countries

Chapter 3 revealed a puzzle: the technology to automate tasks and to enable remote and platform work exists, but CADR's transition to a future of work defined by nonroutine tasks and altered working arrangements is only partial. To try to solve this puzzle, this chapter considers the factors beyond technological potential that underlie employment trends in the region. Technology use is found to explain only a small portion of the changes in tasks in CADR countries. Employment structure and skills play a much more important role. The prevalence of services sector employment across CADR countries implies less vulnerability to automation, but at the expense of the dominance of low-productivity employment. Education levels have improved, but the lack of tertiary-educated workers and problems of educational quality interrupt the potential complementarities between workers and technology. CADR's transition to the future of work is also being affected by technological progress abroad. The rise of global platforms creates an opportunity to connect CADR services employment to global markets, but robot adoption abroad could reduce employment opportunities for workers in CADR countries by reducing offshoring and for CADR workers in other countries by reducing the demand for migrants.

SETTING THE STAGE: LOOKING BEYOND TECHNOLOGICAL POTENTIAL

The transition of CADR countries to the future of work has been only partial. Despite the existence of technology to automate many tasks and to enable remote and platform work, CADR countries have not fully transitioned to the so-called “future of work.” Employment is evolving towards nonroutine tasks, but routine ones still dominate. Remote work surged during the pandemic but now seems to be diminishing. Platform work is present but makes up a small share of total jobs in some countries. This highlights a deficiency of research on the future of work, which tends to focus on the “technological potential” for a task or an occupation to be automated or performed remotely and to set aside other essential factors influencing which types of workers are hired and which types of capital investments are made.

Employment structure, skills, adoption and diffusion of technology, and globalization mediate the impact of technology on jobs. Chapter 3 showed that there is variation across and within CADR countries in how intensive employment is in routine, automatable tasks. This variation can be decomposed into the different factors underlying employment change to understand which factors are most important. Factors that are key to understanding changes in what work is being done and how work is being done include the adoption and diffusion of technology (Do firms and workers use new technologies?), but also employment structure (Do sectors that use technology dominate?), globalization (Is the economy open to technological influences?), and the supply of skills (Do workers have skills that are complementary to technology?).⁴¹

⁴¹ For a discussion of the role of these factors, see Caunedo, Keller, and Shin (2021); Lewandowski et al. (2022); Oesch (2013); Lo Bello, Puerta, and Winkler (2019); and Martins-Neto et al. (2021). Other factors not discussed here include labor market institutions and the availability of reliable and high-quality infrastructure (Breemersch, Damijan, and Konings 2017; Cirera, Comin, and Cruz 2022; Oesch 2013).

Understanding each of these factors can help show why technology is not having the kinds of impacts in CADR countries that it is in advanced economies.

Changes in the nature of work in CADR countries are being influenced not only by developments within the region but also by technological progress abroad. New digital working arrangements are expanding opportunities for cross-border provision of services in the context of employment structures in CADR countries that skew towards low-productivity services. Better and cheaper ICT could enable the provision of services from CADR countries, facilitating delivery across borders. This could create opportunities to scale services operations beyond local markets to reach global consumers with benefits for productivity, competitiveness, and living standards (World Bank and WTO 2023). On the other hand, automation abroad could lead to a reversal of the offshoring that has created jobs in CADR countries. Automation abroad could drive a process of deoffshoring⁴² as automation-induced labor savings at home and higher labor costs abroad change firms' calculations about where to produce goods.⁴³ New technologies may also weaken the demand for CADR migrants outside of CADR countries, particularly in the United States, though increased demand is also possible if automation leads to expansions in output in jobs that favor migrants. This chapter discusses each of the factors underlying employment change in CADR countries, including and beyond the adoption and diffusion of technology, and highlights how technological progress abroad could play a role in shaping the future of work in the region.

THE CHANNELS OF EMPLOYMENT CHANGE

Skills, employment structure, adoption and diffusion of technology, and globalization all play a role in explaining the evolution of employment in CADR countries. Examining the relationship between these different factors and how intensive a job is in the routine tasks that are associated with jobs of the past shows that each is important in explaining what workers do at work in CADR countries.⁴⁴ Across CADR countries:

- More education is associated with employment that is less intensive in routine tasks.
- Less agricultural work is associated with employment that is less intensive in routine tasks.
- Greater technology use is associated with employment that is less intensive in routine tasks.
- Greater global value chain participation is associated with employment that is more intensive in routine tasks.⁴⁵

Technology is not a primary factor explaining differences in the tasks that workers do in CADR countries. Decomposing the variation in the routine intensity of employment shows that employment structure—the sectoral distribution of employment—explains about half of the cross-country variation in routine intensity among CADR countries and is the most important factor for within-country differences in nearly every CADR country (figure 4.1). Worker characteristics, primarily skills,⁴⁶ explain another third of the cross-country variation and are the second most important factor explaining within-country differences in nearly every CADR country. Notably, technology only explains 8 percent of the variation across countries. Globalization is a more important factor than technology in all CADR countries except Panama. This result contrasts with results for high-income countries where technology is found to be the main contributor to cross-country variation (Lewandowski et al. 2022). The following sections delve into each of these factors.

42 Reshoring means moving production back to the original country of production. “Deoffshoring” is a broader concept, which captures production that would have been but is not offshored and production that is moved to a third country as well as reshoring.

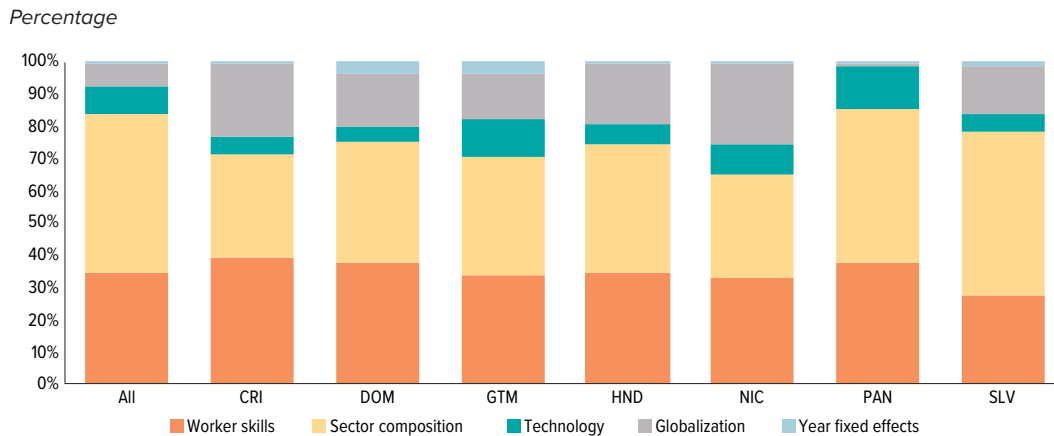
43 See, for example, Artuc, Bastos, and Rijkers (2023) and Maloney and Molina (2019).

44 See appendix E for full results and an explanation of the methodology for estimating the determinants of routine task intensity across countries.

45 As in Lewandowski, Madoñ, and Winkler (2023), this finding is specific to forward linkages—that is, production and shipment of goods that are reexported. Results for backward linkages—that is, importation of inputs that are used to produce goods that are then exported, are not statistically significant.

46 The decomposition includes three worker characteristics: gender, age, and education. Education is the dominant factor across countries.

FIGURE 4.1: Factors Contributing to Cross-Country Variation in Routine Task Intensity, 2010–2021



Sources: Borin, Mancini, and Taglioni 2021; SEDLAC (CEDLAS and The World Bank).

Note: Results in the figure show the decomposition of the R-squared from an ordinary least squares (OLS) regression where the routine task intensity (RTI) index is regressed on worker characteristics (gender, age, and educational level), structural change (sector fixed effects), technology (share of ICT-intensive occupations), and globalization (global value chain-related trade). The results use all available years (2011–21 for Costa Rica, 2010–21 for the Dominican Republic and El Salvador, 2010–19 for Guatemala and Honduras, 2010–14 for Nicaragua, and 2011–18 for Panama) and include year fixed effects. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Employment Structure

Jobs in CADR’s less advanced economies are less vulnerable to technological change in part because of the continued prevalence of agricultural employment. The bias of the economic structure of several CADR countries towards agriculture makes them less vulnerable to automation of the routine tasks that are concentrated in manufacturing and (certain) service sector jobs (Martins-Neto et al. 2021). Cross-country evidence suggests that structural transformation—the shift of jobs out of agriculture and into industry and services—raises exposure to automation-linked routinization (Das and Hilgenstock 2022).⁴⁷ For example, a recent study of European Union countries shows that later structural transformation—higher initial shares of employment in agriculture—in Central and Eastern European countries contributed to an increase in employment in routine-intensive jobs in contrast to the decline experienced in Western Europe (Hardy, Keister, and Lewandowski 2018).⁴⁸ This implies that the slow structural transformation of several CADR countries—particularly Guatemala, Honduras, and Nicaragua—is linked to lower exposure to automation. Unfortunately, this lower exposure comes at the expense of higher-productivity (nonagricultural) employment.

However, technological advances can spur productivity increases in agriculture in CADR, including among smallholder farmers. Digital technologies can improve the information available to farmers and expand their access to input and output markets and financial products, in turn improving their efficiency and productivity (Schroeder, Lampietti, and Elabed 2021; Morris et al. 2020; FAO 2022). Smartphone apps and messaging services can link farmers to expert advice on farming techniques, provide tools in a range of information-related areas (for example, pest detection, quality control, and grading), and facilitate the use of shared asset or machinery hire services (“Uber for tractors”) that connect equipment owners with potential users. Digital histories linked to phone usage can make financial products available to farmers lacking credit histories. E-commerce platforms improve price discovery and facilitate matching of buyers and sellers. More sophisticated technologies like distributed ledger technology such as blockchain can improve quality control and traceability, while geo-enabled technologies like remote sensors and drones combined

⁴⁷ This has also been found in the case of Central and Eastern European countries (Hardy, Keister, and Lewandowski 2018).

⁴⁸ See also Bárány and Siegel (2018) examining the role of structural change in employment and wage polarization in the United States.

with AI-enabled analysis can facilitate precision agriculture that can improve how fields and animals are managed. Robots and automated equipment operation can reduce the need for manual labor for some tasks. Table 4.1 highlights examples of digital tools currently deployed in CADR countries. Despite these opportunities, deployment of digital technologies in agriculture faces challenges including lack of digital literacy among smallholder farmers, a preference for using cash and relying on personal relationships, limited connectivity, and expensive data services and equipment (Loukos and Arathoon 2021).

TABLE 4.1: Examples of Digital Interventions Targeted to Smallholder Farmers in CADR

Country	Tool
CRI	<ul style="list-style-type: none"> • Agromensajes provides advice on market prices for fresh produce. • Coffee Cloud provides alerts on pests and diseases and weather for coffee. • CR Orgánico provides e-commerce services for organic fresh produce. • IICA/PROCAGICA uses smart farming IoT sensors for coffee. • Celotor uses smart farming IoT sensors for cattle.
DOM	<ul style="list-style-type: none"> • IICA/PROCAGICA uses smart farming IoT sensors for coffee.
GTM	<ul style="list-style-type: none"> • Precios del Café provides advice on market prices for coffee. • APP MAGA provides advice on market prices for fresh produce. • Cacao Móvil provides advice on best practices for coffee. • Coffee Cloud provides alerts on pests and diseases and weather for coffee. • Digitagro provides e-commerce services for fresh produce. • IICA/PROCAGICA uses smart farming IoT sensors for coffee.
HND	<ul style="list-style-type: none"> • Cacao Móvil provides advice on best practices for coffee. • Coffee Cloud provides alerts on pests and diseases and weather for coffee. • IICA/PROCAGICA uses smart farming IoT sensors for coffee.
NIC	<ul style="list-style-type: none"> • Cacao Móvil provides advice on best practices for coffee. • Clima y Café and Cafenica Pronósticos is a localized weather and alert system for coffee. • IICA/PROCAGICA uses smart farming IoT sensors for coffee.
PAN	<ul style="list-style-type: none"> • Mercadito provides e-commerce services for fresh produce. • IICA/PROCAGICA uses smart farming IoT sensors for coffee.
SLV	<ul style="list-style-type: none"> • Cacao Móvil provides advice on best practices for coffee. • Coffee Cloud provides alerts on pests and diseases and weather for coffee. • Smart Agro 4.0 uses smart farming IoT sensors for coffee, potatoes, cotton, fresh produce. • IICA/PROCAGICA uses smart farming IoT sensors for coffee.

Source: Loukos and Arathoon 2021.

Note: IoT is Internet of Things and refers to a network of devices equipped with sensors that exchange data; IICA = Inter-American Institute for Cooperation on Agriculture. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

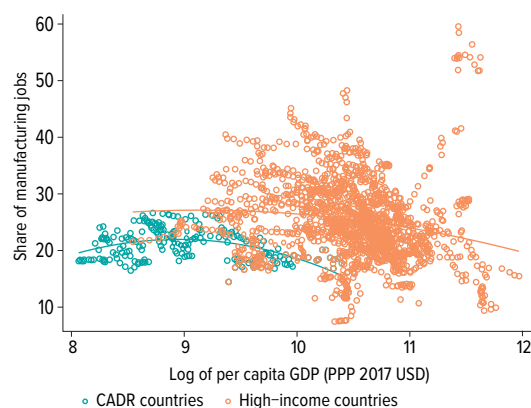
Even as relatively high levels of agricultural employment persist in several CADR countries, the region is also experiencing premature deindustrialization. The canonical path of economic development involves employment first shifting from agriculture to (higher-productivity) industry and then from industry to (lower-productivity) services as industrial productivity increases. Recent evidence suggests that in developing countries and in Latin America, the shift of employment from industry to services is happening at lower levels of development and at lower levels of peak manufacturing employment (Beylis et al. 2020; Rodrik 2016).⁴⁹ The same pattern of “premature deindustrialization” is apparent for CADR countries (figure 4.2). Indeed, the industrial share of employment contracted in all CADR countries except Panama and Honduras between 1991 and 2019 (figure 4.3). Factors contributing to this early deindustrialization include barriers to the movement of resources into manufacturing such as labor regulations and mismatched skills (Sinha 2022).

⁴⁹ The same is observed for sector value-added, though the phenomenon is more apparent for employment (Beylis et al. 2020). See also Felipe, Mehta, and Rhee (2019).

Premature deindustrialization may mean that CADR countries do not follow the same path towards increased exposure to routinization as the United States and other more advanced economies. As structural transformation proceeds in CADR countries, the risks of routinization could increase. However, the transition of employment from agriculture directly to services suggests that these risks will only increase moderately via the structural transformation channel. Low-paid services are harder to automate because they require more dexterous interactions, because the cost of automation technology is often high relative to labor cost, and because human interaction is at least at times an important component of service provision (Autor 2022).

FIGURE 4.2: Deindustrialization in CADR and High-Income Countries, 1991–2021

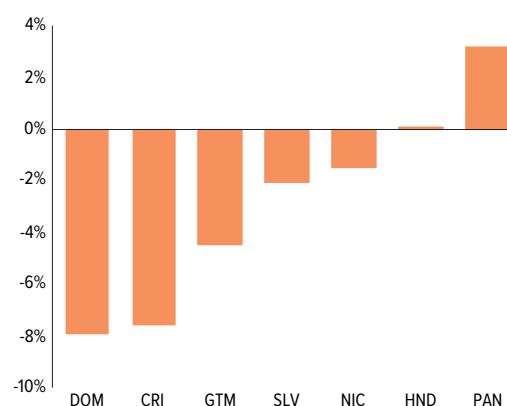
Percentage, log GDP per capita



Source: World Development Indicators data, World Bank.
Note: Each data point corresponds to one country and one year. The years are between 1991 and 2021.

FIGURE 4.3: Change in the Industrial Share of Employment, 1991–2019

Percentage points



Source: World Development Indicators data, World Bank.
Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Though deindustrialization implies a lower risk of automation, it raises concerns about future growth in CADR countries because manufacturing has historically been an accelerator of economic development.

Several characteristics thought to be unique to the manufacturing sector explain its links to growth. These include tradability and scalability, scope to innovate, and spillovers combined with a significant capacity to absorb low-skilled workers and make them more productive (Hallward-Driemeier and Nayyar 2018; Nayyar, Hallward-Driemeier, and Davies 2021). The early shrinkage of the industrial sector and expansion of services in CADR countries thus raises alarms about future sources of productivity growth as services do not typically have these attributes. There are high-productivity, tradable services but employment in these subsectors tends to be limited in number and confined to higher-skilled jobs in information, finance and insurance, professional, and educational services (Blinder and Krueger 2013; Dingel and Nieman 2020; Jensen and Kletzer 2010). In contrast, the employment-intensive services that increasingly dominate employment in the region tend to lack the productivity growth and job creation that are associated with manufacturing jobs.

However, developments in ICT could enhance the benefits that services jobs have for development within the region.

Technological advancements are giving the services sector some of the same positive productivity benefits that have historically been associated with manufacturing (Nayyar and Cruz 2018; Nayyar, Cruz, and Zhu 2018; Nayyar, Hallward-Driemeier, and Davies 2021). ICT is increasingly enabling remote delivery of services (for example, via platforms), which in turn increases the potential for scalability including across borders. Estimates find that about a third of jobs in the United States can be performed remotely, which suggests the potential to provide them overseas (Dingel and Nieman 2020).⁵⁰ This amounts

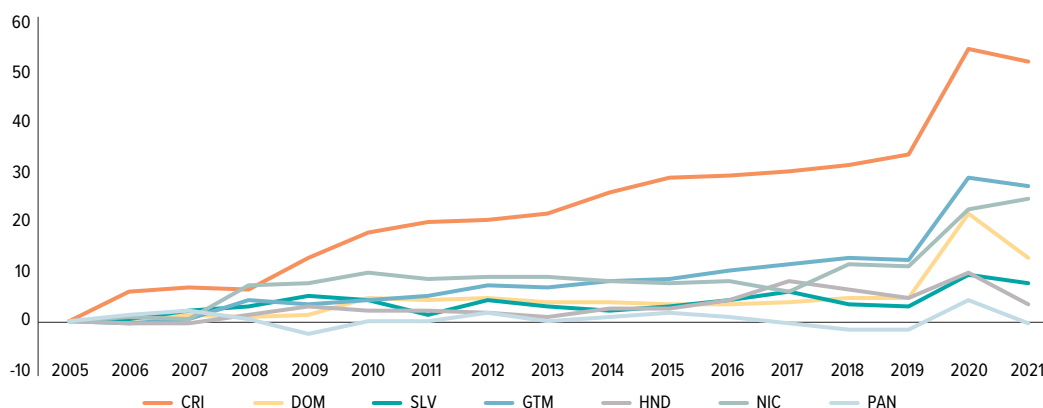
⁵⁰ Dingel and Nieman (2020) focuses specifically on whether a job can be done from home, while estimates of offshorability contemplate whether a job can be done overseas (Blinder 2006; Blinder 2009; Blinder and Krueger 2013; Jensen and Kletzer 2010). This results in differences particularly in the manufacturing sector where few jobs can be done remotely but many jobs can be done overseas.

to tens of millions of jobs in the United States alone. In sum, improvements in ICT could help expand the reach of lower-skilled, high-employment sectors like retail and personal services, facilitate the access of lower-skilled workers to higher-skilled, low-employment sectors like ICT, and increase opportunities in higher-skilled social services like education and health (Nayyar, Hallward-Driemeier, and Davies 2021).

Trade in services is becoming more important in CADR. In Central America, services exports grew faster than goods between 1991 and 2017 (Ulku and Zaourak 2021). Cross-border services trade boosted GDP per capita in Costa Rica, the Dominican Republic, Guatemala, and Panama between 2000 and 2014 (WTO 2019). Services exports can be important to employment. In Costa Rica, for instance, cross-border services exports are responsible for more than 10 percent of jobs (World Bank and WTO 2023). While traditional industries like tourism and travel still dominate services exports in the region, improvements in ICT increasingly make proximity between producers and consumers less important and cross-border provision of services more viable, which is reflected in the increasing share of modern services like finance, ICT, and professional and business services in the services export basket of CADR countries. In several CADR countries, the share of digitally deliverable services exports—exports that could, given adequate infrastructure and financial resources, be delivered digitally—has increased substantially during the last two decades (figure 4.4). Data on trade in services that are actually facilitated by digital technologies is only available for Costa Rica, where around 40 percent of services exports were enabled by ICT in 2017 (BCCR 2019).

FIGURE 4.4: Digitally Deliverable Services Exports, 2005–21

Percentage points (2005 = 0)



Source: UNCTAD.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

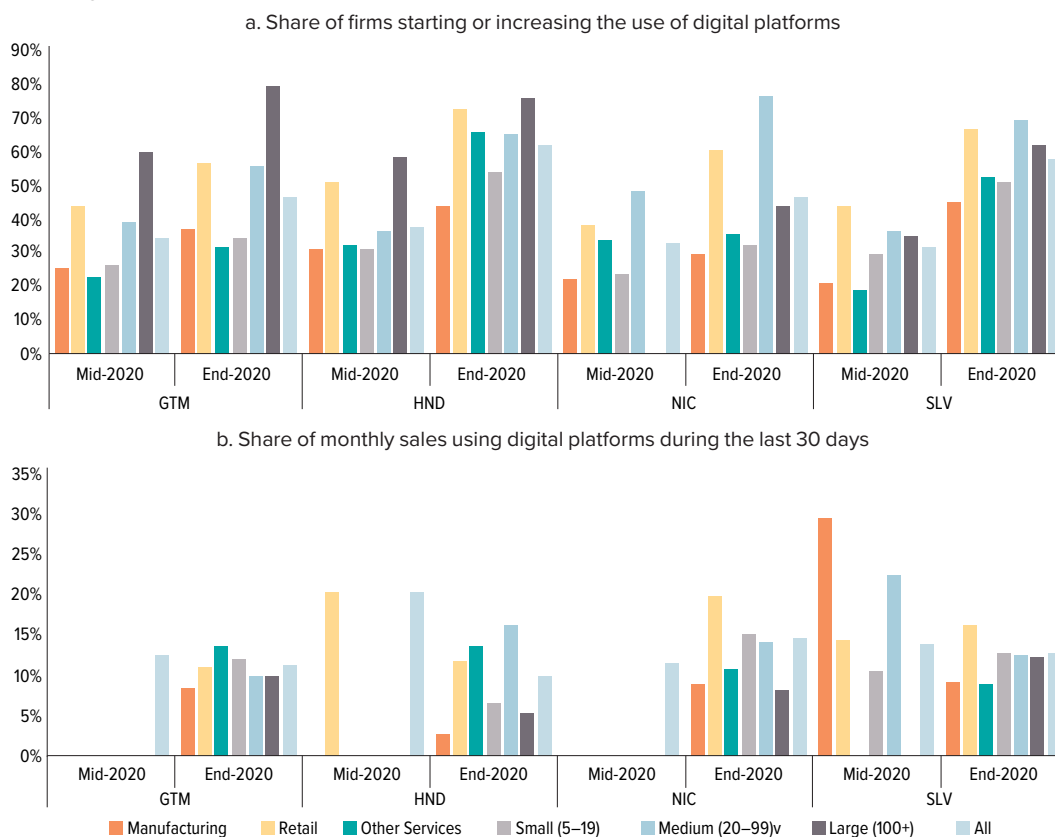
The emergence of digital platforms has enabled the growth of cross-border services delivery. As chapter 3 describes, platforms can enable workers in CADR to access a global market for jobs and tasks. Platforms can also create opportunities for cross-border services provision. Platforms allow firms, including SMEs in developing countries, to undertake a multitude of business functions from marketing to e-commerce, financing, and payments. Platforms can lower entry barriers, create network effects, and enable SMEs to access additional consumers and sourcing options in regional and global markets (ADB 2021; OECD 2021). Digital platforms use became common including among small firms during the COVID-19 pandemic (figure 4.5a). Still, sales made via digital platforms are low (figure 4.5b).

Digital technologies, particularly digital platforms, are opening new opportunities for small businesses in CADR. The [Future of Business Survey](#) is a survey of small- and medium-sized enterprises with an active Facebook Business page conducted by Meta with the World Bank and the OECD. The survey provides insight into how small businesses engage with digital tools in general and digital platforms in particular.

SMEs across CADR report using digital tools to facilitate online sales and purchases: more than 40 percent say they use such technologies. Most report that less than one-quarter of their purchases and sales are online. However, when they do use the internet for purchases and sales, firms in CADR are more likely to connect with suppliers or buyers outside their home country (figure 4.6a–b). This is consistent with improved ICT expanding markets for SMEs. Digital platforms in particular seem capable of transformative impacts. Large shares of firms across CADR report that digital platforms had a very or extremely important impact on their business. Larger shares of firms in CADR than in Korea or the United States report that digital platforms increased their sales and their customer or supplier base (figure 4.6c–d). SMEs most commonly report using digital platforms for advertising and communication, but other uses are also common including payments (Costa Rica and Guatemala), product or service development (Dominican Republic and El Salvador), and sale or purchase of goods or services (Honduras and Nicaragua).

FIGURE 4.5: Use of Digital Platforms, 2020

Percentage



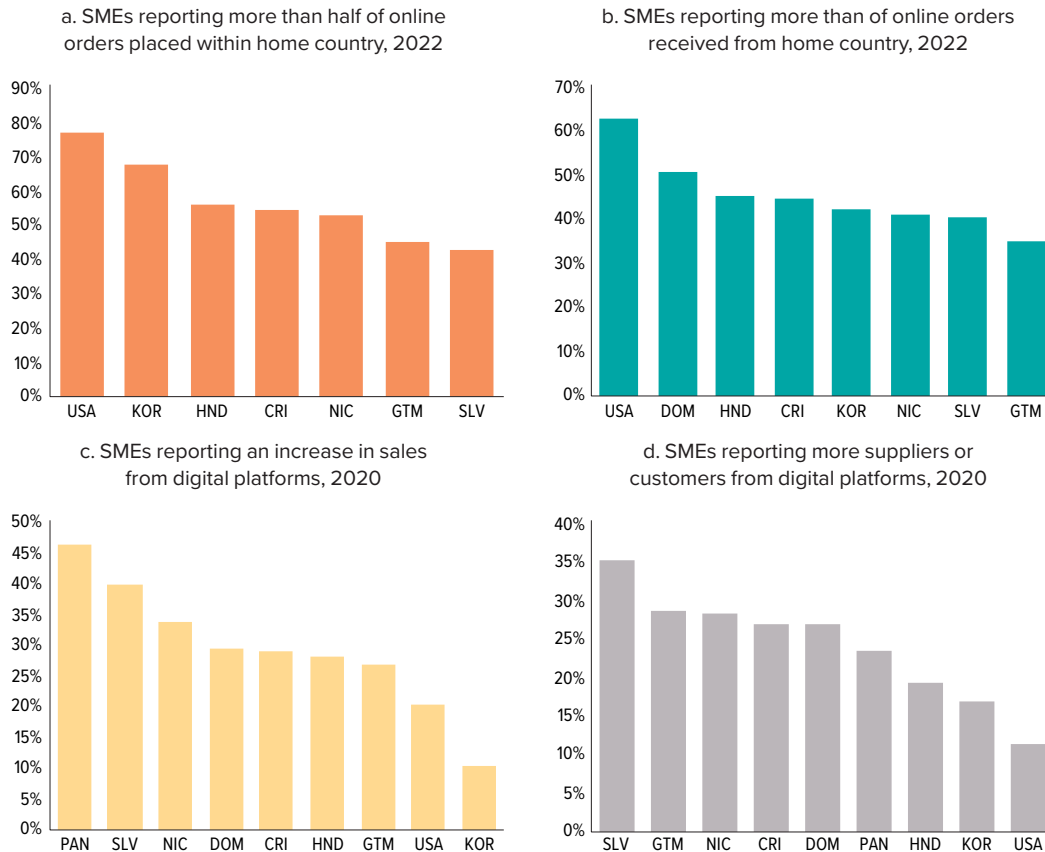
Source: World Bank Business Pulse Survey 2020.

Note: GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama.

In sum, the prevailing employment structure in CADR countries implies both less vulnerability to automation in the near term and a more challenging services-driven growth model. The continued prevalence of agricultural employment in several CADR countries on one hand, and the prevalence of services employment in all CADR countries on the other, mean relatively fewer workers do the tasks that have been automated away in advanced economies. But this leaves the challenge of substantial shares of workers employed in less-productive economic sectors. Technological advances in agriculture and digital trade in services offer potential new avenues for growth.

FIGURE 4.6: SME Engagement with Digital Tools, 2020 and 2022

Percentage



Source: [Future of Business Surveys](#) 2020, 2022.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; NIC = Nicaragua; PAN = Panama; SME = small and medium-sized enterprise; SLV = El Salvador, USA = United States of America.

Supply of Skills

A larger supply of less-skilled workers favors more routine-intensive employment. The supply of skills is a key factor in technology adoption (Caunedo, Keller, and Shin 2023; Martins-Neto et al. 2021). Human capital is one of the most important determinants of how quickly a country adopts technologies (Benhabib and Spiegel 1994; Comin and Hobijn 2004). Firms in countries with more abundant less-skilled labor select technologies complementary to less-skilled labor, which are different from the technologies selected by firms in countries with more abundant high-skilled labor (Caselli and Colemann 2006; Eden and Gaggl 2020). For example, research on less-developed Central and Eastern European countries finds that upskilling, particularly increasing tertiary education attainment, contributed to the growth in nonroutine cognitive tasks in these countries, even as structural change implied more routine-intensive jobs (Hardy, Keister, and Lewandowski 2018).

The low skill levels in the CADR region contribute to the prevalence of routine-intensive employment. Education levels have improved throughout the CADR region, driven by a decline in workers who have primary education or less and an increase in those who have secondary education (figure 4.7). This is consistent with the recent trends away from routine employment identified in chapter 3. However, low skill levels predominate in most CADR countries. Education levels in the higher-income CADR countries are low relative to the most developed economies globally, and those in the lower-income CADR countries

are low relative to the higher-income CADR countries. In Costa Rica, the Dominican Republic, and Panama, around a quarter of workers are tertiary educated versus more than half of workers in Korea and the United States. Very few workers in Korea and the United States have less than secondary education while at least a quarter do in Costa Rica, the Dominican Republic, and Panama. In the remaining CADR countries, 14 percent or less of workers have tertiary education. Seventy percent of workers in Guatemala have primary education or less.

FIGURE 4.7: Education of the Employed Population in CADR Countries, 2000–21

Percentage



Source: SEDLAC (CEDLAS and the World Bank).

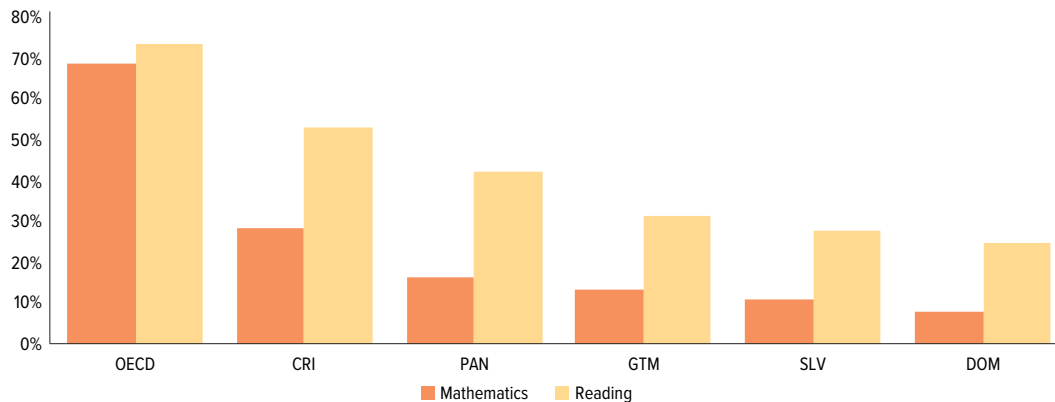
Note: Low education is less than 9 years of school, medium is between 9 and 13 years, and high is 14 or more.

Low educational quality could also help explain the prevalence of routine-intensive employment.

Indicators of learning and education system performance in CADR suggest that students may not be acquiring the skills that would enable them to take on more skill-intensive jobs. For the subset of CADR countries that participate in the Program for International Student Assessment, an internationally comparable student assessment administered to 15-year-olds, the results are stark (figure 4.8). Even in the best performing country in the region, Costa Rica, less than 60 percent of 15-year-olds meet the minimum proficiency standard in reading and just 40 percent in math. In the poorest performing CADR countries, less than 30 percent and 20 percent do, respectively. This compares with at least three-quarters of students in both subjects in the OECD.

FIGURE 4.8: Share of Students Meeting Minimum Proficiency in Reading and Math, 2022

Percentage of 15-year-olds



Source: OECD 2022a.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; OECD = Organisation for Economic Co-operation and Development; PAN = Panama; SLV = El Salvador.

Workers in CADR countries also seem to lag in the kinds of skills needed to accomplish the new tasks associated with new technologies. Globally, technological progress is translating into stronger demand for critical thinking and other higher-order cognitive skills, socioemotional skills, digital skills, and combinations of these skills (World Bank 2016, 2019). There is growing complementarity between social and cognitive skills (Deming and Kahn 2018; Weinberger 2014). The availability of ICT skills in particular is associated with the adoption of digital technologies (Nicoletti, von Rueden, and Andrews 2020). Though data on skills is scarce in CADR, the kinds of skills associated with technological change seem to be lacking. For example, an analysis of job vacancies in the Dominican Republic finds that teamwork, service orientation, responsibility, and big data are the most demanded skills (Guataquí 2021). However, firms report difficulty filling vacancies with the most important limitation being the lack of adequate technical skills among jobseekers (MEPyD 2022). Inadequate digital skills are also cited as a limitation when trying to fill vacancies. In El Salvador, digital startups report low quality training and education as barriers to hiring talent (World Bank 2022c). Data on technology skills taken from LinkedIn profiles in Costa Rica and Panama show a similar lag in technology skills in these countries (box 4.1).

BOX 4.1: The Availability of Technology Skills in Costa Rica and Panama

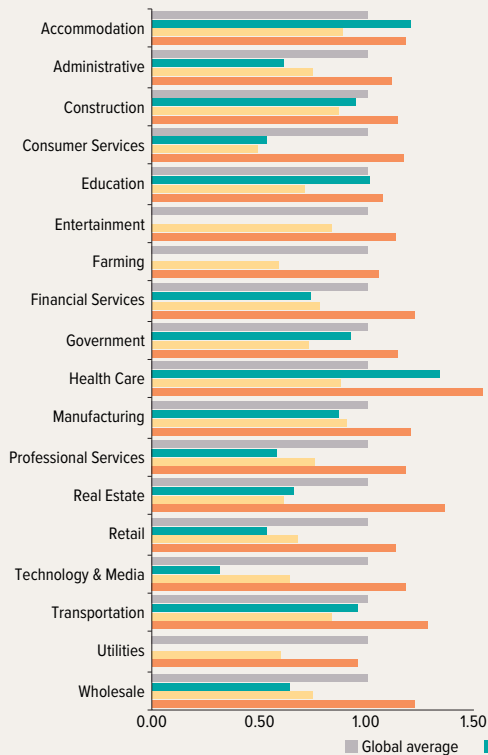
Data from LinkedIn provide insight into the extent to which different types of skills are utilized in Costa Rica and Panama. The global job networking site LinkedIn has detailed data on its users, including on the skills they have learned during employment. In CADR, Costa Rica and Panama have sufficient LinkedIn users to make valid insights with this data. The user profile data on skills is used to calculate skill penetration—that is, the share of an industry’s top 50 skills that come from one of 249 different skills categories that group the thousands of skills of LinkedIn users. Argentina is included in the analysis as a comparator for Costa Rica and Panama.

Costa Rica and Panama lack the technology and disruptive technology skills most closely associated with new technologies. The skills penetration metric shows that Costa Rica and Panama lag substantially relative to the global average in the penetration of technology skills like digital literacy, graphic design, and mobile app and web development and in disruptive technology skills like AI, data science, and robotics (figure B4.1). Panama does perform above the global average on technology skills in several industries—hospitals and health care, accommodation and food services, and education—but is well below the global average in others such as technology, information, and media. Costa Rica performs below the global average across all sectors. The performance of both countries is worse in the disruptive technology skills that are most closely associated with the most innovative technologies. Only Costa Rica’s real estate and equipment rental sector performs above the global average.

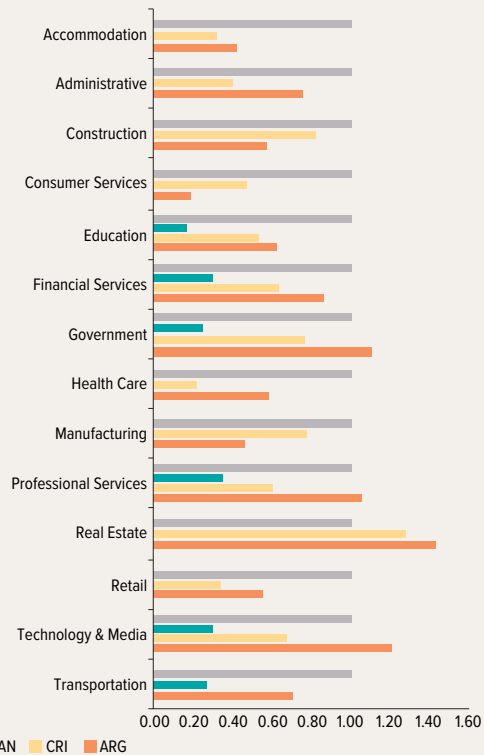
FIGURE B4.1.1: Penetration of Technology and Disruptive Technology Skills, 2022

Relative skills penetration (1 = global average)

a. Technology



b. Disruptive technology



Source: LinkedIn 2022.

Note: ARG = Argentina; CRI = Costa Rica; PAN = Panama.

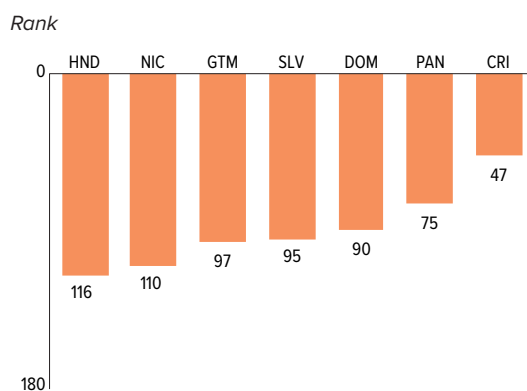
Lack of management skills may also be hindering adoption of technologies in CADR. Good management is increasingly viewed as a prerequisite to technology adoption. For instance, low management quality is associated with lower digital technology adoption in Europe (Nicoletti, von Rueden, and Andrews 2020). Evidence from the World Bank’s Firm-Level Adoption of Technology Surveys show that “firm capabilities”—management capacity, education, and ability to learn—are necessary for technology to function effectively (Cirera, Comin, and Cruz 2022). The surveys, which focus on developing countries, find that lack of these capabilities is the second-most important obstacle to adoption among firms of all sizes after lack of demand and uncertainty. These findings are consistent with the evidence that management practices are a key component of firm success (Bloom, Sadun, and Van Reenen 2017). Data on management practices in CADR are very limited. However, the World Management Survey, which measures management practices across countries, was undertaken in Nicaragua. The average management score in Nicaragua is 2.4, the seventh lowest among the 35 countries surveyed (Bloom, Sadun, and Van Reenen 2017). This is consistent with findings of a “management gap” between the quality of management in Latin America and that in more developed economies (Lederman et al. 2014).

Adoption and Diffusion of Technology

Employment may be shifting more slowly away from routine-intensive employment in CADR simply because technology use is less common. There is substantial variation across countries globally in technological sophistication. Recent efforts to better understand the role of technology in developing country settings finds that innovation is generally at the margins and firms are not close to the technological frontier (Cirera, Comin, and Cruz 2022; Cirera and Maloney 2017).

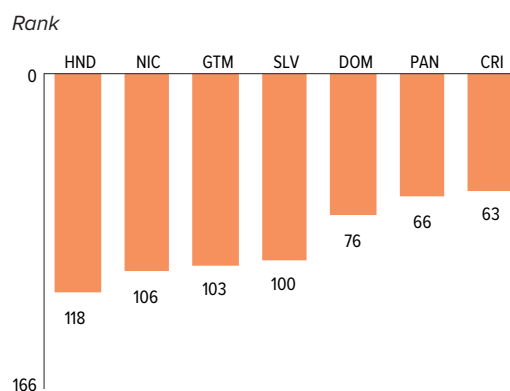
CADR countries rank low on summary measures of technological progress. The World Bank’s Digital Adoption Index (DAI) measures digital technology adoption by the people, governments, and businesses of most countries in the world. The DAI shows that out of 180 countries, the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua score in the bottom half of countries globally (figure 4.9). Costa Rica and Panama rank better but are still below most OECD countries. A similar picture emerges from the Frontier Technologies Readiness Index compiled by the United Nations Conference on Trade and Development (UNCTAD) (figure 4.10). The index shows the same 5 countries ranking at or below the average of 166 countries on the specific ICT readiness sub-measure.

FIGURE 4.9: The Digital Adoption Index, 2016



Source: World Bank 2016.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 4.10: The Frontier Technology Readiness Index: ICT, 2022

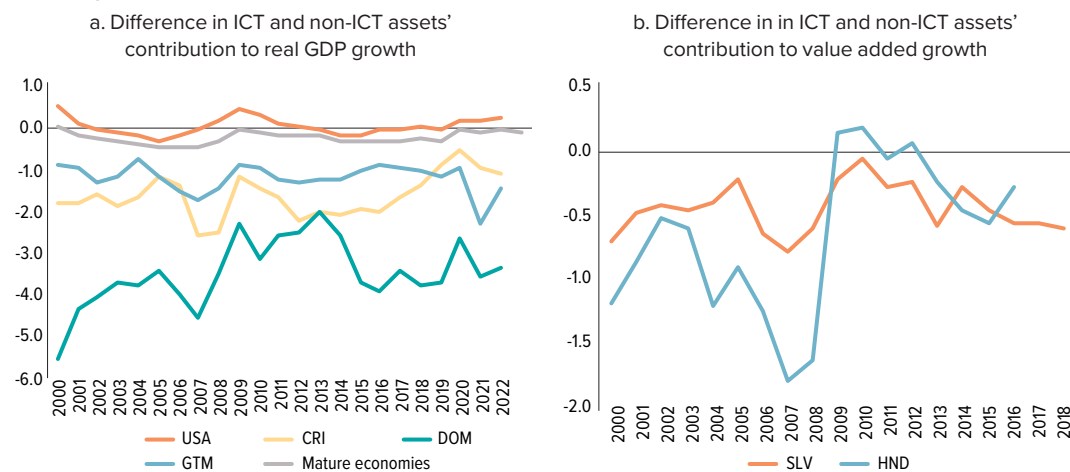


Source: UNCTAD 2023.
 Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Slow technological progress is reflected in the relatively small contribution of ICT to economic growth in CADR countries. The Conference Board's Total Economy Database includes data on the contribution of capital services provided by ICT and non-ICT assets to real GDP growth for Costa Rica, the Dominican Republic, and Guatemala (figure 4.11a). These data provides an indication of the intensity of ICT use in production (Eden and Gaggl 2020; Spiezia 2012). The contribution of ICT assets to GDP growth has been substantially lower than the contribution of non-ICT assets in all CADR countries since 2000. In the United States, in contrast, ICT assets have made a larger contribution than non-ICT assets. Data compiled by the Inter-American Development Bank and the University of Santiago, Chile generally show similar trends for El Salvador and Honduras using the contribution of ICT and non-ICT assets to value-added growth (figure 4.11b).

FIGURE 4.11: The Contribution of ICT and Non-ICT Assets to Economic Growth, 2000s–10s

Percentage points



Source: The Conference Board.

Note: A negative value indicates non-ICT assets contributed more to growth than ICT assets. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; USA = United States of America.

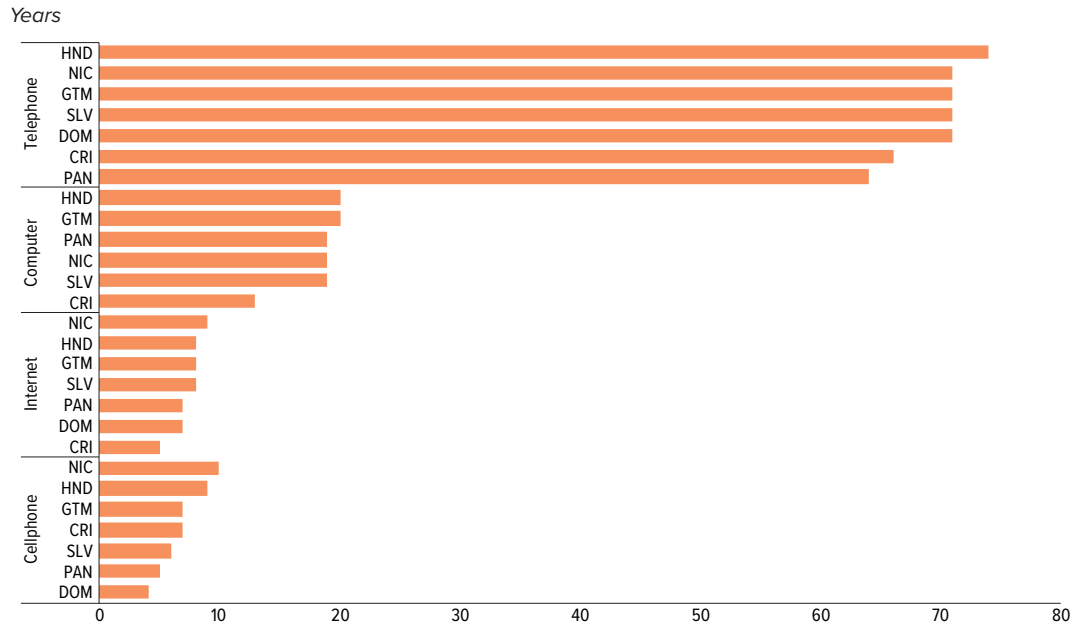
Source: LAKLEMS.

Note: A negative value indicates non-ICT assets contributed more to growth than ICT assets. HND = Honduras; SLV = El Salvador.

CADR countries have generally been slower to adopt new technologies, though these lags have shortened with each significant technological advancement. On average, the most advanced economies globally have adopted technologies 42 years earlier than developing countries, though these gaps have narrowed over time (Comin and Hobijn 2010; Comin and Mestieri 2018). CADR countries lagged about 70 years behind the United States in the adoption of the telephone (figure 4.12). Adoption of the computer lagged the United States by between 13 years in Costa Rica and 20 in Honduras. Lags were also experienced for the internet and for cell phones. However, with each new technology, the lags have become shorter. The mean lag in CADR declined from 70 years for the telephone to 25 for the computer, just over 7 for the internet, and just under 7 for the cell phone.

However, diffusion is limited even when technology is available. Intensity of use is a critical factor that can mediate the impact of technology on the labor market. Even in a country where a technology is adopted, take-up and use might be limited. For example, cell phones are prevalent in CADR countries, highlighting the importance and availability of this technology (figure 4.13a). However, use of the internet varies across countries. Costa Rica and the Dominican Republic have rates of internet use that approach those of Korea and the United States (figure 4.13b), but in all other CADR countries, at least one-third of the population did not use the Internet in 2021. Notably, unlike lags in technology adoption, lags between advanced and developing countries in how intensively technologies are used have widened over time (Comin and Mestieri 2018).

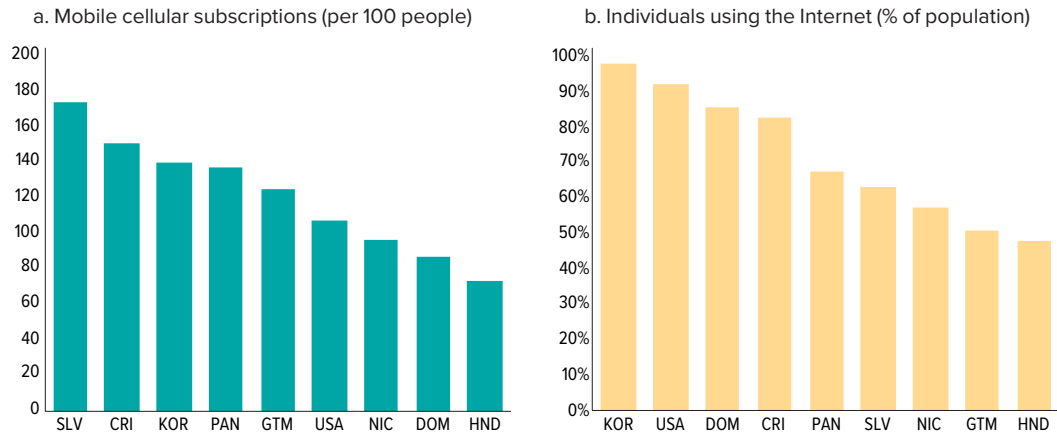
FIGURE 4.12: Lags in Technology Adoption in CADR Countries



Source: Comin, Hobijn, and Rovito 2008.

Note: Lags are calculated as the years between a benchmark year and the year in which the United States had the same adoption as the CADR country in the benchmark year. Data are not available for computers for the Dominican Republic. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 4.13: Diffusion of the Internet and Cell Phones, 2021



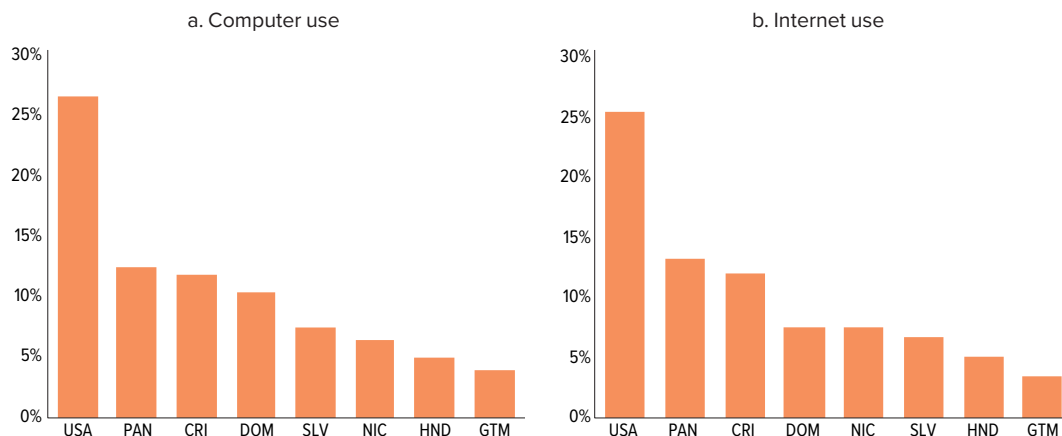
Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

The evidence of low diffusion of technology is evident in the small share of CADR workers using computers and the internet. Ten percent or less of workers in the Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua work in jobs that are intensive in the use of computers or the internet (figure 4.14a–b). The share in Costa Rica and Panama is slightly higher at 12 to 13 percent. However, these shares are significantly lower than that in the United States, which is 27 percent in the case of computers and 25 percent in the case of the internet.

FIGURE 4.14: Use of Computers and the Internet at Work, 2021

% of workers in computer- and internet-intensive occupations



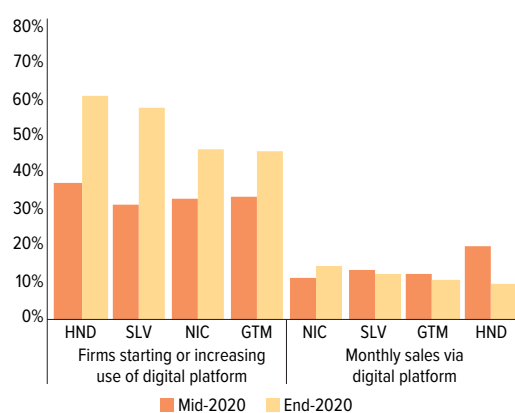
Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras, 2018 for Panama, and 2014 for Nicaragua. Computer- and internet-intensive occupations are defined as occupations in the top 25 percent of computer and internet use at work as defined using PIAAC data from comparator countries. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

Technology use by CADR firms is also limited. Data on technology use by CADR firms is outdated, but surveys undertaken during the COVID-19 pandemic and trade data on robots provide insight into the prevalence of deployment of new technologies by firms.⁵¹ The World Bank’s Business Pulse Survey fielded during the COVID-19 pandemic shows that half or more of firms in El Salvador, Guatemala, Honduras, and Nicaragua reported starting to use or increasing their use of digital platforms at the end of 2020 (figure 4.15). Despite this high prevalence, the share of monthly sales using digital platforms is relatively low at 15 percent or less in all four countries. In Chile, in contrast, the share was 40 percent in mid-2021. Data

FIGURE 4.15: Use of Digital Platforms, 2021

Percentage



Source: World Bank Business Pulse Surveys 2021.

Note: GTM = Guatemala; HND = Honduras; NIC = Nicaragua; SLV = El Salvador.

TABLE 4.1: Imports of Industrial Robots, 2021

US\$

Country	Imports
United States	1,082,146,087
South Korea	270,898,096
Costa Rica	7,726,490
Dominican Republic	2,096,294
Honduras	841,254
El Salvador	501,163
Panama	122,704
Guatemala	48,693
Nicaragua	1,850

Source: [Observatory of Economic Complexity](#).

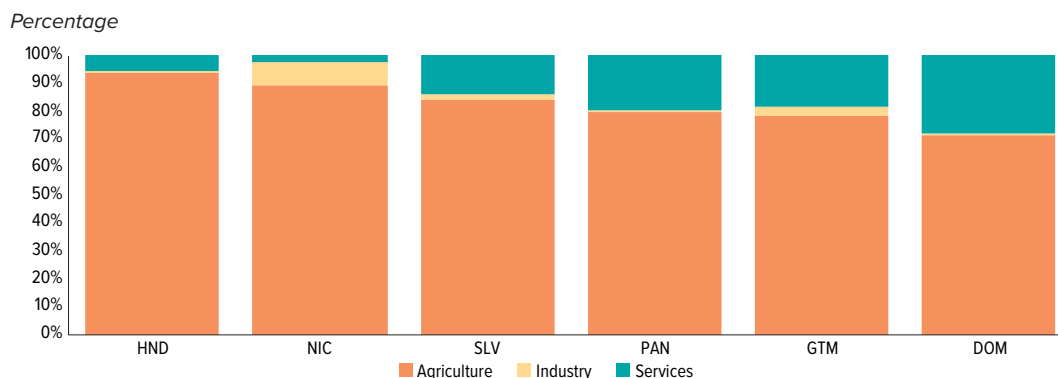
Note: Industrial robot imports are defined using Harmonized System (HS) Code 8479.50.

⁵¹ Data on how firms use technology is available for Enterprise Surveys for all CADR countries. However, this data is old. El Salvador is the only country where data was collected in the last five years. These older data show that e-mail use by firms is widespread, websites are common but far from universal, and most firms do not use technology licensed from a foreign-owned company. Many firms introduce new products and processes, but spending on research and development is not common.

on firms' use of robots is not available for CADR countries, but trade data on imports of industrial robots provide suggestive evidence that robotic technologies are not widespread. Costa Rica and the Dominican Republic lead the way with imports in 2021 of US\$7.7 million and US\$2.1 million respectively (table 4.1). At tens of thousands of dollars per robot, these imports could represent around 300 robots imported by Costa Rica or six for every 100,000 people and 80 by the Dominican Republic or less than one robot for every 100,000 people. These imports are very low compared to the US\$1 billion of robots imported by the United States (13 for every 100,000 people) and the US\$270 million imported by South Korea (21 for every 100,000 people). However, they are also much larger than other countries in CADR whose imports were less than US\$850,000 (equivalent to 35 robots or less than half a robot for every 100,000 people).

The persistence of agricultural employment in several CADR countries is further evidence of the lack of diffusion of technologies in the region. The green revolution brought new technologies to farmers in LAC in the 1960s and 1970s, shifting labor out of agriculture and into more productive economic activities (FAO 2022; Fuglie et al. 2020; Schlogl and Sumner 2018). However, technological progress in agriculture has not occurred evenly across the region (Elverdin, Piñeiro, and Robles 2018). Data on agricultural mechanization is very limited and, where available, outdated, but estimates based on projections compiled by the United States Department of Agriculture suggest that farm machinery measured in total horsepower per hectare is around 10 percent of the level in the United States in Guatemala, Honduras, and Nicaragua versus 50 percent and 66 percent in Costa Rica and Panama (USDA 2023). This lack of mechanization helps explain the persistence of agricultural employment in the former 3 countries where about 30 percent of employment remains in agriculture. The lack of mechanization also helps explain why several CADR countries have high rates of automatability: more than 70 percent of jobs at high risk of automation are in agriculture in every CADR country (figure 4.16). The figure is as high as 94 percent in Honduras. The persistence of agricultural employment highlights the puzzle at the beginning of the chapter: many jobs have been automatable for a long time but have not been automated (Schlogl and Sumner 2018).

FIGURE 4.16: Share of Jobs at High Risk of Automation by Sector, 2021



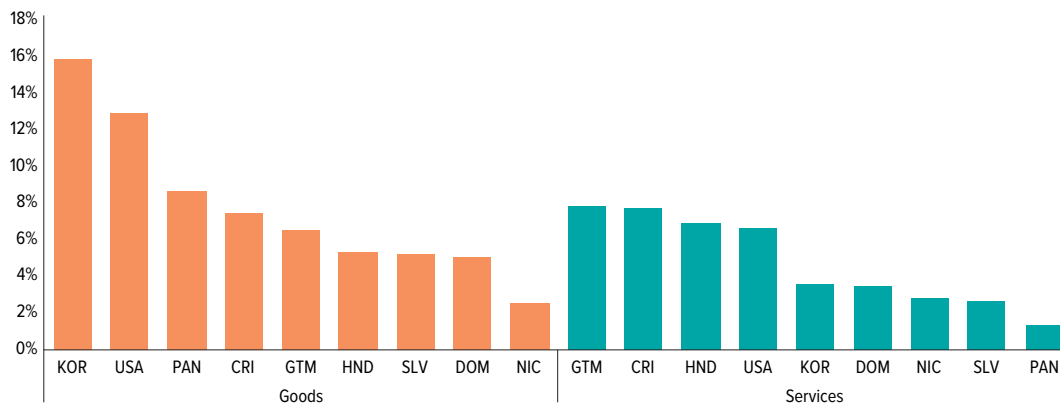
Source: Frey and Osborne 2017; SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras, 2018 for Panama, and 2014 for Nicaragua. DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Trade data provide evidence that imports of technology from abroad are limited. Imports of ICT goods are low, suggesting that CADR countries are not relying on technologies developed outside of the region (figure 4.17). In other developing economies, technology transfer has been shown to shift demand towards more highly skilled workers, a phenomenon referred to as skill-enhancing trade or skill-enhancing technology import (Araújo, Bogliacine, and Vivarelli 2011; Conte and Vivarelli 2011; Meschi, Taymaz, and Vivarelli 2011, 2016). Imports of ICT services are also limited.

FIGURE 4.17: Imports of ICT Goods and ICT Services as Share of Total Trade, 2021

Percentage of total trade in merchandise and services



Source: UNCTAD.

Note: CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; KOR = Korea; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

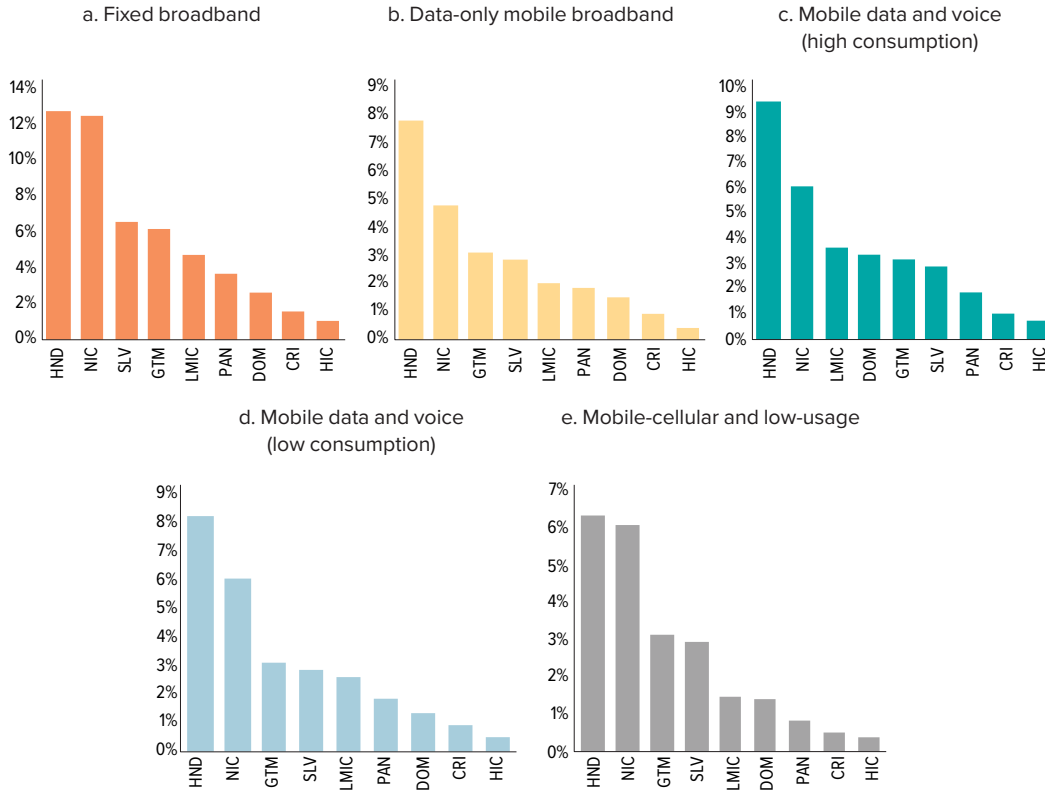
The cost of new technologies may play a different role in CADR than in advanced countries. The decline in the price of computer capital is a key driver of the trend away from occupations that are intensive in routine tasks (Autor and Dorn 2013; Autor, Levy, and Murnane 2003). However, there is evidence that this decline is primarily a developed country phenomenon. For instance, the relative price of investment has declined substantially in advanced economies, driven by computers and equipment, but only mildly in emerging ones (Dao, Das, and Koczan 2019). Consistent with the evidence in chapter 3, this decline has been linked to the greater polarization experienced in developed economies (Das and Hilgenstock 2022). Additionally, cost pressures may not arise to incentivize the adoption of labor-saving technologies in the way they do in developed countries, given the availability of relatively cheap labor. Even in the United States, cost is one of the top two reasons firms cite for not adopting automation technologies (Acemoglu et al. 2022).

The relatively high cost of ICT services in most CADR countries provides an example of how cost may inhibit technological adoption and diffusion. The International Telecommunications Union (ITU), the United Nation’s ICT agency, collects comparable international price data on several types of ICT services. These services are expensive in all CADR countries relative to high-income countries (figure 4.18). The region’s more developed countries—Costa Rica, the Dominican Republic, and Panama—all face prices that are well above those of high-income countries globally. Prices in the region’s less-developed countries—El Salvador, Guatemala, Honduras, and Nicaragua—are higher still, and generally higher than those in low- and middle-income countries. Prices in Honduras and Nicaragua in particular are well above CADR peers, as well as other comparators.

Beyond cost, the challenges of organizational change can also inhibit technology adoption. Recent literature on technology adoption, particularly of AI, highlights the importance of firm structures in determining where new technologies are applied (Agrawal, Gans, and Goldfarb 2023; Bresnahan 2021; Brynjolfsson and Mitchell 2017). Adoption requires rethinking organizational design, business models, and production methods, a process that can take years and significant expertise to accomplish (Feigenbaum and Gross 2023). For example, many producers of soccer balls in Pakistan did not take up a new waste-reducing technology offered to them, likely because of misaligned incentives within the firm—a payment that adjusted these incentives’ increased uptake (Atkin et al. 2017). The informal firms prevalent in CADR countries are unlikely to be well suited to the kind of organizational redesign required to repurpose business models for new technologies, especially the most sophisticated ones.

FIGURE 4.18: Prices of ICT Service Baskets, 2022

Percentage of GNI



Source: ITU 2022.

Note: CRI = Costa Rica; DOM = Dominican Republic; GNI = gross national income; GTM = Guatemala; HIC = high-income countries; HND = Honduras; LMIC = low- and middle-income countries; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Globalization

Globalization tends to favor more employment in routine-intensive jobs in developing countries.

The emergence of global value chains (GVCs) and offshoring is a countervailing force to technology's tendency to favor employment intensive in nonroutine tasks. Developed countries tend to offshore jobs that are intensive in routine tasks to developing countries where labor costs are cheaper (Caunedo, Keller, and Shin 2023; OECD 2017b).⁵² Indeed, cross-country research shows that the offshoring of jobs intensive in routine tasks led to *increased* demand for routine-intensive jobs in emerging China and Poland (Reijnders and de Vries 2018).⁵³ Other cross-country evidence finds that participation in GVCs works alongside structural transformation to increase routine-intensive employment (Das and Hilgenstock 2022). This is found to be true only for occupations that can be offshored (Lewandowski, Madoń, and Winkler 2023).

52 In developed countries, in contrast, offshoring is associated with wage and employment losses for workers in routine-intensive occupations and wage and employment gains for those in nonroutine-intensive ones (Hummels, Munch, and Xiang 2018). However, routine-biased technological change is found to be a more important factor in explaining job polarization in developed countries (Goos, Manning, and Salomons 2014).

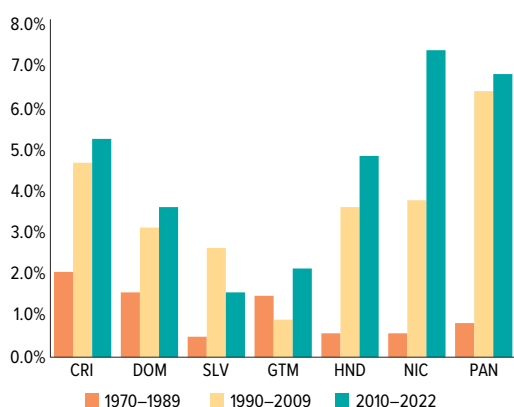
53 Technological change had a larger impact, meaning that the overall trend in these countries was towards employment intensive in nonroutine tasks.

Connections to the global economy have become increasingly important in CADR in recent decades.

Foreign direct investment (FDI) inflows grew from a regionwide average of 1.0 percent of GDP between 1970 and 1989 to 4.5 percent between 2010 and 2022 (figure 4.19). This is in part the result of the entry of CADR countries in manufacturing GVCs, particularly in textile and garments (Dominican Republic, El Salvador, Guatemala, and Nicaragua), automotive (El Salvador, Honduras, and Nicaragua), and medical devices (Costa Rica and the Dominican Republic) (Fernandes, Nieves, and Winkler 2022; Ulku and Zaourak 2021). Though the sophistication of exports is low, several CADR countries are fairly integrated in GVCs. GVC-related output makes up more than 15 percent of total output in Honduras, Nicaragua, and Panama (figure 4.20). This is substantially less than Viet Nam’s 36 percent, but similar to that of Mexico and more than that of Colombia and India. In every CADR country, the manufacturing sector is the most important contributor to GVC participation.

FIGURE 4.19: Net Inflows of Foreign Direct Investment, 1970–2022

Percentage of GDP

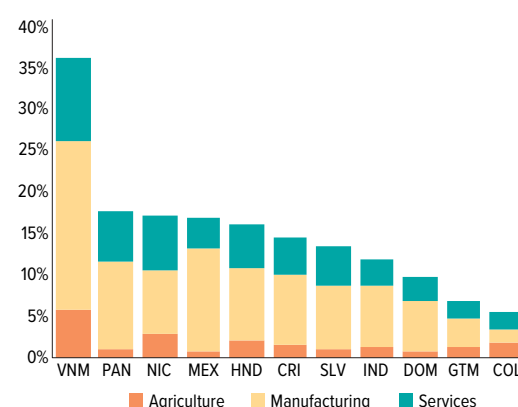


Source: World Development Indicators data, World Bank.

Note: CRI = Costa Rica; DOM = Dominican Republic; GDP = gross domestic product; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

FIGURE 4.20: Share of Output in GVCs by Sector, 2021

Percentage of output



Source: Borin, Mancini, and Taglioni 2021.

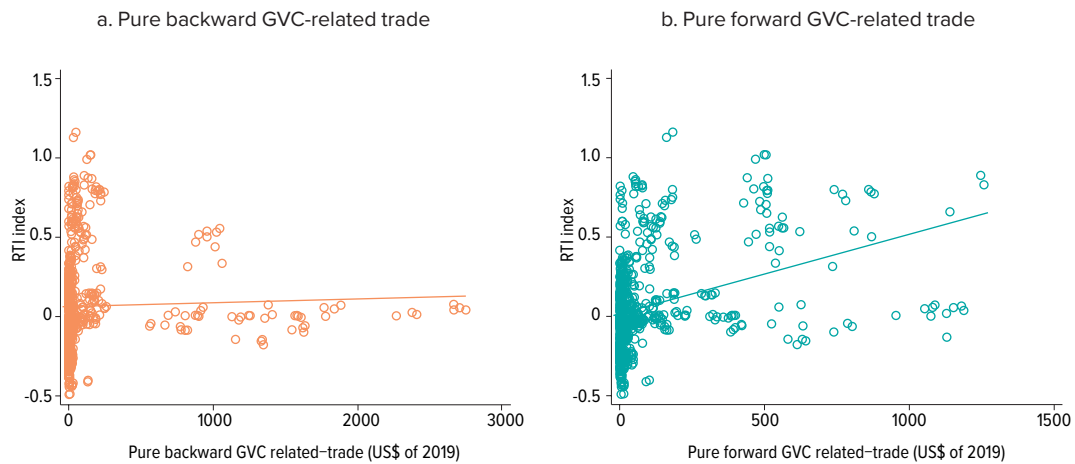
Note: COL = Colombia; CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; IND = India; MEX = Mexico; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; VNM = Viet Nam.

Consistent with the global findings, the association between the RTI index and participation in GVCs is positive in CADR countries.

Positive correlations between the RTI at the country, sector, and year level and the corresponding value of GVC measures indicate that a higher value in GVC activities favors routine-intensive employment. Notably, the positive correlation primarily arises for the forward GVC measure than when using the backward GVC measure, meaning that routine-intensive employment is more common when value added is generated within domestic supply chains without imported inputs (figure 4.21a–b).⁵⁴

⁵⁴ This is consistent with global cross-country comparisons (Lewandowski, Madoń, and Winkler 2023).

FIGURE 4.21: Relationship Between Routine Task Intensity Index and GVCs, 2010–2021



Sources: Borin, Mancini, and Taglioni 2021; SEDLAC (CEDLAS and The World Bank); WITS; PIAAC 2017.

Note: The years are 2011–2021 for Costa Rica, 2010–2021 for the Dominican Republic and El Salvador, 2010–2019 for Guatemala and Honduras, 2010–2014 for Nicaragua, and 2011–2018 for Panama. GVC = global value chain; RTI = routine task intensity.

Though the industrial sector has shrunk in every CADR country except Honduras and Panama, international trade has contributed positively to manufacturing and so likely to the growth of routine-intensive employment. As previously described, the industrial sector of every CADR country except Honduras and Panama shrank between 1991 and 2019. However, trade has counteracted this trend. Recent research on Central America decomposes the factors leading to deindustrialization and finds that international trade had a mitigating influence, meaning that it promoted industrial expansion (Sinha 2022). Looking at each country separately, international trade contributed positively to industrial employment in Costa Rica, Guatemala, Honduras, and Panama but negatively in El Salvador and Nicaragua, though the magnitude of the effect was small in these two countries.

Robot Adoption and Offshoring

Recent evidence suggests that technological progress abroad could reduce the reliance of more developed countries on (routine-intensive) production in developing countries. There is some evidence that offshoring of goods production has reached a peak and that reshoring has increased, though this is uncertain due to measurement challenges (Baldwin 2022; Feenstra 2017; Krenz and Strulik 2021). Automation in more developed countries is a possible mechanism driving this change: automation can create labor savings that incentivize companies to bring jobs back for domestic production or create new jobs domestically instead of abroad. Indeed, cross-country research shows that robots increase reshoring and decrease offshoring (Carbonero, Ernst, and Ekkehard 2020; De Backer et al. 2018; Krenz, Prettnner, and Strulik 2021). This phenomenon has been documented for several LAC countries. Adoption of robots in the United States, for instance, has been found to have negative employment effects in Brazil, Colombia, and Mexico (Artuc, Christiaensen, and Winkler 2019; Faber 2020; Kugler et al. 2020; Stemmler 2019).

Robot adoption in the United States has a negative effect on labor markets in most CADR countries. Following the previous literature in this area, we examine the impact that adoption of robots in the United States has on employment in CADR countries.⁵⁵ The United States is the main export partner for all CADR countries except Panama, so any shift in offshoring patterns in the United States would have a substantial effect on these countries. We are able to undertake the analysis for Costa Rica, the Dominican Republic, El

⁵⁵ See appendix F for full results and a detailed description of the methodology.

Salvador, and Honduras. The period of analysis is 2010 to 2019. Overall, adoption of robots in the United States has a negative impact on employment in the region, likely as a result of reduced opportunities for offshoring. In the Dominican Republic and El Salvador, the average yearly change in CADR countries' exposure measure to robot adoption in the United States is associated with a decline of 0.4 percentage points in labor force participation and employment for workers with medium education. In Costa Rica, the effects of robot adoption are channeled through an increase of 0.2 percentage points in unemployment for low- and medium-educated workers. Honduras is an exception. Robot adoption led to an increase of 0.2 percentage points in the labor force participation of medium-educated workers there. This may be linked to the composition of Honduras's export basket to the United States, which is dominated by raw materials (42 percent of total exports in 2021) and could allow the country to benefit where robot adoption leads to expansions in demand.

Still, factors beyond automation will have a significant influence on the participation of CADR countries in the global economy. Despite evidence of reshoring, the phenomenon remains limited. Indeed, offshoring continues with evidence of growth from the United States through the 2010s (Krenz, Prettnner, and Strulik 2021). Global instability related to trade tensions between the United States and China and to armed conflict, increasing labor costs, and trade tariffs in China, as well as a growing desire to limit supply chain vulnerability after COVID-19 pandemic-related disruptions are shifting decisions about where to invest to countries closer to the FDI source (IFC 2023). The CADR region's proximity to the United States will likely continue to make its countries good candidates for nearshoring, which increased from 15 percent of total United States FDI between 2003 and 2006 to 18 percent between 2016 and 2019 (OECD 2020b). As was discussed earlier in the chapter, the growing importance of trade in services will create new opportunities for offshoring. Finally, there is evidence that robots themselves can have a positive relationship to FDI. Robot density in high-income economies increases FDI stock in developing countries, though this positive impact declines once a certain level of robot density is reached (Hallward-Driemeier and Nayyar 2019).⁵⁶

Robot Adoption and Migration

Technological advances could reduce the demand for migrant workers from CADR countries. CADR migrant workers might experience a decline in demand if they are employed in industries where automation is occurring. This may even lead to wage declines if these previously employed migrants seek out less-exposed industries and increase labor supply. Automation may also lead to a smaller inflow of migrants. For instance, the end of the *bracero* agreements that had allowed agricultural workers from Mexico to work in the United States did not increase domestic employment or wages in part because employers changed production technology or production levels (Clemens, Lewis, and Postel 2018).⁵⁷ Instances of increased immigration enforcement that have reduced the supply of migrant workers have also been shown to lead to increases in automation (Charlton 2023; Ifft and Jodlowski 2022; Konstandini, Mykerezi, and Escalante 2014).⁵⁸

On the other hand, technological advances may alter the type of migrants demanded without reducing the level of migrant flows. As described in chapter 2, automation can increase employment in some cases; for example, when automation-linked labor savings result in increased demand. Migrants may be beneficiaries of this increased employment if increases are concentrated in sectors demanding the skills in which migrants tend to specialize. For instance, migrants in the United States tend to specialize in manual-intensive jobs that are in relatively high demand as routine tasks are automated. Evidence for this is presented in chapter 3, which shows how migration from CADR countries has increased in recent decades and become more concentrated in jobs intensive in nonroutine manual (and interpersonal) tasks. Evidence from Germany and the United States shows that the spread of personal computers, robots, and

⁵⁶ See also Artuc, Bastos, and Rijkers (2023) and Maloney and Melina (2019).

⁵⁷ See also Lewis (2011).

⁵⁸ Studying the relationship between robots and internal migrants in China, Giuntella (2019) finds that the population share of internal migrants declined in provinces with more industrial robots.

AI either does not decrease immigration inflows or actually lead to more immigration, in part as a result of migrants specializing in certain (manual-intensive) tasks (Basso, Peri, and Rahman 2020; Giesing and Rude 2022; Mandelman and Zlate 2022).

Robot adoption in the United States had no observable impact on overall migration flows from CADR countries to the United States in the 2000s and 2010s. Following the previous literature in this area, we examine the impact that adoption of robots in the United States has on inflows of CADR migrants and on the employment outcomes of these migrants.⁵⁹ We use data on robot adoption at the sector level from the International Federation of Robots and focus on impacts on local markets known as commuting zones during two periods, the second of which (2010 to 2019) saw significantly more robot adoption than the first (2000 to 2010).⁶⁰ The adoption of robots does not affect the overall number of migrants from CADR countries to the United States. However, robot adoption does have an effect on the distribution of migrants by their level of education in the second period and on labor market indicators in both periods.

Robot adoption in the United States in the early 2000s increased the demand for high-skilled CADR migrants but in low-skilled, nonroutine occupations. During the first period between 2000 and 2010, an increase of one robot per thousand industrial workers was associated with a higher employment rate and a lower unemployment rate for high-educated CADR migrants. This could be the result of complementarity between high-educated CADR migrant workers and robots or of an increase in aggregate demand due to a surge in productivity. The evidence indicates that nearly half of highly educated CADR migrants work in occupations that only require low- to mid-skilled qualifications, compared to about 20 percent of nonmigrant workers. We speculate that the increase in their employment rate is related to a switch to lower-skilled, nonroutine, manual (less automatable) jobs, particularly in food preparation and building and grounds cleaning and maintenance, where a demand expansion linked to automation created more employment.

Robot adoption in the United States between 2010 and 2019 led to less demand for high-educated CADR migrants. In the second period between 2010 and 2019, the results go in the opposite direction. The employment rate of high-educated CADR migrants declined 0.4 percentage points for each additional robot, while the total number of high-educated CADR migrants fell by 53 migrants for each additional robot adopted. The negative employment impact could be a direct effect of robot adoption if high-educated CADR migrants were employed in those industries more exposed to automation during this period, or of a weakening of their response to the demand expansion effect that seems to have been at play in the first period. The evidence shows that the participation of high-educated CADR migrants in jobs requiring lower levels of education stopped increasing and even declined during this period. Additionally, the change in the industrial distribution of employment of high-educated CADR migrants and the change in robot adoption has a correlation close to zero, suggesting that labor outcomes of high-educated CADR migrants continued to be driven mainly by the aggregate demand implications of automation.

⁵⁹ See appendix F for a detailed description of the methodology.

⁶⁰ Around 170,000 robots were adopted in the United States between 2010 and 2019, versus around 100,000 between 2000 and 2010.

Chapter 5

Policy Recommendations

This chapter sets forth policy priorities to help facilitate technological change while mitigating the negative effects of disruptions that occur as a result of this progress. Supporting technology adoption and diffusion will be key to CADR countries' continued development. This will need to be done taking into account the unique circumstances in CADR countries, particularly the persistence of agricultural employment in several and the rapid shift to services employment across the region. Business advisory and related services can promote technology uptake, improve the management skills that are often a prerequisite of technology adoption, and improve linkages between small businesses and the digital platforms that can open new markets. From a labor market perspective, two priorities emerge for CADR countries to take advantage of the benefits of technological progress while mitigating the downsides. First, pathways for developing skills complementary to new technologies will be essential. Second, social protection and labor market policies will need to be adapted to new working arrangements on one hand and to the disruptions associated with technological progress on the other. Within these adaptations lies a short-term opportunity to expand access to social protection by developing partnerships among digital platforms, governments, and service providers.

SETTING THE STAGE: FACILITATING TECHNOLOGICAL PROGRESS FROM WHICH WORKERS CAN BENEFIT

CADR countries have not yet experienced significant disruptions from technological progress, nor have they taken full advantage of its potential benefits. Chapter 3 and chapter 4 provided empirical evidence of the relatively limited viability of automation in CADR countries. Labor market disruptions associated with technological change have been limited thus far in CADR. While many workers in the region seem to be at risk of losing their jobs to machines, a number of factors related to employment structure, skills, the use of technology, and globalization mean that this risk has not materialized and is unlikely to do so in the near term. However, this also means that the region is not yet benefiting from the potential gains associated with technological progress.

The challenge for policymakers in CADR is to balance policies that enable technological progress and the benefits it brings with policies that mitigate the effects of any ensuing disruptions. Technological progress is a key component of development, allowing for increased productivity, new products and services, and access to new markets. Chapter 2 provided evidence that in many cases, technological progress goes hand in hand with better employment outcomes. Given the low adoption and diffusion of technology in CADR countries described in chapter 4, supporting adoption and diffusion will be key to facilitating CADR countries' continued development. From a labor market perspective, two priorities emerge for CADR countries to take advantage of the benefits of technological progress while mitigating the downsides. First, pathways for developing skills complementary to new technologies will be essential. Second, social protection and labor market policies will need to be adapted to new working arrangements on one hand, and to the disruptions associated with technological progress on the other. The region's

TABLE 5.1: Policies to Facilitate Technological Change and Mitigate the Negative Effects of Resulting Disruptions

Objective 1: Promote the adoption and diffusion of technology by building firm capabilities		
Building strong foundations	<ul style="list-style-type: none"> • Ensure quality infrastructure (e.g., electricity, internet service, mobile networks) • Promote competition, ensure regulations enable technology adoption and diffusion, and expand access to finance 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Strengthen business advisory and technology extension services, and technology centers to promote technology uptake among firms and improve management capabilities	Utilizing extension services to increase technology uptake in the agricultural sector	Targeting services through assessments of market failures, strength of demand, and risk of overcrowding the market
Promote SME use of digital platforms by increasing digital skills, awareness, and technology uptake	Piloting initiatives that develop digital skills among SMEs	Developing initiatives that help connect SMEs to overseas markets
Objective 2: Strengthen pathways for skills development and deployment		
Building strong foundations	<ul style="list-style-type: none"> • Invest in early childhood education and strengthen basic literacy and numeracy for school-age children 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Develop labor market insight tools to collect, analyze, and disseminate information about the labor market	Introducing or strengthening labor force surveys and utilizing administrative data	Deploying vacancy, skills profiling, and other specialized surveys and exploring novel sources of labor market information (for example, online job postings)
Build foundations-driven, demand-oriented education and training systems that are designed to be lifelong and targeted to workers at greater risk of labor market disruptions	Piloting remedial skills and demand-driven training programs that improve literacy and numeracy and basic digital skills and that fill labor market demand in strategic areas	Identifying areas of growing demand in real time, developing training programs in response, and incorporating other support services into these training programs
Design digitally enabled, fit-for-purpose intermediation programs that focus on overcoming geographic disparities and information problems	Building a public employment services system that is a reliable information source Exploring global skills partnerships (GSPs) to create safe and inclusive migration pathways	Expanding the public employment services system to provide labor market intelligence, career and skills guidance, job matching, and referral services
Objective 3: Adapt social protection and labor market policies to new forms of work		
Building strong foundations	<ul style="list-style-type: none"> • Move away from reliance on traditional employer-employee relationships for financing and providing social protection 	
All CADR countries can work to	CADR's less developed countries can focus more on	CADR's more developed countries can focus more on
Exploit the potential of platform work	Avoid regulations that lead to further labor market segmentation	In the short term, explore models for expanding access to social protection to platform workers
Monitor potential anti-competitive practices	Develop models of the businesses, characteristics, and anti-competitive potential of digital platforms	Develop more sophisticated analyses of the particular anticompetitive practices of platforms, especially issues related to data

more developed countries—Costa Rica, Panama, and, in many respects, the Dominican Republic—are generally at a more advanced stage of structural change and technology adoption. This means that different CADR countries have somewhat different priorities (table 5.1). The region’s less advanced countries need to focus more on building foundational structures and piloting new initiative while the region’s more advanced countries can work to improve the sophistication of existing systems.

PROMOTE THE ADOPTION AND DIFFUSION OF TECHNOLOGY BY BUILDING FIRM CAPABILITIES

CADR countries lag in the adoption and diffusion of technology. Chapter 4 describes the deficits in technology use by CADR workers and firms. Overall measures of adoption of digital technologies as well as measures related to adoption of frontier technologies show that all countries in the region are substantially behind advanced economies.

A range of barriers can interrupt a firm’s adoption of new technology. Good infrastructure—electricity, internet service, and mobile networks—is key to enabling technological progress. Beyond these basic enabling factors, firms face several challenges. Recent research by the World Bank organizes the drivers of technology adoption at the firm level into factors internal and external to the firm (table 5.2). External factors include market conditions and regulations, access to finance, and the supply of knowledge and human capital. Internal factors are firm capabilities that include skills, management and organizational practices, and the informational and behavioral biases of entrepreneurs and managers. The assessment makes clear that, far from just pushing certain types of technology, policies to support technology adoption must focus on improving the availability of information and the abilities of firms to manage and learn, especially from external sources (Caselli and Colemann 2006).

TABLE 5.2: Drivers of Technology Adoption Among Firms

Factors		Examples
External	Competition, demand, regulations	• Competition creates incentives to adopt technology.
	Access to finance	• Access to finance permits firms to finance investment in technology.
	Access to knowledge and human capital	• Knowledge transfer from other firms, within the firm, from consultant firms, or from exporting can create technology demand.
Internal	Information and behavioral biases	• Biases like reference group neglect can lead entrepreneurs to believe they are already investing in more sophisticated technology. • Lack of information about returns to technology, difficulty evaluating uncertainty, or lack of knowledge about use of technology can lead a firm not to adopt new technology.
	Management and organization	• Low management quality leads to less technology adoption.
	Know-how and skills capabilities	• Human capital in a firm is necessary for the adoption of more sophisticated technologies.

Source: Cirera, Comin, and Cruz 2022.

Governments can support technology uptake among firms. The point of departure for policymakers is ensuring that infrastructure of sufficient quality is in place to allow firms to adopt more sophisticated technologies and that regulations do not create challenges to adoption (Cirera, Comin, and Cruz 2022; Dutz, Almeida, and Packard 2018). Beyond this, a range of policies can be used to address the internal and external drivers of technology adoption. This section focuses on policies that can support the skills and knowledge needed inside and outside of the firm to facilitate uptake, though policies that increase

access to finance, subsidize technology, or increase competition are also crucial (box 5.1). In any case, an assessment of the market failures justifying government intervention and a diagnostic of the causes of underutilization of technology is a critical first step (Cirera, Comin, and Cruz 2022).

BOX 5.1: Promoting Competition, Rightsizing Regulations, and Expanding Access to Finance to Facilitate Technology Adoption

Promoting competition, rightsizing regulations, and expanding access to finance are key components of promoting technology adoption and of benefiting from the opportunities that adoption creates. Competition helps spur technology adoption, particularly where there are low levels of competition. This is evident in the tendency for greater global linkages to increase adoption and technological sophistication. Regulation can both facilitate and hinder technology adoption. Regulations in areas including e-payments, consumer protection, and cybersecurity can address new issues raised by digital commerce, facilitate remote and cross-border transactions, and promote trust. At the same time, regulations can restrict digital markets from flourishing when there are strict restrictions on the goods or services available in digital marketplaces or when restrictions make data transfer challenging. In these cases, regulations can hinder the expansion of markets that increase opportunities for small and medium-sized enterprises. Regulations that impose taxes and tariffs on ICT can hinder technology adoption with knock-on effects on GDP growth. Finally, insufficient access to finance can impede technology adoption if firms need to undertake costly technology investments on their own. Overall, to address these issues an adaptable regulatory framework is needed with policies that promote competition and access to finance, ranging from careful consideration of any taxes and tariffs on ICT to efforts to increase the financial sector's knowledge of and comfort with financing for technology-related projects.

Sources: Cirera, Comin, and Cruz 2022; Dutz, Almeida, and Packard 2018; Jaller, Gaillard, and Molinuevo 2020.
Note: GDP = gross domestic product; ICT = information and communication technology.

Business advisory services, technology extension services, and technology centers can promote technology uptake.⁶¹ Business advisory services provide advice on a range of general business functions ranging from human resources to accounting and marketing and advertising. The services are typically targeted to SMEs, which often lack skills and knowledge across these areas. More effective models begin with a diagnostic phase followed by the development of an action plan. Digital upgrading programs are a business advisory service devoted to facilitating the uptake of digital technologies. A subset of these programs focuses on linking firms to digital platforms by providing support in areas like customer orientation, pricing, and reputation maintenance. Technology extension services are another option that tends to focus on the demand for and the skills needed to utilize more sophisticated, sector-specific technologies. They typically function via field offices and extension staff. Finally, technology centers tend to be sector-specific and help develop new technologies or adapt existing ones and provide the skills needed to adopt these technologies. Technology centers generally focus more on the diffusion of technologies in developing countries than on research and development. Evidence on the impacts of each of these three types of services is rare, though suggestive of positive effects on upgrading technology. Important considerations for policy are factors that can limit effectiveness, which include the availability of expertise, the strength of demand among the firms most in need of support, and the risk of overcrowding the market for business support services. The importance of taking these limiting factors into account makes these types of services better suited for CADR's more advanced countries.

⁶¹ This paragraph is based on Cirera, Comin, and Cruz (2022).

Special focus is needed in CADR's less advanced economies on how technology can help modernize agriculture. Agricultural sectors in CADR remain large as a share of employment relative to more advanced economies, particularly in Guatemala, Honduras, and Nicaragua. A focus on uptake of digital technologies and automation in agriculture via extension services could help spur growth (Yusuf 2017). Low adoption of technology in CADR's agricultural sectors is likely undermining agricultural productivity, given the strong link between the two (Fuglie et al. 2020). For example, in El Salvador, technological change and technical efficiency (a proxy for managerial performance) have been detrimental to agricultural productivity (Bravo-Ureta et al. 2022). This points to the potential utility of extension services that can enhance the adoption and diffusion of technologies and improve managerial abilities. Provision of these services is made more important by the negative impacts of climate change on agricultural productivity and the need for mitigation and adaptation strategies that themselves require new technologies (box 5.2) (Bravo-Ureta et al. 2022; Lachaud, Bravo-Ureta, and Ludena 2017). Although evidence for the impacts of business support services on technology uptake in general is limited, positive results are common for agricultural extension services (Cirera, Comin, and Cruz 2022). Chapter 4 provided examples of how digital technologies ranging from SMS messages to remote sensors can help increase the productivity of smallholder farmers.

BOX 5.2: Green Jobs in CADR

Shifting to greener growth strategies will involve both the development of new technologies and the disruption of labor markets. Climate change is causing substantial economic damage and reducing productivity in CADR countries as the frequency and intensity of extreme weather-related events increase and slow onset effects like temperature increase take hold (World Bank 2022a). Despite these challenges, CADR countries have opportunities for more sustainable, low-carbon development (World Bank 2023a; 2023b). This transition will require adopting cleaner, lower-carbon technologies. As with any technology-related transition, however, there is potential for labor market disruption. The extent to which a shift towards greener growth could affect labor markets in CADR countries can be evaluated by looking at the green task intensity (GTI) of jobs in the region—that is, how many jobs involve green tasks currently (narrow GTI) and how many could be green if greener technologies were adopted (broad GTI) (Granata and Posadas 2022).⁶²

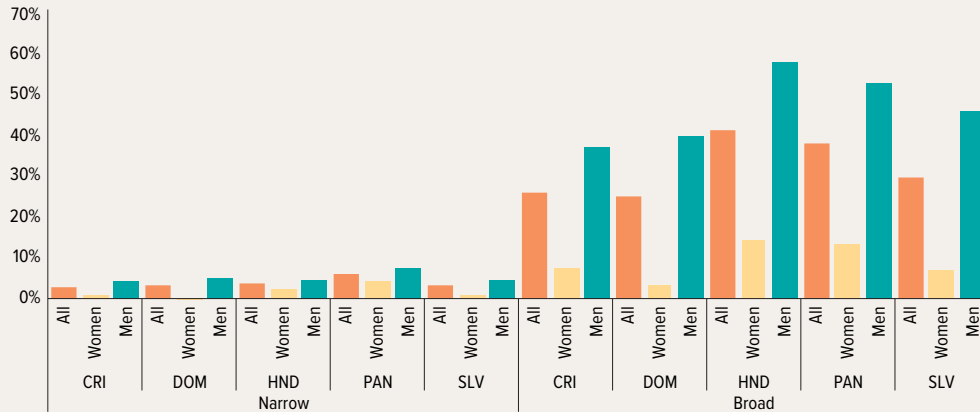
Green jobs make up a small share of employment in CADR countries currently, but greener technologies could expand the scope of green employment substantially, particularly in agriculture. Between 3 and 6 percent of employment in Costa Rica, the Dominican Republic, El Salvador, Honduras, and Panama is in jobs that currently involve environmentally friendly tasks (figure B5.2.1). This share rises significantly when jobs with tasks that could be environmentally friendly, given greener technologies, are considered. This compares with estimates of between 2 and 15 percent of employment in Indonesia and 4 and 41 percent in Viet Nam using the same methodology, and between 2 and 3 percent in the United States using an alternative methodology (Doan et al. 2023; Granata and Posadas 2022; Vona, Marin, and Consoli 2019). The large increase under the broad measure is driven by agriculture: with more environmentally friendly technologies, employment in agriculture, which accounts for a substantial share of employment in the CADR countries considered, would be a source of many green jobs (figure B5.2.2). Notably, men are more likely to work in green jobs than women, and the introduction of green technologies would primarily expand the employment of men in green jobs rather than women.

62 Green tasks reduce a consumer's and/or firm's environmental impact (Granata and Posadas 2022).

BOX 5.2: Green Jobs in CADR (continued)

FIGURE B5.2.1: Share of Green Jobs in CADR Countries Overall and by Gender, 2021

Percentage of employment

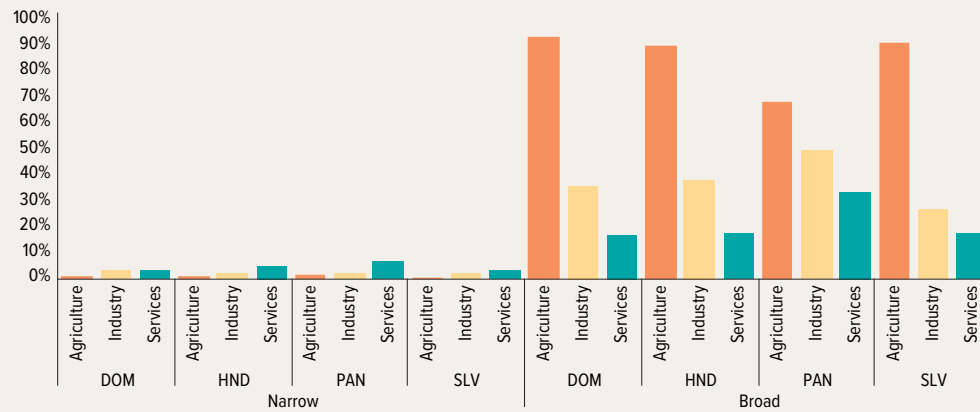


Sources: Granata and Posadas 2022; SEDLAC (CEDLAS and The World Bank).

Note: Data are 2019 for Honduras. CRI = Costa Rica; DOM = Dominican Republic; HND = Honduras; PAN = Panama; SLV = El Salvador.

FIGURE B5.2.2: Share of green jobs in CADR countries by sector, 2021

Percentage of employment



Sources: Granata and Posadas 2022; SEDLAC (CEDLAS and The World Bank).

Note: Data are 2019 for Honduras. Data is not available by sector for Costa Rica.

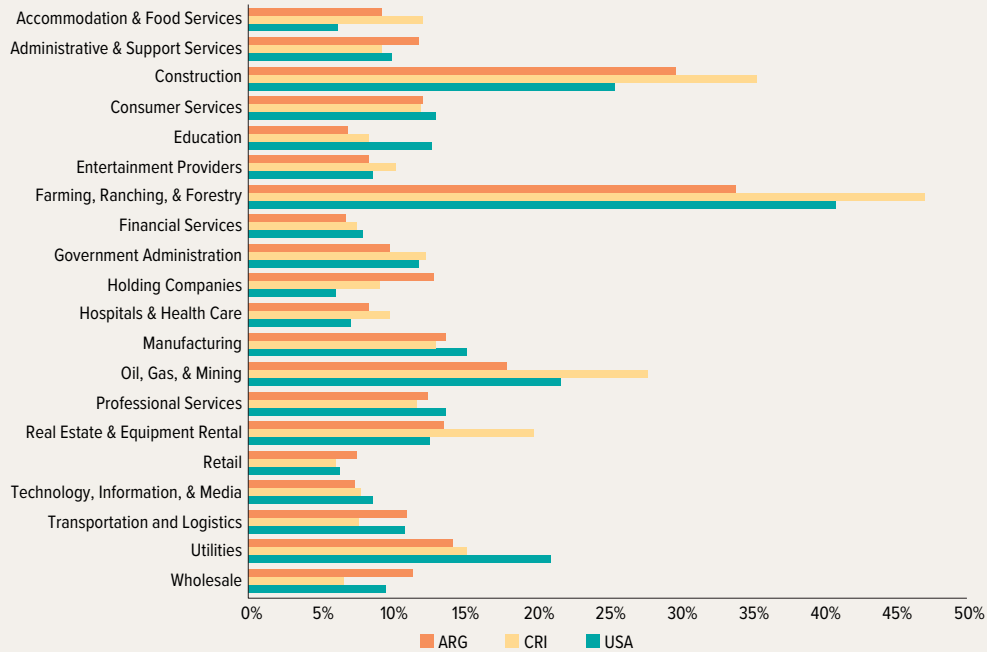
Data from LinkedIn suggests that green jobs are prevalent in some sectors in Costa Rica.

The professional networking site LinkedIn calculates a measure of green talent as the share of LinkedIn members in an industry working in a green job or who have at least one green skill. Data is only available for Costa Rica, which performs favorably compared to Argentina and the United States on green talent. An average of 15 percent of LinkedIn members in Costa Rica have green talent versus 13 percent in Argentina and 14 percent in the United States. The industries with the most green talent are farming, construction, and oil and gas—the same as in Argentina and the United States—while those with the least are retail, wholesale, and finance (figure B5.2.3).

BOX 5.2: Green Jobs in CADR (continued)

FIGURE B5.2.3: Green Talent in Costa Rica and Comparator Countries, 2023

Percentage of employment



Source: LinkedIn.

At the more sophisticated end of the skills spectrum, management skills are a key part of the ecosystem needed for technology adoption. As described in chapter 4, good management is increasingly viewed as a prerequisite for technology adoption and a key determinant of firm performance. Improved capabilities were an important part of the substantial growth experienced by countries in East Asia (Cirera and Maloney 2017). Business trainings that seek to improve management practices generally have positive impacts, though given their typically short duration, impacts are expected to be fairly small (McKenzie 2021). New approaches to such trainings could improve effectiveness and scale the programs to larger numbers of small and medium-sized firms. These alternatives include adapting programs to local contexts, targeting programs to women, and taking advantage of technology to expand the audiences reached.

Policy can also help small and medium-sized businesses take advantage of opportunities in digital trade in services by increasing their use of platforms. Platforms create an opportunity for small businesses to expand their customer and supplier bases but accessing and utilizing them can be challenging for inexperienced firms. SMEs in all CADR countries with data available cite the need for more technical skills and knowledge as one of the top three challenges when using or trying to adopt digital platforms (table 5.2). Though a range of policy instruments is available to facilitate adoption and use of platforms, any public program must be clear about its motivation and the market failure being addressed. Platforms themselves have motivations for making themselves attractive to users and even to provide training. The most common policy objective for programs promoting SME use of platforms is to increase digital skills and awareness and uptake of technologies (OECD 2021). Several OECD countries have developed initiatives that help SMEs evaluate how they could benefit from digital technologies, provide information on platforms, and instruct SMEs on how to utilize platforms to their advantage. These include Australia’s Guide to Digital Transformation, Denmark’s E-Commerce Center, and the United Kingdom’s

E-Exporting Programme that helps support businesses to sell overseas online. There is some evidence that programs of this type are effective. A recent impact evaluation of a large-scale training program for new e-commerce sellers finds that sellers receiving training in practical skills in online business operations earned higher revenue and attracted more consumers (Jin and Sun 2021).

TABLE 5.3: Main Challenges Cited by SMEs When Using or Trying to Adopt Digital Platforms, 2022

Percentage of firms citing challenge as one of top 3 challenges

Country	Top 3 challenges
Costa Rica	<ol style="list-style-type: none"> 1. Need for more technical skills and knowledge (34%) 2. Extreme or unfair competition (32%) 3. Fees for accessing digital platforms (23%)
Dominican Republic	<ol style="list-style-type: none"> 1. Need for more technical skills and knowledge (35%) 2. Need for more resources or infrastructure (for example, broadband) (23%) 3. No challenges (22%)
El Salvador	<ol style="list-style-type: none"> 1. Need for more technical skills and knowledge (40%) 2. No challenges (24%) 3. Extreme or unfair competition (23%)
Guatemala	<ol style="list-style-type: none"> 1. Extreme or unfair competition (33%) 2. Fees for accessing digital platforms (31%) 3. Need for more technical skills and knowledge (28%)
Honduras	<ol style="list-style-type: none"> 1. Need for more technical skills and knowledge (37%) 2. Fees for accessing digital platforms (28%) 3. Extreme or unfair competition (26%)
Nicaragua	<ol style="list-style-type: none"> 1. Need for more technical skills and knowledge (32%) 2. No challenges (22%) 3. Extreme or unfair competition (21%)

Source: [Future of Business Surveys](#).

Note: Data are not available for Panama. Adoption is for the sale or purchase of goods and services.

STRENGTHEN PATHWAYS FOR SKILLS DEVELOPMENT AND DEPLOYMENT

Mitigating the disruptions and taking advantage of the opportunities of technological progress will require a special focus on investments in human capital. Chapter 4 described the human capital quantity and quality challenges facing CADR countries that are contributing to low technology adoption, a phenomenon that has long been identified as a challenge in LAC (Maloney 2002). Ensuring that current and future workers are equipped with the right skills to complement new technologies is an essential component of taking advantage of the growth made possible by technological advancement. Strengthening skills development pathways in basic, secondary, and tertiary education for children and youth as well as in technical and vocational education and training (TVET) and upskilling and reskilling programs for adults, will be critical (Ferreyra et al. 2021). To the extent that the demand for tasks and skills is changing in CADR countries, demand-driven TVET for future workers and demand-driven upskilling and reskilling for current workers will be important. At the same time, incorporating the socioemotional and digital literacy skills that are becoming essential across occupations throughout the learning cycle from early childhood development to training programs will be essential.

Building human capital is necessary but insufficient, as people also need to be able to deploy their investments in human capital effectively. Skills building programs generally have a positive impact on employment and earnings, but designing them with labor market insertion in mind is critical to ensuring

that these impacts are meaningful and cost-effective. The impact of training programs on employment and earnings in developing countries, including LAC, is positive but modest (Escudero et al. 2019; McKenzie 2017). More promising programs tend to target sectors with growing labor market demand, combine training with complementary services including labor market intermediation and financial support, take into account the challenges faced by particular groups, and address mismatches in skills across geographies and sectors (Carranza and McKenzie 2023; Ferreyra et al. 2021; Katz et al. 2022; Kluge et al. 2019; McKenzie 2017; Stöterau 2019). For labor market intermediation programs in particular, encouraging job search in different places, updating a candidate's beliefs, and improving a candidate's ability to signal their skills are linked to greater effectiveness (Carranza and McKenzie 2023). These efforts need to be adapted to the unique challenges facing different groups.

Improving skills development pipelines requires strengthening three aspects of employment support services. First, labor market insight tools collect, analyze, and disseminate information about the labor market to help design employment programs that are able to target disadvantaged groups, funnel beneficiaries to sectors in growing demand, and update beliefs and correct biases about the labor market that may hold individual jobseekers back. Second, foundations-driven, demand-oriented education and training systems provide the foundational abilities and in-demand skills that current and future workers need to complement technological progress. Finally, digitally enabled, fit-for-purpose intermediation programs help deploy human capital effectively by complementing private sector offerings, utilizing technology to expand the scope and efficiency of service delivery, and focusing on service gaps and underserved groups.

Deploy Labor Market Insight Tools

Strengthening skills pathways begins with identifying the skills that are needed to facilitate technological progress and the skills that are needed as technology advances. This means enhancing efforts to anticipate and respond to needs for more specialized skills.

Developing tools that can rapidly identify private sector demand is more important than identifying specific skills in advance. Technological change means that skill needs change rapidly. For example, cross-country evidence suggests that vocational education, which tends to provide training in specific skills, assists with entry into jobs but can then reduce a worker's adaptability to technological change (Hanushek et al. 2017).⁶³ Tools to identify in-demand skills can help policymakers inform training and educational institutions about the kinds of skills that are currently in demand in the labor market to help create skills development pathways that are adaptable and that complement technological progress (Isik-Dikmelik et al. 2022). In Switzerland, for example, updated education curricula are shown to hasten the arrival of new technologies in firms (Schultheiss and Backes-Gellner 2022b). Crucially, these tools can help target limited training resources to areas where demand is strong and growing. A variety of instruments are available to undertake such identification. These vary in sophistication and can be deployed in a sequential manner over time to create a fuller picture as labor market information capacities are developed (table 5.3). In the case of digital skills in particular, the World Bank has developed a guidebook for developing digital skills country action plans that includes guidance on how to assess demand for and supply of digital skills in environments where data is limited (World Bank 2021a; 2021b).

63 Similarly, graduates in science, technology, engineering, and math majors in the United States enjoy high wages upon entering the labor market but over time technologies replace tasks using these skills leading to lower returns (Deming and Noray 2018).

TABLE 5.4: Tools for Identifying In-Demand Skills

Tool	Objective	Examples
Critical occupations list	<ul style="list-style-type: none"> Combine quantitative and qualitative data sources to identify occupations that are in shortage 	<ul style="list-style-type: none"> Malaysia Indonesia
Occupational employment and vacancy survey	<ul style="list-style-type: none"> Firm survey collecting data on demand at the detailed occupational level 	<ul style="list-style-type: none"> Indonesia United States
Survey of detailed skills and tasks	<ul style="list-style-type: none"> Worker surveys collecting data on skills and tasks 	<ul style="list-style-type: none"> European Union Indonesia United States Vietnam
Online vacancy data	<ul style="list-style-type: none"> Collect online job postings that have information on skills, education, and experience requirements and can also be used to assess demand 	<ul style="list-style-type: none"> Australia Indonesia United States

Source: Based on Posadas and Testaverde 2022.

Build Foundations-driven, Demand-oriented Education and Training Systems

Increasing the skill level of the workforce is necessary to complement technological change. For future workers, this begins with enhancing the quality and increasing the availability of early childhood education (Vegas and Santibáñez 2009), improving the quality of basic education so that students master foundational skills in the early years of schooling (World Bank 2022e), and increasing the share of young people who obtain secondary and post-secondary education and the quality of their learning in these years (OECD 2023). For current workers, this means adopting training approaches that build both foundational and specialized skills that are demanded in the labor market.

Foundational skills are essential for both current and future workers. Tasks that involve foundational skills like literacy, numeracy, and socioemotional skills are key to unlocking the benefits of technological progress both because they form the building blocks of more advanced, specialized skills and because they complement other skills (Levin et al. 2023). Without strong foundations, it is difficult for students and workers to benefit from more advanced training. In Mexico, for example, scholarship programs to encourage youth to stay in school failed to raise learning levels because the young people lacked the foundational skills to succeed in secondary education (de Hoyos, Attanasio, and Meghir 2019). Evidence indicates that foundational skills are important complements for new technologies (Dalvit et al. 2023; Cunningham et al. 2022; World Bank 2018). In the United States, for example, jobs requiring high levels of social interaction grew substantially between 1980 and 2012, while there is evidence of growing complementarity between social and cognitive skills, which are correlated with pay and firm performance, perhaps because of differences in how firms utilize technology (Deming 2017; Deming and Kahn 2018; Weinberger 2014).

Digital skills are a linchpin of efforts to benefit from technological progress. Digital skills are the skills needed to accomplish tasks with ICT. These can be broken down into a set of basic skills—digital literacy—used to perform rudimentary tasks (for example, e-mailing, using digital devices, and storing and accessing digital information); intermediate ones for using professional software for analysis, creation, management, and design; and advanced ones for undertaking specialized tasks like data science, cybersecurity, or programming (Cunningham et al. 2022; UNESCO 2017b; IFC 2019). Digital occupations like software developers, programmers and engineers, and data scientists and engineers are growing quickly (OECD 2022b). At the same time, digital skills are growing in importance across occupation types (Feijao et al. 2021; Cunningham et al. 2022; World Bank 2021a). For example, digital literacy is key in agriculture to enable small-scale farmers to access and benefit from digital support services like market and weather services (FAO 2022; Morris, Sebastian, and Perego 2020; Fuglie et al. 2020). Regardless of occupation, platform workers need basic digital skills to manage the apps through which they access jobs and receive payment.

Education and training can help prepare the workforce to benefit from technological progress while also assisting workers displaced by automation. Several principles can help ensure that education and training is impactful in the context of technological progress.

First, education and training should focus on the provision of transferable, particularly foundational, skills. As previously described, there is increasing evidence of the importance of foundational skills like basic literacy and numeracy, soft or socioemotional skills like critical thinking and teamwork, and digital skills. Improving these foundational skills for future workers requires significant effort across the education system, beginning with early childhood education (box 5.3) and continuing through education for school-aged children and young people. Improving basic literacy and numeracy can be achieved by improving student readiness to learn through early childhood interventions; focusing curriculum, assessment, and instruction on essential learning and foundational reading and math; improving teaching quality and effectiveness; and aligning school management to focus on foundations (World Bank, 2022h).

BOX 5.3: The Labor Market Benefits of Early Childhood Education

Quality childcare can have long-run positive impacts on labor market outcomes. Quality childcare is important to enable women to participate fully in the workforce, particularly in CADR where women's labor force participation is low and motherhood pushes many women into part-time and informal jobs (Díaz and Rodríguez-Chamussy 2016). In addition to the short-term benefits for women's labor force participation, quality childcare can have positive long-run effects on labor market outcomes by helping young children develop the cognitive and socioemotional skills that enable them to reach their full potential as adults (Devercelli and Beaton-Day 2020).

Quality childcare that includes a focus on early childhood education (ECE) can help prepare young children for school. Children's brains develop rapidly in early childhood. Deficits in early years can have lasting impacts. The early learning provided in childcare settings can help children build the cognitive and language skills needed to succeed when they enter school, as well as the socioemotional skills that are increasingly critical later in life (Devercelli and Beaton-Day 2020).

These benefits can last into employment in adulthood. A recent study comparing outcomes of children who benefited from the initial years of the Head Start Early Childhood Education (ECE) program in the mid-1960s in the United States to those who just missed the introduction of the program found significant effects on human capital formation and long-run economic outcomes (Bailey, Sun, and Timpe 2021). Head Start children received 0.65 more years of education and were 12 percentage points more likely to complete college than their peers who did not benefit. Adults who benefited from the program as children were more successful in the labor market, working an average of two more weeks per year than nonbeneficiaries. Quality ECE also has significant positive effects on later life outcomes in less developed settings. A study of 12 low- and middle-income countries found that adults who participated in ECE programs as children were more likely to be employed in jobs requiring higher skill levels (Shafiq, Devercelli, and Valerio 2018).

Vocational and short-course training can play an important role in reinforcing foundational skills for those already in the workforce. For example, in Cambodia, pilots of a skills bridging program to provide foundational skills to out-of-school youth led 60 percent of the participants to enroll in certificate programs in technology (World Bank, UNESCO, and ILO 2023). In the Dominican Republic, vocational and soft skills training provided by the *Programa Juventud y Empleo* increased employment among women (Acevedo et al. 2020). Notably, the participants who only received the soft skills training benefited as much as participants who received the technical training. In Colombia, vocational training participants

who received training emphasizing social skills did not experience the same type of erosion of training benefits that recipients who received training emphasizing technical skills did (Barrera-Osorio, Kugler, and Silliman 2023). Digital skills training can teach basic digital literacy or provide more advanced, but still not firm-specific, technical skills like programming or cybersecurity (box 5.4). A recent impact evaluation of a coding bootcamp program for women in Argentina and Colombia found that the bootcamps increased coding skills and the probability of getting a job in the technology sector (Aramburu and Goicoechea 2021). Training of this type may be effective because it addresses a market failure in skills provision—employers may underinvest in transferable skills that workers could take to other firms—and because soft and basic digital skills are more durable than technical skills, the demand for which evolves quickly over time (Carranza and McKenzie 2023; Schultheiss and Backes-Gellner 2022a).

BOX 5.4: Incorporating Digital Skills Training into Technical and Vocational Education and Training

TVET systems globally have responded slowly to the growing demand for digital skills. A World Bank, UNESCO, and ILO (2023) report on TVET highlights digital skills training as a challenge for TVET systems globally. Many learners enter TVET programs lacking foundation skills. Many instructors lack proficiency to adequately instruct learners and to ensure that the digital skills curricula developed in TVET systems respond to labor market demands (Banga and te Velde 2019). The low level of digital skills among both learners and instructors was made clear during the COVID-19 pandemic when TVET systems struggled to transition to remote learning.

TVET programs can mainstream digital skills into training offerings. TVET programs can integrate training in foundational skills with training in key digital, socioemotional, and cognitive skills demanded by the labor market. This can be done via standalone courses that provide instruction in basic foundational skills first and then layer practical skills training in separate courses, or via courses that integrate foundational and transversal skills acquisition into the practical course content (World Bank, UNESCO, and ILO 2023). Programs aiming to support the development of advanced, job-specific digital skills can integrate those alongside other industry capabilities and soft skills or utilize “boot camp” models narrowly focused on specific digital skills. For example, an Integrated Skills Development Scheme by the Ministry of Textiles in India covered both the digital (graphic design and robotics hardware and software) and soft skills (business and merchandising) needed to enter this sector.

Second, technical training should be directed towards skills provision in areas where skills are in demand. Beyond training in foundational skills, training is more effective when directed to areas of demand. For example, sector-targeted training programs in the United States focus on connecting less-skilled workers with better jobs in industries with increased demand. The programs show positive impacts on earnings, which is likely related to training in transferable and certifiable skills, combining technical training with soft skills and career-readiness training, and wraparound support services (Katz et al. 2022). The tools to identify the in-demand skills previously described can help target industries with strong labor market demand that are suitable for such sector-focused training.

Third, training should be viewed as a lifelong activity. The constant changes in skills associated with technological progress mean that skills need to be updated throughout working lives. Lifelong learning systems recognize that workers will face different labor market landscapes throughout their lives, and help individuals have more responsibility for their learning pathways. These learner-focused approaches utilize e-learning to connect trainings to workers at scale; contemplate different financing approaches that may provide individuals with vouchers to select their own trainings; and adapt training programs to the needs of different types of learners: for example, recognizing that the pedagogy suitable for adult workers

is different from that suitable for young ones (Bendini, Levin, and Oral-Savonitto 2019). Notably, the kind of retraining that is required because of technological change and automation may not require learning entirely new fields, but instead adapting skills to new tasks that emerge within occupations. As noted in chapter 2, much of the change in work that results from technological progress occurs within occupations rather than across them. Research from Germany, for example, shows that occupations that evolved from being routine to less routine experienced wage gains (Bachmann et al. 2022).

Finally, training will need to be targeted to particular types of workers who face greater challenges recovering from displacement by technology. These groups vary from country to country, but as chapter 3 shows, in CADR, the most vulnerable to disruption are generally less-educated, male, younger, and rural workers. This is important because there is evidence from OECD countries that workers who are at higher risk of automation receive less job training (Nedelkoska and Quintini 2018). Still, identifying the most vulnerable to disruption is insufficient, as different workers have different opportunities after losing their jobs and when deciding to enter the labor market. For instance, in advanced economies, women may have fewer options for labor market transitions after technology-related labor market disruptions, though reskilling can narrow the gap (WEF 2018b). Research from China and Germany shows that whereas younger people exposed to robots seek out training, older workers tend to drop out of the labor market (Battisti, Dustmann, and Schönberg 2023; Giuntella, Lu, and Wang 2022). Understanding these differences is critical to targeting training to those who need it most (box 5.5).

BOX 5.5: The Complex Interaction of Technology, Labor Markets, and Gender

Many factors will influence how technological progress in and outside of CADR countries interacts with the employment of women in the region, with some factors reinforcing barriers and others creating opportunities. One set of factors relates to the current distribution of human capital by gender, including gender differences in education level (Ñopo 2012), field of study (for example, gender gaps in science, technology, engineering, and mathematics education) (UNESCO 2017a), and digital skills (OECD 2020a; OECD 2018a). Another set relates to gender differences in how human capital is deployed, including occupational segregation (for example, gender gaps in management roles) and sectoral segregation (for example, gender gaps in clerical and factory work and in health and care services) (World Bank 2012a; Sinha 2020); segregation of tasks done within occupations (for example, gender differences in who does undesirable tasks not associated with promotion) (Babcock et al. 2017; Chan and Anteby 2017); gender differences in returns to skills associated with the future of work (Bustelo, Flabbi, and Viollaz 2020); and gender differences in engagement with new working arrangements like work-from-home and platform work (Berniell et al. 2021; ECLAC and ILO 2021). A final set relates to how gender is mediated through technology itself, including gender differences in access to and use of ICT (Quirós et al. 2022; Agüero, Bustelo, and Viollaz 2020); the gender biases and gender neutrality of technology itself (UNESCO 2022); and the potential for certain technologies to break down physical obstacles to women's participation in work that requires physical strength (Mealy, Rio-Chanona, and Farmer 2018). Evidence on each of these different factors is not available for CADR countries, but some initial insights are possible.

Employed women in CADR are less susceptible to automation. Chapter 3 showed that women are generally at lower risk than men of automation by computers, AI, and mobile robotics. Several factors explain this lower risk. First, employed women have higher education levels than men in CADR, which are correlated with working in less automatable jobs. Second, employment in CADR countries is gender segregated. Women tend to work in services and sales jobs, which are harder to automate, while men tend to work as plant and machine operators and assemblers and in crafts jobs, which are easier to automate. Third, this gender segregation extends beyond paid work to unpaid work at home. Women are much more likely than men in CADR countries to participate in

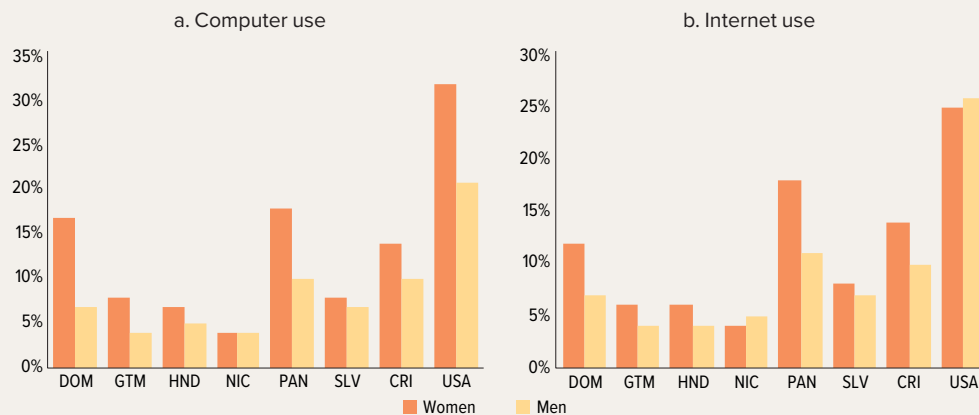
BOX 5.5: The Complex Interaction of Technology, Labor Markets, and Gender (continued)

unpaid work at home. This work is excluded from estimates of automatability, though technologies like domestic appliances may, in fact, automate these tasks in the same way that tasks done in paid jobs are automated, which may free women’s time to take on paid work.

The ultimate impact of automation on women’s labor market outcomes in CADR depends not just on susceptibility to automation, but on how well female workers displaced from their jobs are able to recover and on how well female workers can benefit from the expansions in demand that result from automation. Current female workers in CADR seem well placed to take advantage of technological progress. The higher education levels of employed women mean that their skills are more likely to be complementary to new technologies. In fact, across all CADR countries, employed women are already more likely to work in jobs intensive in computers and the internet (figure B5.5.1). Women are also overrepresented in the kinds of service jobs that may expand as automation creates spillover benefits. Still, while less susceptible to automation, these service jobs tend to be low productivity and low wage. Where women are displaced, evidence from advanced economies suggests that providing retraining can be essential because women may have fewer options for job transitions after technology-related labor market disruptions (WEF 2018b).

FIGURE B5.5.1: Use of Computers and the Internet at Work by Gender, 2021

Percentage of workers in computer- and internet-intensive occupations



Sources: SEDLAC (CEDLAS and The World Bank); PIAAC 2017.

Note: The years are 2019 for Guatemala and Honduras, 2014 for Nicaragua, and 2018 for Panama. Computer- and internet-intensive occupations are defined as occupations in the top 25 percent of computer and internet use at work as defined using PIAAC data from comparator countries. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador; USA = United States of America.

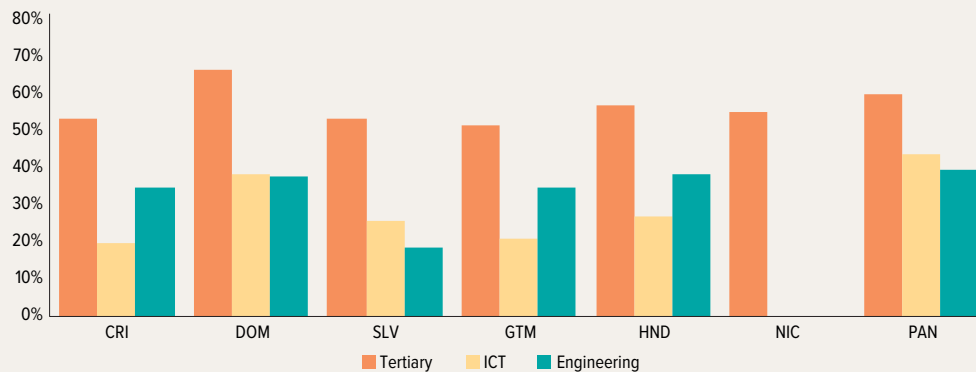
On the other hand, women face challenges to benefiting fully from automation. Despite higher enrolment rates in tertiary education, women in CADR countries are less likely to study in the science, technology, engineering, and mathematics (STEM) fields that are complementary to many technological advancements (figure B5.5.2). In the Dominican Republic, for example, women make up 67 percent of students in tertiary education programs but just under 40 percent of students in ICT- and engineering-focused tertiary degree programs. Returns to STEM and ICT skills are also higher for men (Bustelo, Flabbi, and Viollaz 2020). Social norms related to women’s work will play a critical role in how women benefit, or do not, from technological progress. Research on Costa Rica, El Salvador, and Panama shows that lower obstacles to human capital accumulation for women led to improvements in female labor market participation and increased women’s participation in high-income jobs between

BOX 5.5: The Complex Interaction of Technology, Labor Markets, and Gender (continued)

1995 and 2015 (Sinha 2020). However, increases in labor market discrimination in Costa Rica and Panama muted this transformation. Norms could thus inhibit the kinds of labor market transitions necessary for women in CADR to benefit from technological progress.

FIGURE B5.5.2: Female Enrolment in Tertiary Programs and in ICT- and Engineering-Related Tertiary Degree Programs, 2021

Percentage of students who are female



Source: UNESCO Institute for Statistics for tertiary enrolment; UNESCO (2020) for ICT and engineer enrolment.

Note: The years are 2019 for Costa Rica and Honduras and 2020 for El Salvador and Guatemala. Data is not available for ICT and Engineering for Nicaragua. CRI = Costa Rica; DOM = Dominican Republic; GTM = Guatemala; HND = Honduras; NIC = Nicaragua; PAN = Panama; SLV = El Salvador.

Changing working arrangements are likely to have different, and perhaps more substantial, impacts on women than on men in CADR countries. Chapter 3 showed that a higher share of women than men in CADR countries works in jobs that can be done from home. Expansions in the adoption or diffusion of ICT technologies are then likely to disproportionately enable remote work for women. Chapter 3 also showed that women are frequent participants in online-based platform work, particularly in the Dominican Republic where they make up nearly two-thirds of workers on Workana. This means that in some countries in the region, women seem to be benefiting as platform work becomes more common.

The flexibility associated with new types of working arrangements could have benefits for women who are balancing paid and unpaid work responsibilities but could also entrench restrictive social norms related to women’s roles inside and outside of the household. The flexibility that characterizes remote work and platform jobs may complement the working patterns of women in CADR. For instance, motherhood increases women’s employment in more flexible jobs like parttime employment and self-employment (Berniell et al. 2023). The rise of remote and platform work could thus draw some women (back) into the workforce. Expansions in access to markets enabled by platforms could also benefit self-employed women disproportionately, given their overrepresentation in service jobs. At the same time, however, these new developments in working arrangements may reinforce normative expectations about women’s role inside and outside of the household. Intergenerational norms tend to pressure women in CADR, especially married women, to avoid working outside of the house (Chioda 2016). Increased opportunities for home-based work could reinforce these norms by making home-based work more attractive. Finally, location-based platform work exhibits the same kind of gender segregation as work outside the gig economy: women tend to concentrate in sectors traditionally viewed as “female” like personal care, cleaning, and beauty (Deshpande, Singh, and Murthy 2022).

BOX 5.5: The Complex Interaction of Technology, Labor Markets, and Gender (continued)

Beyond the changes in tasks and working arrangements that are the main focus of this report, technologies including but also beyond computers, AI, and mobile robotics could shift incentives and preferences for women to participate in the labor market. “Home technologies” like domestic appliances (for example, washers, dryers, and freezers) and access to infrastructure (for example, electricity and water) and “health technologies” like contraception may reduce time spent on (unpaid) domestic work, changing household’s incentives and preferences and potentially leading more women to enter the paid labor market. For instance, Almeida and Viollaz (2022) find a positive relationship between household ownership of a washing machine and female labor force participation in Guatemala. Cubas (2016) finds that falling relative prices for appliances and increased access to electricity were associated with increased female labor force participation in Brazil and Mexico.⁶⁴ Gasparini and Marchionni (2015) find a positive relationship between contraception use and female labor force participation in LAC.⁶⁵ “Home-work technologies” like access to the Internet may increase opportunities to engage in (more flexible) platform work.⁶⁶ This is particularly important because women face obstacles to accessing technology in CADR. Data from Meta’s Survey on Gender Equality at Home show that women in all countries in the region are less likely than men to have access to smartphones and computers.

Mitigating the disruptions and taking advantage of the opportunities of technological progress will require special focus on adapting responses to the particular obstacles—and opportunities—faced by women. This means addressing the preexisting labor market challenges faced by women, many of which create barriers to deploying their human capital in the labor market, and thus, to taking advantage of the opportunities created by technological progress. Policies to encourage women’s participation in STEM fields, to expand access to care, and to improve regulatory policies and enforcement related to nondiscrimination in the workplace stand out as priorities for governments in the region to improve the development and deployment of women’s human capital as technological progress advances.

Design Digitally Enabled, Fit-for-purpose Intermediation Programs

Beyond efforts to develop human capital, deploying skills in the labor market is an additional challenge. Workers may lack information about jobs and wages. Employers may be uncertain about the skills of job candidates. Workers may be in locations where job creation is weak. Labor market intermediation tools can help overcome these barriers. These include the provision of labor market information, career guidance and job applications workshops that improve workers’ expectations about the labor market, skills certificate programs that assist with skills signaling, and subsidies that help jobseekers search for or travel to jobs in other locations.

Intermediation programs are more successful when they focus on overcoming barriers that prevent jobseekers from matching with jobs where there is labor market demand. Existing intermediation efforts may struggle to have substantial impacts if they do not do enough to help workers find jobs in the long run or if they replicate services already provided (more effectively) by the private sector. In their review of the effectiveness of labor market intermediation services, Carranza and McKenzie (2023) highlight the potential for transport subsidies and skill signaling interventions to help connect jobseekers with

64 See also Dinkelman (2011) and Koolwal and van de Walle (2013). See Cavalcanti and Tavares (2008), Greenwood, Seshadri, and Yorukoglu (2005), and Coen-Pirani, León, and Lugauer (2010) for research on developed countries.

65 See also, for example, Bailey (2006) and Albanesi and Olivetti (2016) for the United States.

66 See, for example, Dettling (2017).

employment. The interventions seem to be more successful because they help jobseekers overcome geographic disparities in jobs in the first case, and information problems in the second. Because many jobseekers in CADR countries search for jobs via personal networks, young, informal, and less-skilled workers may be more affected by information problems as they may not have access to networks with accurate information on good jobs. An obvious, though crucial, success factor for these programs is labor market demand: without jobs, interventions to link workers to employment cannot succeed. This again emphasizes the importance of using labor market information to identify areas of strong demand.

Technology is enabling improvements in the delivery of intermediation services. Technology is being used to increase jobseekers' access to labor market information that is relevant to their job search. In Peru, text messages have been used to inform jobseekers about opportunities matching their profiles. These messages had a positive impact on employment (Dammert, Galdo, and Galdo 2015). In the United Kingdom, an online tool that provided jobseekers with relevant occupations and jobs expanded the options they considered and increased their job interviews (Belot, Kircher, and Muller 2019). New tools have also been developed that assist with the identification and classification of jobseeker skills and the presentation of these skills to employers (box 5.6). These tools use simple questions to elicit information about jobseekers' experiences beyond employment that may be useful in the labor market, which can be particularly relevant for young people or women who may lack traditional labor market experience. Finally, governments are experimenting with incorporating platform jobs onto traditional online job search portals, in part to help disadvantaged workers build experience and work histories that are tracked and verified in the platform (box 5.7). A potential area to explore is how CADR migrants returning from abroad could be engaged in platform work. Less-skilled migrants returning from the United States may have the English skills that can be a barrier to work on platforms for less-skilled workers. Call centers have become more common in the region, taking advantage of migrants returning or deported from the United States with good English skills.

BOX 5.6: Using SkillCraft to Connect Disadvantaged Young People to the Labor Market

SkillCraft produces assessments of twenty-first century skills to help connect disadvantaged young people with the labor market. SkillCraft is a free online skills assessment and career guidance tool developed by South Africa's Youth Employment Service (YES) and Harambee Youth Employment Accelerator in partnership with the World Bank. The application uses standardized assessments delivered in the form of interactive games and quizzes to assess 23 twenty-first century skills and traits. The application is accessible via computer, tablet, or mobile device. Based on user results, the program produces two outputs: a printable, formal certificate that can be shared with potential employers; and an interactive feedback report meant to be used by the jobseekers to help them identify and select jobs or entrepreneurship opportunities that align with their skills and traits. A recent evaluation of the program conducted by the World Bank and YES found that the tool produced reliable assessments of twenty-first century skills among disadvantaged youth, providing an equitable and unbiased assessment of skills for participants across education levels and genders. In addition, the evaluation found that the assessment provided useful feedback for jobseekers, leading to improvements in job search behaviors. A comparison between a group who only received the skills certificate and those who received both the interactive feedback tool and the skills certificate found that the interactive feedback tool increased the likelihood of the jobseekers sharing the skills certificate with potential employers, perhaps because it helped them understand the relevance of twenty-first century skills to jobs they were seeking.

Source: World Bank 2022d.

BOX 5.7: Public Gig Work Platforms

Some governments are undertaking initiatives to connect workers with platform jobs. In Malaysia, for example, the [eRezeki](#) platform helps connect potential workers with platform jobs in the private sector. Workers can visit in-person centers to receive support in setting up profiles and selecting platforms and jobs, whether online- or location-based, that match their skills. In the United States the City of Long Beach, California has taken a more advanced approach, creating the [WorkLB](#) program to connect workers with flexible job opportunities, including in the provision of city services. Launched in 2018 and expanded during the COVID-19 pandemic, the program originally offered opportunities such as backup school support staff, event staff, and community health teams. Since then, the program has expanded to include both public and private employment opportunities ranging from childcare to food service. The platform allows workers to acquire badges that certify their capabilities and to search based on specific available working hours and job locations. The program also has an emphasis on worker protections, ensuring that all positions posted are with formal employers (Briggs and Rowan 2023).

Intermediation programs can also help create safe and inclusive migration pathways. Migrants from CADR tend to work in low-skilled occupations, primarily in the United States. Informal migration is common. Though thus far fairly limited in their application, Global Skills Partnerships (GSPs) have significant potential as a model to facilitate safe, regular migration that is mutually beneficial for origin and destination countries, including for more skilled occupations ranging from tourism to care. Under GSPs, destination countries provide resources to train people in the origin country in skills that are in demand in both. Trainees then decide whether to migrate—via a legal pathway—or to remain in the home country. GSPs require the involvement of public employment and migration agencies as well as the private sector and depend on the labor market insights and demand-driven training described in the previous two sections. One such GSP, the Australia Pacific Training Coalition, provides training in 14 Pacific Island countries and has enrolled more than 18,000 students since 2007 (Chand, Clemens, and Dempster 2021). Digital job platforms can potentially facilitate matches between workers and employers utilizing GSPs based on skills, experience, and preferences.

ADAPT SOCIAL PROTECTION AND LABOR MARKET POLICIES TO NEW FORMS OF WORK

The shifts in work that are occurring in CADR will create additional challenges for social protection and labor market policies that already confront large informal workforces. Even moderate technological progress will create disruptions in labor markets in CADR countries. Where the deployment of technology and the development and deployment of human capital improve, economic growth is likely to ensue, but so too will more significant labor market disruptions. At the same time, the rise of platform work complicates labor market regulations. Platforms raise questions about how to ensure that platform workers have equal access to benefits and workplace protections. On one hand, the rise of this new form of employment creates an opportunity for formalization: earnings via platform work are observable and so can be incorporated into social protection schemes, as has been done in Indonesia, Malaysia, and Uruguay (ILO 2021b). On the other hand, there is a risk that a poorly coordinated regulatory response leads to further labor market segmentation by creating new special classifications for platform workers.

Reform of labor market regulations in response to the emergence of platform work should seek to avoid further labor market segmentation. Platform workers frequently lack access to social protection and other workplace protections like unemployment, sickness, and disability insurance that are frequently tied to traditional employment (Datta and Chen 2023; ILO 2021b). This is often because platform and other “nonstandard” workers do not fit into definitions of employment prescribed in labor codes and other regulations. Approaches to fill this gap include incorporating platform and other nonstandard workers into existing regulatory frameworks or creating a new category of workers to extend existing protections

to these groups, or defining a minimum level of protections that apply to all workers, regardless of type (Apella, Moroz, and Zunino 2023). While the best approach will vary from country to country, the risk of generating additional labor market segmentation through additional regulations is substantial and could further exacerbate existing challenges for CADR's large informal labor markets.

Basing the design of labor regulations on an analysis of market failures is key. Simply expanding existing regulations may not be appropriate because of existing challenges with enforcement and differences in the market failures justifying regulations⁶⁷ (Moroz and Santos 2022). Indeed, certain issues that go beyond labor market regulations may be more salient in the case of platform work. For example, monopsony is a significant concern in some cases: studies of workers on Amazon Mechanical Turk and of Uber drivers find low residual labor supply elasticities, indicating strong employer buying power (Chen et al. 2019; Dube et al. 2020; Kingsley, Gray, and Suri 2015). This is also true in the case of platforms that facilitate digital provision of services. These platforms have characteristics—returns to scale, network externalities, the accumulation and use of personal data—that make market concentration more likely (Cirera, Comin, and Cruz 2022). This makes competition and antitrust regulations important. This can begin with developing heuristics of the business models, characteristics, and anti-competitive potential of different digital platforms and evolve into more sophisticated analyses of the particular anticompetitive practices of platforms, especially issues related to data (Nyman and Barajas 2021). Efforts to increase competition in general are also important because they can increase incentives for technology adoption and output expansion, critical factors to compensate for the labor market disruptions of technological progress (Dutz, Almeida, and Packard 2018; Vivarelli 2014).

In the long term, moving away from reliance on the traditional employer-employee relationship for the financing and provision of protections and benefits is necessary. Technological progress will continue creating disruptions in CADR's labor markets. These disruptions will make policies protecting people's wellbeing even more important. At the same time, labor market disruptions will also make access to jobs with social protection and other workplace benefits challenging, particularly in CADR countries where coverage of social protection is low. This makes a general rethinking of social protection financing and provision important. In general, reform should be biased towards creating uniform protections designed to apply to all forms of work and to models that move away from reliance on the traditional employer-employee relationship for the financing and provision of protections and benefits (Packard et al. 2019; Beylis et al. 2020).

In the short term, the emergence of platform work creates an opportunity to expand access to social protection. Platform work has a few special characteristics that make expanding access to its workers easier than expanding access to other types of informal workers. These include the observability of income, which is paid online, and the existence of a few large formal employers (rather than many small employers) that governments can feasibly work with directly (Moroz and Santos 2022). Gig workers seem to want to pay for greater protection. In Malaysia, a recent study found substantial unmet demand for social insurance and a high willingness to pay for it (Ghorpade, Rahman, and Jasmin 2023). Governments can partner with platforms to identify informal workers and incorporate them into social registries; introduce novel design and behavioral interventions into existing social protection schemes to facilitate enrolment and payment of contributions; and link with third-party providers of financial services like insurance and savings accounts targeted to the needs of gig workers (Anand and Murthy 2023; Datta and Chen 2023; Tapia 2023). For example, deductions for work accident and death benefits are automatically deducted from the e-wallets of workers for ride-hailing apps GoJek and Grab in Indonesia. In Malaysia, Grab offers a matching contribution to workers who register with the government's retirement savings scheme.

⁶⁷ For example, the externalities from worker dismissals may be lower in the case of platform work because platform work tends not to be a worker's primary employment and the costs of switching jobs is lower.

References

- Abdullaev, Umidjon and Marcello Estevão. 2013. "Growth and Employment in the Dominican Republic: Options for a Job-Rich Growth." Working Paper 13/40, IMF, Washington, DC.
- Abramovsky, Laura, and Rachel Griffith. 2006. "Outsourcing and Offshoring of Business Services: How Important Is ICT?" *Journal of the European Economic Association* 42 (2–3):594–601.
- Acemoglu, Daron, and David Autor. 2011. "Skills, Tasks and Technologies: Implications for Employment and Earnings." In *Handbook of Labor Economics*, Volume 4B, edited by Orley Ashenfelter and David Card, 1043–171. Amsterdam: North Holland.
- Acemoglu, Daron, and Pascual Restrepo. 2018. "The Race between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment." *American Economic Review* 108 (6): 1488–1542.
- Acemoglu, Daron, and Pascual Restrepo. 2019. "Automation and New Tasks: How Technology Displaces and Reinstates Labor." *Journal of Economic Perspectives* 33 (2): 3–30.
- Acemoglu, Daron, and Pascual Restrepo. 2020. "Robots and Jobs: Evidence from US Labor Markets." *Journal of Political Economy* 128 (6): 2188–2244.
- Acemoglu, Daron, and Pascual Restrepo. 2022. "Tasks, Automation, and the Rise in U.S. Wage Inequality." *Econometrica* 90 (5): 1973–2016.
- Acemoglu, Daron, Gary Anderson, David Beede, Catherine Buffington, Eric Childress, Emin Dinlersoz, Lucia Foster, Nathan Goldschlag, John Haltiwanger, Zachary Kroff, Pascual Restrepo, and Nikolas Zolas. 2022. "Automation and the Workforce: A Firm-Level View from the 2019 Annual Business Survey." Working Paper 30659, National Bureau of Economic Research, Cambridge.
- Acevedo, Paloma, Guillermo Cruces, Paul Gertler, and Sebastian Martinez. 2020. "How Vocational Education Made Women Better Off but Left Men Behind." *Labour Economics* 65: 101824.
- Adams-Prassl, Abi, Teodora Boneva, Marta Golin, and Christopher Rauh. 2022. "Work That Can Be Done from Home: Evidence on Variation within and across Occupations and Industries." *Labour Economics* 74: 102083.
- ADB (Asian Development Bank). 2021. *Global Value Chain Development Report 2021: Beyond Production*. Manila: ADB.
- Agrawal, Ajay, Joshua S. Gans, and Avi Goldfarb. 2019. "Artificial Intelligence: The Ambiguous Labor Market Impact of Automating Prediction." *Journal of Economic Perspectives* 33 (2): 31–50.
- Agrawal, Ajay, Joshua S. Gans, and Avi Goldfarb. 2023. "Artificial Intelligence Adoption and System-wide Change?" *Journal of Economics & Management Strategy* (November): 1–11.
- Agrawal, Ajay, John Horton, Nicola Lacetera, and Elizabeth Lyons. 2015. "Digitization and the Contract Labor Market: A Research Agenda." In *Economic Analysis of the Digital Economy*, edited by Avi Goldfarb, Shane M. Greenstein, and Catherine E. Tucker, 219–250. Chicago: University of Chicago Press.

- Agüero, Aileen, Monserrat Bustelo, and Mariana Viollaz. 2020. “¿Desigualdades en el mundo digital? Brechas de género en el use de las TIC.” Technical Note 01879, IDB, Washington, DC.
- Akerman, Ander, Ingvil Gaarder, and Magne Mogstad. 2015. “The Skill Complementarity of Broadband Internet.” *The Quarterly Journal of Economics* 130 (4): 1781–824.
- Albanesi, Stefania, and Claudia Olivetti. 2016. “Gender Roles and Medical Progress.” *Journal of Political Economy* 124(3):650-95.
- Anand, Malika, and Gayatri Murthy. 2023. “Financial Services for Gig Workers: Lessons on Getting Design and Delivery Right.” Brief, Consultative Group to Assist the Poor, Washington, DC.
- Antonczyk, Dirk, Thomas DeLeire, and Bernd Fitzenberger. 2018. “Polarization and Rising Wage Inequality: Comparing the U.S. and Germany.” *Econometrics* 6 (2).
- Albanesi, Stefania, and Claudia Olivetti. 2016. “Gender Roles and Medical Progress.” *Journal of Political Economy* 124 (3): 650–95.
- Albinowski, Maciej, and Piotr Lewandowski. 2022. “The Impact of ICT and Robots on Labour Market Outcomes of Demographic Groups in Europe.” Discussion Paper 15752, Institute of Labor Economics, Bonn.
- Alipour, Jean-Victor, Oliver Falck, and Simone Schüller. 2020. “Germany’s Capacities to Work from Home.” Discussion Paper Series 13152, Institute of Labor Economics, Bonn.
- Almeida, Rita K., and Mariana Viollaz. 2022. “Women in Paid Employment: A Role for Public Policies and Social Norms in Guatemala.” Policy Research Working Paper 9919, World Bank, Washington, DC.
- Althoff, Lukas, Fabian Eckert, Sharat Ganapati, and Conor Walsh. 2022. “The Geography of Remote Work.” *Regional Science and Urban Economics* 93: 103770.
- Apella, Ignacio, and Gonzalo Zunino. 2022. “El cambio tecnológico y las tendencias del mercado laboral en América Latina y el Caribe: un análisis basado en las tareas.” *Revista de la CEPAL* 136: 65–88.
- Apella, Ignacio, Harry Moroz, and Gonzalo Zunino. 2023. *Regulating Nonstandard Forms of Employment in Uruguay: Insights from International Experience and Options for the Future*. Washington, DC.: World Bank.
- Aramburu, Julian, and Ana Goicoechea. 2021. *Coding Bootcamps for Female Digital Employment: Evidence from a Randomized Control Trial in Argentina and Colombia*. Washington, DC.: World Bank.
- Araújo, Bruno César, Francesco Bogliacino, and Marco Vivarelli. 2011. “Technology, Trade, and Skills in Brazil: Evidence from Microdata.” *CEPAL Review* 105: 157–71.
- Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. 2016. “The Risk of Automation for Jobs in OECD Countries.” OECD Social, Employment and Migration Working Papers 189, Organisation for Economic Co-operation and Development, Paris.
- Artuc, Erhan, Paulo Bastos, and Bob Rijkers. 2023. “Robots, Tasks, and Trade.” *Journal of International Economics* 145: 103828.
- Artuc, Erhan, Luc Christiaensen, and Hernand Winkler. 2019. “Does Automation in Rich Countries Hurt Developing Ones: Evidence from the U.S. and Mexico.” Policy Research Working Paper 8741, World Bank, Washington, DC.

- Atalay, Englin, Phai Phongthientham, Sebastian Sotelo, and Daniel Tannenbaum. 2018. "New Technologies and the Labor Market." *Journal of Monetary Economics* 97: 48–67.
- Atalay, Englin, Phai Phongthientham, Sebastian Sotelo, and Daniel Tannenbaum. 2020. "The Evolution of Work in the United States." *American Economic Journal: Applied Economics* 12 (2): 1–34.
- Atkin, David, Antoinette Schoar, and Sumit Shinde. 2023. "Working from Home, Worker Sorting and Development." Working Paper 31515, National Bureau of Economic Research, Cambridge.
- Autor, David. 2022. "The Labor Market Impacts of Technological Change: From Unbridled Enthusiasm to Qualified Optimism to Vast Uncertainty." Working Paper 30074, National Bureau of Economic Research, Cambridge.
- Autor, David H., and David Dorn. 2013. "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market." *American Economic Review* 103 (5): 1553–97.
- Autor, David H., Frank Levy, and Richard J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *The Quarterly Journal of Economics* 118 (4): 1279–333.
- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney. 2006. "The Polarization of the U.S. Labor Market." *AEA Papers & Proceedings* 96 (2): 189–94.
- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney. 2008. "Trends in U.S. Wage Inequality: Revising the Revisionists." *The Review of Economics and Statistics* 90 (2): 300–23.
- Autor, David H., Caroline Chin, Anna M. Salomons, and Bryan Seegmiller. 2022. "New Frontiers: The Origins and Content of New Work, 1940–2018." Working Paper 30389, National Bureau of Economic Research, Cambridge, MA.
- Azuara, Oliver, Stephanie González, and Lukas Keller. 2019. "Who Drives on Ride-Hailing Platforms in Latin America: A Profile of Uber Drivers in Brazil, Chile, Colombia and Mexico." Technical Note 1779, Inter-American Development Bank, Washington, DC.
- Babcock, Linda, Maria P. Recalde, Lise Vesterlund, and Laurie Weingart. 2017. "Gender Differences in Accepting and Receiving Requests for Tasks with Low Promotability." *American Economic Review* 107(3):714-47.
- Bachmann, Ronald, Merve Cim, and Colin Green. 2019. "Long-Run Patterns of Labour market Polarization: Evidence from German Micro Data." *British Journal of Industrial Relations* 57 (2): 350–76.
- Bailey, Martha J. 2006. "More Power to the Pill: The Impact of Contraceptive Freedom on Women's Life Cycle Labor Supply." *The Quarterly Journal of Economics* 121(1):289-320.
- Bailey, Martha J., Shuqiao Sun, and Brenden Timpe. 2021. "Prep School for Poor Kids: The Long-Run Impacts of Head Start on Human Capital and Economic Self-Sufficiency." *American Economic Review* 111 (12): 3963–4001.
- Baldwin, Richard. 2022. "Globotics and Macroeconomics: Globalisation and Automation of the Service Sector." Working Paper Series 30317, National Bureau of Economic Research, Cambridge.
- Banegas, Nancy, and Hernan Winkler. 2020. *Jobs Diagnostic: El Salvador. Understanding Challenges for More and Better Jobs in El Salvador: An Integrated Approach*. Jobs Series. Washington, DC.: World Bank.

- Banga, Karishma, and Dirk Willem te Velde. 2019. "Preparing Developing countries for the Future of Work: Understanding Skills-Ecosystem in a Digital Era." Background Paper, Pathways for Prosperity Commission, Oxford.
- Bárány, Zsófia, and Christian Siegel. 2018. "Job Polarization and Structural Change." *America Economic Journal: Macroeconomics* 10 (1): 57–89.
- Barrera-Osorio, Felipe, Adriana Kugler, and Mikko Silliman. 2023. "Hard and Soft Skills in Vocational Training: Experimental Evidence from Colombia." *The World Bank Economic Review* 37 (3): 409–36.
- Barrero, Jose Maria, Nicholas Bloom, and Steven J. Davis. 2021. "Why Working from Home Will Stick." Working Paper 28731, National Bureau of Economic Research, Cambridge.
- Bashir, Sajitha, T.H. Gindling, and Ana Maria Oviedo. 2012. *Better Jobs in Central America: The Role of Human Capital*. Washington, DC.: World Bank.
- Basso, Gaetano, Giovanni Peri, and Ahmed S. Rahman. 2020. "Computerization and Immigration: Theory and Evidence from the United States." *Canadian Journal of Economics* 53 (4): 1457–94.
- Battisti, Michele, Christian Dustmann, and Uta Schönberg. 2023. "Technological and Organizational Change and the Careers of Workers." *Journal of the European Economic Association* 21 (4):1551–94.
- BCCR (Banco Central de Costa Rica). 2019. *Costa Rica: Exportaciones de Servicios Mediante Redes de Tecnología, Información y Comunicación (TIC)*. Banco Central de Costa Rica, San José.
- Behrens, Kristian, Sergey Kichko, and Jacques-François Thisse. 2021. "Working From Home: Too Much of a Good Thing?" Working Paper 8831, CESifo, Munich.
- Belafi, Carmen, Yue-Yi Hwa, and Michelle Kaffenberger. 2020. "Building on Solid Foundations: Prioritising Universal, Early, Conceptual and Procedural Mastery of Foundational Skills." RISE Insight Series. Oxford; Research on Improving Systems of Education Programme.
- Belot, Michèle, Philipp Kircher, and Paul Muller. 2019. "Providing Advice to Jobseekers at Low Cost: An Experimental Study on Online Advice." *The Review of Economic Studies* 86 (4):1411–47.
- Bendini, Magdalena, Victoria Levin, and Isil Oral-Savonitto. 2019. "Stocktaking of Adult Literacy Programs: Design Features for Impact." Presentation at the World Bank, Washington, DC., June 10, 2019.
- Benhabib, Jess, and Mark M. Spiegel. 1994. "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data." *Journal of Monetary Economics* 34:143–73.
- Berg, Andrew, Edward F. Buffie, and Luis-Felipe Zanna. 2018. "Should We Fear the Robot Revolution? (The Correct Answer Is Yes)." Working Paper 18/116, International Monetary Fund, Washington, DC.
- Berger, Thor, and Carl Benedikt Frey. 2016. "Did the Computer Revolution Shift the Fortunes of U.S. Cities? Technology Shocks and the Geography of New Jobs." *Regional Science and Urban Economics* 57: 38–45.
- Berniell, Inés, Lucila Berniell, Dolores de la Mata, María Edo, and Mariana Marchionni. 2023. "Motherhood and Flexible Jobs: Evidence from Latin American Countries." *World Development* 167 (July 1, 2023).
- Berniell, Lucila, and Daniel Fernandez. 2021. "Jobs' Amenability Is Not Enough: The Role of Household Inputs for Safe Work under Social Distancing in Latin American Cities." *World Development* 140 (April).

- Berniell, Inés, Leonardo Gasparini, Mariana Marchionni, and Mariana Viollaz. 2021. “The Role of Work-from-Home in the Gender Asymmetries of COVID-19: An Analysis for Latin America Based on High-Frequency Surveys.” Policy Research Working Paper 9887, Washington, DC., World Bank.
- Bessen, James, Erich Denk, and Chen Meng. 2022. “The Remainder Effect: How Automation Complements Labor Quality.” Research Paper Series 22–3, Boston University School of Law, Boston.
- Beylis, Guillermo, Roberto Fattal Jaef, Michael Morris, Ashwini Rekha Sebastian, and Rishabh Sinha. 2020. *Going Viral: COVID-19 and the Accelerated Transformation of Jobs in Latin America and the Caribbean*. Washington, DC.: World Bank.
- Blinder, Alan S. 2006. “Offshoring: The Next Industrial Revolution?” *Foreign Affairs* (2): 113–128.
- Blinder, Alan S. 2009. “How Many US Jobs Might Be Offshorable?” *World Economics* 10 (2): 41–78.
- Blinder, Alan S., and Alan B. Krueger. 2013. “Alternative Measures of Offshorability: A Survey Approach.” *Journal of Labor Economics* 31 (2): S97–128.
- Bloom, Nicholas, Raffaella Sadun, and John Van Reenen. 2017. “Management as Technology?” Working Paper 22327, National Bureau of Economic Research, Cambridge.
- Blyde, Juan S. 2020. “Heterogenous Labor Impacts of Migration across Skills Groups: The Case of Costa Rica.” Working Paper 1145, Inter-American Development Bank, Washington, DC.
- Borin, Alessandro, Michele Mancini, and Daria Taglioni. 2021. “Measuring Exposure to Risk in Global Value Chains.” Policy Research Working Paper 9785, World Bank, Washington, DC.
- Bravo-Ureta, Boris E., Eric Njuki, Ana Claudia Palacios, and Lina Salazar. 2022. “Agricultural Productivity in El Salvador: A Preliminary Analysis.” Working Paper Series 01319, Inter-American Development Bank, Washington, DC.
- Breemersch, Koen, Jože P. Damijan, and Jozef Konings. 2017. “Labour Market Polarization in Advanced Countries: Impact of Global Value Chains, Technology, Import Competition from China and Labour Market Institutions.” OECD Social, Employment and Migration Working Paper 197, Organisation for Economic Co-operation and Development, Paris.
- Bresnahan, Timothy. 2021. “Artificial Intelligence Technologies and Aggregate Growth Prospects.” In *Prospects for Economic Growth in the United States*, edited by John W. Diamond and George R. Zodrow, 132–70, Cambridge: Cambridge University Press.
- Bresnahan, Timothy. 1999. “Computerisation and Wage Dispersion: An Analytical Reinterpretation.” *The Economic Journal* 109: F390-415.
- Briggs, Xavier and Wingham Rowan. 2023. “To Enhance Community Services and Empower Workers, Local Governments Are Building Their Own Gig Work Platforms.” Brookings Commentary, May 9, 2023. <https://www.brookings.edu/articles/to-enhance-community-services-and-empower-workers-local-governments-are-building-their-own-gig-work-platforms/>.
- Brynjolfsson, Erik, Danielle Li, and Lindsey Raymond. 2023. “Generative AI at Work.” Policy Research Working Paper 31161, National Bureau of Economic Research, Cambridge.

- Brynjolfsson, Erik, Thomas W. Malone, Vijay Gurbaxani, and Ajit Kambil. 1989. "Does Information Technology Lead to Smaller Firms?" Center for Information Systems Research Working Paper 211, Massachusetts Institute of Technology, Cambridge.
- Brynjolfsson, Erik, and Tom Mitchell. 2017. "What Can Machine Learning Do? Workforce Implications." *Science* 358 (6370): 1530–4.
- Brynjolfsson, Erik, Tom Mitchell, and Daniel Rock. 2018. "What Can Machines Learn and What Does It Mean for Occupations and the Economy." *AEA Papers and Proceedings* 108: 43–7.
- Brynjolfsson, Erik, Tom Mitchell, and Daniel Rock. 2023. "Quantifying the Distribution of Machine Learning's Impact on Work." Unpublished Working Paper.
- Busso, Matías, and Diana Hincapié. 2017. "The Market for Skills: Beyond Supply and Demand." In *Learning Better: Public Policy for Skills Development*, edited by Matías Busso, Julián Cristia, Diana Hincapié, Julián Messina, and Laura Ripani, 69–98. Washington, DC.: Inter-American Development Bank.
- Bustelo, Monserrat, Luca Flabbi, and Mariana Viollaz. 2020. "The Gender Labor Market Gap in the Digital Economy." Working Paper Series 01056, Washington, DC., IDB.
- Calí, Massimiliano and Giorgio Presidente. 2021. "Automation and Manufacturing Performance in a Developing Country." Policy Research Working Paper 9653, World Bank, Washington, DC.
- Carbonero, Francesco, Ekkehard Ernst, and Enxo Weber. 2020. "Robots Worldwide: The Impact of Automation on Employment and Trade." IAB Discussion Paper 7/20, German Federal Employment Agency, Nuremberg.
- Carranza, Eliana, and David McKenzie. 2023. "Job Training and Job Search Assistance Policies in Developing Countries." Policy Research Working Paper 10576, World Bank, Washington, DC.
- Caselli, Francesco, and Wilbur John Coleman II. 2006. "The World Technology Frontier." *The American Economic Review* 96 (3): 499–522.
- Castro-Leal, Florencia T., and Janet Porras-Mendoza. 2020. *Jobs Diagnostic: Nicaragua. Toward a Jobs and Economic Transformation Strategy*. Jobs Series. Washington, DC.: World Bank.
- Caunedo, Julieta, Elisa Keller, and Yongseok Shin. 2023. "Technology and the Task Content of Jobs across the Development Spectrum." *The World Bank Economic Review* 37 (3): 479–93.
- Cavalcanti, Tiago, and José Tavares. 2008. "Assessing the 'Engines of Liberation': Home Appliances and Female Labor Force Participation." *The Review of Economics and Statistics* 90 (1): 81–8.
- Chan, Curtis K., and Michel Anteby. 2016. "Task Segregation as a Mechanism for Within-Job Inequality: Women and Men of the Transportation Security Administration." *Administrative Science Quarterly* 61(2):184-216.
- Chand, Satish, Michael A. Clemens, and Helen Dempster. 2021. "A Pacific Skills Visa: Improving Opportunities for Skilled Migration throughout the Pacific Region." Policy Paper 231, Center for Global Development, Washington, DC.
- Charlton, Diane. 2023. "Closing the Agricultural Gap: Decent Migrant Work or Automation?" Policy Note, Rome Dialogue II, Rome.

- Chen, M. Keith, Judith A. Chevalier, Peter E. Rossi, and Emily Oehlsen. 2019. "The Value of Flexible Work: Evidence from Uber Drivers." *Journal of Political Economy* 127 (6): 2735–94.
- Chioda, Laura. 2016. *Work and Family: Latin American and Caribbean Women in Search of a New Balance*. Washington, DC: World Bank.
- Chiplunkar, Gaurav, and Pinelopi Koujianou Goldberg. 2022. "The Employment Effects of Mobile Internet in Developing Countries." Working Paper 30741, National Bureau of Economic Research, Cambridge.
- Choudhury, Prithwiraj, Cirrus Foroughi, and Barbara Larson. 2020. "Work-from-Anywhere: The Productivity Effects of Geographic Flexibility." *Strategic Management Journal* 42: 655–83.
- Cirera, Xavier, Diego Comin, and Marcio Cruz. 2022. *Bridging the Technological Divide: Technology Adoption by Firms in Developing Countries*. Washington, DC: World Bank.
- Cirera, Xavier, Barbara Cunha, and Woori Lee. 2022. "Post Covid-19. Building a Resilient and More Sustainable Recovery in El Salvador, Guatemala, and Honduras." World Bank, Washington, DC.
- Cirera, Xavier, and William F. Maloney. 2017. *The Innovation Paradox: Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up*. Washington, DC: World Bank.
- Clemens, Michael A., Ethan G. Lewis, and Hannah M. Postel. 2018. "Immigration Restrictions as Active Labor Market Policy: Evidence from the Mexican Bracero Exclusion." *American Economic Review* 108 (6): 1468–87.
- Coase, Ronald. 1937. "The Nature of the Firm." *Economica* 4 (16): 386–405.
- Coen-Pirani, Daniele, Alexis León, and Steven Lugauer. 2010. "The Effect of Household Appliances on Female Labor Force Participation: Evidence from Microdata." *Labour Economics* 17: 503–13.
- Comin, Diego, and Bart Hobijn. 2004. "Cross-country Technology Adoption: Making the Theories Face the Facts." *Journal of Monetary Economics* 51: 39–83.
- Comin, Diego, and Bart Hobijn. 2010. "An Exploration of Technology Diffusion." *American Economic Review* 100: 2031–59.
- Comin, Diego, Bart Hobijn, and Emilie Rovito. 2008. "Technology Usage Lags." *Journal of Economic Growth* 13: 237–56.
- Comin, Diego, and Martí Mestieri. 2018. "If Technology Has Arrived Everywhere, Why Has Income Diverged?" *American Economic Journal: Macroeconomics* 10 (3): 137–78.
- Conte, Andrea, and Marco Vivarelli. 2011. "Imported Skill-Biased Technological Change in Developing Countries." *The Developing Economies* 49 (1): 36–65.
- Cortes, Guido Matias. 2016. "Where Have the Middle-Wage Workers Gone? A Study of Polarization Using Panel Data." *Journal of Labour Economics* 34 (1): 63–105.
- Cortés, Patricia, Ying Feng, Nicolás Guida-Johnson, and Jessica Pan. 2023. "Automation and Gender: Implications for Occupational Segregation and the Gender Skill Gap." Working Paper 32030, National Bureau of Economic Research, Cambridge.
- CSF (Centre for Strategic Futures). 2015. *Foresight*. Singapore: CSF.

- Cubas, German. 2016. "Distortions, Infrastructure, and Female Labor Supply in Developing Countries." *European Economic Review* 87: 194–215.
- Cunningham, Wendy, Harry Moroz, Noël Muller, and Aivin Solatorio. 2022. "The Demand for Digital and Complementary Skills in Southeast Asia." Policy Research Working Paper 10070, World Bank, Washington, DC.
- Cusolito, Ana Paula, Daniel Lederman, and Jorge Peña. 2020. "The Effects of Digital-Technology Adoption on Productivity and Factor Demand Firm-level Evidence from Developing Countries." Policy Research Working Paper 9333, World Bank, Washington, DC.
- Dalton, Michael, and Jeffrey A. Groen. 2022. "Telework during the COVID-19 Pandemic: Estimates using the 2021 Business Response Survey." *Monthly Labor Review*, Bureau of Labor Statistics, Washington, DC.
- Dalvit, Nicolò, Rafael de Hoyos, Leonardo Iacovone, Ioanna Pantelaiou, Aleksandra Peeva, and Iván Torre. 2023. *The Future of Work: Implications for Equity and Growth in Europe*. Washington, DC.: World Bank.
- Dammert, Ana C., Jose Galdo, and Virgilio Galdo. 2015. "Integrating Mobile Phone Technologies into Labor-Market Intermediation: A Multi-Treatment Experimental Design." *IZA Journal of Labor & Development* 4 (11).
- Dao, Mai Chi, Mitali Das, and Zsoka Koczan. 2019. "Why Is Labour Receiving a Smaller Share of Global Income?" *Economic Policy* 34 (100): 723–59.
- Das, Mitali, and Benjamin Hilgenstock. 2022. "The Exposure to Routinization: Labor Market Implications for Developed and Developing Countries." *Structural Change and Economic Dynamics* 60: 99–113.
- Datta, Namita, and Rong Chen. 2023. *Working without Borders: The Promise and Peril of Online Gig Work*. Washington, DC.: World Bank.
- De Backer, Koen, Timothy DeStefano, Carlo Menon, and Jung Ran Suh. 2018. "Industrial Robotics and the Global Organisation of Production." Science, Technology and Industry Working Papers, Organisation for Economic Co-operation and Development, Paris.
- de Hoyos, Rafael E., Orazio Pietro Attanasio, and Costas Meghir. 2019. "Can Scholarships Increase High School Graduation Rates ? Evidence from A Randomized Control Trial in Mexico." Policy Research Working Paper 8826, World Bank, Washington, DC.
- de Vries, Gaaitzen J., Elisabetta Gentile, Sébastien Miroudot, and Konstantin M. Wacker. 2020. "The Rise of Robots and the Fall of Routine Jobs." *Labour Economics* 66.
- Del Carmen, Giselle, and Liliana D. Sousa. 2018. "Human Capital Outflows: Selection into Migration from the Northern Triangle." Policy Research Working Paper 8334, World Bank, Washington, DC.
- Delaporte, Isaure, and Werner Peña. 2020. "Working from Home Under COVID-19: Who Is Affected? Evidence From Latin American and Caribbean Countries." Discussion Paper 528. Global Labor Organization, Essen.
- Deloitte. 2014. *Agiletown: the Relentless March of Technology and London's Response*. London: Deloitte.
- Deming, David J. 2017. "The Growing Importance of Social Skills in the Labor Market." *The Quarterly Journal of Economics* 132 (4): 1593–1640.

- Deming, David J., and Lisa B. Kahn. 2018. "Skill Requirements across Firms and Labor Markets: Evidence from Job Postings for Professionals." *Journal of Labor Economics* 31 (S1): S337–69.
- Deming, David J., and Kadeem L. Noray. 2018. "STEM Careers and Technological Change." Working Paper 25065, National Bureau of Economic Research, Cambridge.
- Deshpande, Rani, Nisha Singh and Gayatri Murthy. 2022. "Women in the Platform Economy: Emerging insights." CGAP, Washington, DC.
- Detting, Lisa. 2017. "Broadband in the Labor Market: The Impact of Residential High-Speed Internet on Married Women's Labor Force Participation." *ILR Review* 70 (2): 451–82.
- Devercelli, Amanda E., and Frances Beaton-Day. 2020. *Better Jobs and Brighter Futures: Investing in Childcare to Build Human Capital*. Washington, DC.: World Bank.
- Díaz, Mercedes Mateo, and Lourdes Rodriguez-Chamussy. 2016. *Cashing in on Education: Women, Childcare, and Prosperity in Latin America and the Caribbean*. Washington, DC.: World Bank Group and Inter-American Development Bank.
- Dicarlo, Emanuele, Salvatore Lo Bello, Sebastian Monroy-Taborda, Ana Maria Oviedo, Maria Laura Sanchez-Puerta, and Indhira Santos. 2016. "The Skill Content of Occupations across Low and Middle Income Countries: Evidence from Harmonized Data." Discussion Paper 10224, Institute of Labor Economics, Bonn.
- Dingel, Jonathan I., and Brent Nieman. 2020. "How Many Jobs Can Be Done at Home?" *Journal of Public Economics* 189.
- Dinkelman, Taryn. 2011. "The Effects of Rural Electrification on Employment: New Evidence from South Africa." *American Economic Review* 101:3078-108.
- Doan, Dung, Trang Luu, Nga Thi Nguyen, and Abba Safir. 2023. "Green Jobs: Upskilling and Reskilling Vietnam's Workforce for a Greener Economy." Policy Note, World Bank, Washinton, DC.
- Dube, Arindrajit, Jeff Jacobs, Suresh Naidu, and Siddharth Suri. 2020. "Monopsony in Online Labor Markets." *American Economic Review: Insights* 2 (1): 33–46.
- Dustmann, Christian, Johannes Ludstock, and Uta Schönberg. 2009. "Revisiting the German Wage Structure." *The Quarterly Journal of Economics* 124 (2): 843–881.
- Dutz, Mark A., Rita K. Almeida, and Truman G. Packard. 2018. *The Jobs of Tomorrow: Technology, Productivity, and Prosperity in Latin America and the Caribbean*. Washington, DC.: World Bank.
- Eberhard-Ruiz, Andreas. 2021. *Jobs Diagnostic: Guatemala*. Jobs Series. Washington, DC. World Bank.
- ECLAC (Economic Commission for Latin America and the Caribbean). 2021. "The Economic Autonomy of Women in a Sustainable Recovery with Equality." Special Report, Santiago.
- ECLAC (Economic Commission for Latin America and the Caribbean) and ILO (International Labor Organization). 2021. *Employment Situation in Latin America and the Caribbean: Decent Work for Platform Workers in Latin America*. ECLAC, Santiago.
- Eden, Maya, and Paul Gaggl. 2020. "Do Poor Countries Really Need More IT?" *The World Bank Economic Review* 34 (1): 48–62.

- Egana-del Sol, Pablo, Monserrat Bustelo, Laura Ripani, Nicolas Soler, and Marina Viollaz. 2022. "Automation in Latin America: Are Women at Higher Risk of Losing Their Jobs?" *Technological Forecasting & Social Change* 175.
- Eloundou, Tyna, Sam Manning, Pamela Mishkin, and Daniel Rock. 2023. "GPTs Are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models." Working Paper, arXiv.org.
- Elverdin, Pablo, Valeria Piñeiro, and Miguel Robles. 2018. "La mecanización agrícola en América Latina." Discussion Paper 017410, International Food Policy Research Institute, Washington, DC.
- Escudero, Verónica, Jochen Kluge, Elva López Mourelo, and Clemente Pignatti. 2019. "Active Labour Market Programmes in Latin America and the Caribbean: Evidence from a Meta-Analysis." *The Journal of Development Studies* 55 (12): 2644–661.
- Ezell, Stephen. 2024. "Assessing the Dominican Republic's Readiness to Play a Greater Role in Global Semiconductor and PCB Value Chains." Information Technology & Innovation Foundation, Washington, DC.
- Faber, Marius. 2020. "Robots and Reshoring: Evidence from Mexican Labor Markets." *Journal of International Economics* 127.
- FAO (Food and Agricultural Organization of the United Nations). 2022. *The State of Food and Agriculture: Leveraging Automation for Transforming Agrifood Systems*. Rome: Food and Agriculture Organization.
- Feenstra, Robert C. 2017. "Statistics to Measure Offshoring and its Impact." Working Paper 23067, National Bureau of Economic Research, Cambridge.
- Feigenbaum, James, and Daniel P. Gross. 2022. "Answering the Call of Automation: How the Labor Market Adjusted to the Mechanization of Telephone Operation." Working Paper 28061, National Bureau of Economic Research, Cambridge.
- Feigenbaum, James, and Daniel P. Gross. 2023. "Organizational and Economic Obstacles to Automation: A Cautionary Tale from AT&T in the Twentieth Century." Working Paper 29580, National Bureau of Economic Research, Cambridge.
- Feijao, Carolina, Isabel Flanagan, Christian van Stolk, and Salil Gunashekar. 2021. *The Global Digital Skills Gaps: Current Trends and Future Directions*. Santa Monica: RAND Corporation.
- Felipe, Jesus, Aashish Mehta, and Changyong Rhee. 2019. "Manufacturing Matters...But It's the Jobs That Count." *Cambridge Journal of Economics* 43:139–68.
- Felten, Edward W., Manav Raj, and Robert Seamans. 2018. "A Method to Link Advances in Artificial Intelligence to Occupational Abilities." *AEA Papers & Proceedings* 108: 54–57.
- Felten, Edward W., Manav Raj, and Robert Seamans. 2021. "Occupational, Industry, and Geographic Exposure to Artificial Intelligence: A Novel Dataset and Its Potential Uses." *Strategic Management Journal* 42: 2195–217.
- Felten, Edward W., Manav Raj, and Robert Seamans. 2023. "How Will Language Modelers Like ChatGPT Affect Occupations and Industries." Research Paper, ResearchGate, Berlin.
- Fernandes, Ana, Gaston Nievas, and Deborah Winkler. 2022. "Trade and GVC Integration in Latin America and the Caribbean." In *Deep Trade Agreements: Anchoring Global Value Chains in Latin America and the Caribbean*, edited by Nadia Rocha and Michele Ruta, 15–60. Washington, DC.: World Bank.

- Fernandez, Cristina, and Juan Benavides. 2020. "Las plataformas digitales, la productividad y el empleo en Colombia." Article, Centro de Investigación Económica y Social, Bogotá.
- Ferreira, María Marta, Lelys Dinarte Díaz, Sergio Urzúa, and Marina Bassi. 2021. *The Fast Track to New Skills: Short-Cycle Higher Education Programs in Latin America and the Caribbean*. Washington, DC.: World Bank.
- Frank, Morgan R., Lijun Sun, Manuel Cebrian, Hyejin Youn, and Iyad Rahwan. 2018. "Small Cities Face Greater Impact from Automation." *Journal of the Royal Society Interface* 15.
- Frey, Carl Benedikt, and Michael A. Osborne. 2017. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting & Social Change* 114: 254–80.
- Fuglie, Keith, Madhur Gautam, Aparajita Goyal, and William F. Maloney. 2020. *Harvesting Prosperity: Technology and Productivity in Agriculture*. Washington, DC.: World Bank.
- Gaggl, Paul, and Greg C. Wright. 2017. "A Short-Run View of What Computers Can Do: Evidence from a UK Tax Incentive." *American Economic Journal: Applied Economics* 9 (3): 262–94.
- Gagnon, Jason. 2011. "'Stay with Us?' The Impact of Emigration on Wages in Honduras." Working Paper 300, Organisation for Economic Co-operation and Development, Paris.
- Garcia, José Alexander, and Katherine Javier. 2020. "Los trabajadores de plataformas digitales en la República Dominicana." Documentos de Proyectos, Comisión Económica para América Latina, Santiago.
- Gasparini, Leonardo, Carlo Lombardo, Irene Brambilla, Andrés César, and Guillermo Falcone. 2021. "Routinization and Employment: Evidence for Latin America." Working Paper 276, Centro de Estudios Distributivos, Laborales y Sociales, La Plata.
- Gasparini, Leonardo, and Mariana Marchionni, eds. 2015. *Bridging Gender Gaps? The Rise and Deceleration of Female Labor Force Participation in Latin America*. Buenos Aires: Centro de Estudios Distributivos, Laborales y Sociales.
- Ghorpade, Yashodhan, Amanina Abdur Rahman, and Alyssa Jasmin. 2023. "Social Insurance for Gig Workers: Insights from a Discrete Choice Experiment in Malaysia." Policy Research Working Paper 10629, World Bank, Washington, DC.
- Gibbs, Michael, Friederike Mengel, and Christoph Siemroth. 2023. "Work from Home and Productivity: Evidence from Personnel and Analytics Data on Information Technology Professionals." *Journal of Political Economy Microeconomics* 1 (1): 7–41.
- Giesing, Yvonne, and Britta Rude. 2022. "Robots, AI, and Immigration – A Race for Talent or of Displaced Workers." *EconPol Forum* 23 (5): 20–3.
- Giuntella, Osea, Yi Lu, and Tianyi Wang. 2022. "How do Workers and Households Adjust to Robots? Evidence from China." Working Paper 30707, National Bureau of Economic Research, Cambridge.
- Giuntella, Osea and Tianyi Wang. 2019. "Is an Army of Robots Marching on Chinese Jobs?" Discussion Paper 12281, Institute of Labor Economics, Bonn.
- Goldin, Claudia, and Lawrence F. Katz. 2002. "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions." *Journal of Political Economy* 110 (4): 730–70.

- Goos, Maarten, and Alan Manning. 2007. "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring." *The American Economic Review* 104 (8): 2509–26.
- Goos, Maarten, Alan Manning, and Anna Salomons. 2009. "Job Polarization in Europe." *American Economic Review: Papers & Proceedings* 99 (2): 58–63.
- Goos, Maarten, Alan Manning, and Anna Salomons. 2014. "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring." *American Economic Review* 104 (8): 2509–26.
- Gottlieb, Charles, Jan Grobovšek, and Markus Poschke. 2020. "Working from Home across Countries." *Covid Economics* 8 (22): 71–91.
- Gottlieb, Charles, Jan Grobovšek, Markus Poschke, and Fernando Saltiel. 2021. "Working from Home in Developing Countries." *European Economic Review* 133: 103679.
- Grace, Katja, John Salvatier, Allan Dafoe, Baobao Zhang, and Owain Evans. 2018. "Viewpoint: When Will AI Exceed Human Performance? Evidence from AI Experts." *Journal of Artificial Intelligence Research* 62: 729–54.
- Graetz, George, and Guy Michaels. 2018. "Robots at Work." *Review of Economics and Statistics* 100 (5): 753–68.
- Granata, Julia, and Josefina Posadas. 2022. *Which Jobs Are Green? A Methodological Note on How to Measure Green Jobs for Skills Policy and an Application to Indonesia*. Washington, DC: World Bank.
- Green, David A., and Benjamin M. Sand. 2015. "Has the Canadian Labour Market Polarized?" *Canadian Journal of Economics* 48 (2): 612–46.
- Greenwood, Jeremy, Ananth Seshadri, and Mehmet Yorukoglu. 2005. "Engines of Liberation." *The Review of Economic Studies* 72 (1): 109–33.
- Gregory, Terry, Anna Salomons, and Zierahn. 2022. "Racing with or against the Machine? Evidence on the Role of Trade in Europe." *Journal of the European Economic Association* 20 (2): 869–906.
- Gries, Thomas, and Wim Naudé. 2022. "Modelling Artificial Intelligence in Economics." *Journal of Labour Market Research* 56.
- Guataquí, Juan Carlos Roa, and Diana Isabel Londoño. 2021. *República Dominicana: Análisis de oferta y demanda de empleo y trazabilidad de egresados Infotep, a partir de bases de datos*. Geneva: International Labour Organization.
- Güven, Cahit, Panagiotis Sotirakopoulos, and Aydoğan Ulker. 2020. "Short-term Labour Market Effects of COVID-19 and the Associated National Lockdown in Australia: Evidence from Longitudinal Labour Force Survey." Working Paper 635, Global Labor Organization, Essen.
- Hallward-Driemeier, Mary, and Gaurav Nayyar. 2018. *Trouble in the Making? The Future of Manufacturing-Led Development*. Washington, DC: World Bank.
- Hallward-Driemeier, Mary, and Gaurav Nayyar. 2019. "Have Robots Grounded the Flying Geese? Evidence from Greenfield FDI in Manufacturing." Policy Research Working Paper 9097, World Bank, Washington, DC.
- Hanushek, Eric A., Guido Schwerdt, Ludger Woessmann, and Lei Zhang. 2017. "General Education, Vocational Education, and Labor-Market Outcomes over the Lifecycle." *Journal of Human Resources* 52 (1): 48–87.

- Hardy, Wojciech, Roma Keister, and Piotr Lewandowski. 2018. "Education Upgrading, Structural Change and the Task Composition of Jobs in Europe." *Economics of Transition* 26 (2): 201–31.
- Hatayama, Maho, Mariana Viollaz, and Hernan Winkler. 2023. "Jobs' Amenability to Working from Home: Evidence from Skills Surveys for 53 Countries." *Economía LACEA Journal* 22 (1): 1–18.
- Hausmann, Ricardo, Luis Espinoza, and Miguel Angel Santos. 2017. "Shifting Gears: A Growth Diagnostics of Panama." Working Paper 325, Center for International Development, Harvard University, Cambridge.
- Hiller, Tatiana, and Marisol Rodríguez Chatruc. 2023. "South-South Migration and Female Labor Supply in the Dominican Republic." *Journal of Economic Geography* 23 (2): 419–48.
- Hirvonen, Johannes, Aapo Stenhammer, and Joonas Tuhkuri. 2022. "New Evidence on the Effect of Technology on Employment and Skill Demand." Research Paper, ResearchGate, Berlin.
- Hitt, Lorin M. 1999. "Information Technology and Firm Boundaries: Evidence from Panel Data." *Information Systems Research* 10 (2): 134–49.
- Hjort, Jonas, and Jonas Poulsen. 2019. "The Arrival of Fast Internet and Employment in Africa." *American Economic Review* 109 (3): 1032–79.
- Hötte, Kerstin, Melline Somers, and Angelos Theodorakopoulos. 2023. "Technology and Jobs: A Systematic Literature Review." *Technological Forecasting & Social Change* 194.
- Hummels, David, Jakob R. Munch, and Chong Xiang. 2018. "Offshoring and Labor Markets." *Journal of Economic Literature* 56 (3): 981–1028.
- IDB (Inter-American Development Bank). 2021b. *The Future of Work in Latin America and the Caribbean: How Can Technology Facilitate Job Recovery after COVID-19*. Washington, D.C.: IDB.IFC (International Finance Corporation), 2019. *Digital Skills in Sub-Saharan Africa: Spotlight on Ghana*. Washington, DC: IFC.
- IFC (International Finance Corporation). 2023. *Creating Markets in the Dominican Republic: Investment Opportunities and Growth Pathways to Higher Value Addition, Resilience, and Inclusion*. Washington, DC.: IFC.
- Ifft, Jennifer and Margaret Jodlowski. 2022. "Is ICE Freezing US Agriculture? Farm-level Adjustment to Increased Local Immigration Enforcement." *Labour Economics* 78.
- ILO (International Labour Organization). 2021a. "From Potential to Practice: Preliminary Findings on the Number of Workers Working from Home during the COVID-19 Pandemic." Policy Brief, ILO, Geneva.
- ILO (International Labour Organization). 2021b. *World Employment and Social Outlook: The Role of Digital Labour Platforms in Transforming the World of Work*. Geneva: ILO.
- IMF (International Monetary Fund). 2018. "Technology and the Future of Work." Working Paper, IMF, Washington, DC.
- Isik-Dikmelik, Aylin, Ana Sofia Martinez, Ines Rodriguez, Nancy Banegas, Asta Zviniene, and Polly Jones. 2022. *Stronger Social Protection and Labor Systems in Central America for a Resilient and Inclusive Recovery*. Washington, DC.: World Bank.

- Jaller, Lillyana Daza, Simon Gaillard, and Martín Molinuevo. 2020. "The Regulation of Digital Trade: Key Policies and International Trends." Research Paper, World Bank, Washington, DC.
- Jensen, J. Bradford, and Lori G. Kletzer. 2010. "Measuring Tradable Services and the Task Content of Offshorable Services Jobs." In *Labor in the New Economy*, edited by Katharine G. Abraham, James R. Spletzer, and Michael Harper, 309–35. Chicago: University of Chicago Press.
- Jin, Yizhou, and Zhengyun Sun. 2021. "Lifting Growth Barriers for New Firms: Evidence from an Entrepreneurship Training Experiment with Two Million Online Businesses." Job Market Paper, Harvard Web Publishing, Cambridge.
- Kanazawa, Kyogo, Daiji Kawaguchi, Hitoshi Shigeoka, and Yasutora Watanabe. 2022. "AI, Skill, and Productivity: The Case of Taxi Drivers." Working Paper 30612, National Bureau of Economic Research, Cambridge.
- Katz, Lawrence F., and Kevin M. Murphy. 1992. "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *Quarterly Journal of Economics* 107 (1): 35–78.
- Katz, Lawrence F., Jonathan Roth, Richard Hendra, and Kelsey Schaberg. 2022. "Why do sectoral employment programs work? Lessons from WorkAdvance." *Journal of Labor Economics* 40 (S1): S249–91.
- Kingsley, Sara Constance, Mary L. Gray, and Siddharth Suri. 2015. "Accounting for Market Frictions and Power Asymmetries in Online Labor Markets." *Policy & Internet* 7 (4): 383–400.
- Kluge, Jochen, Susana Puerto, David Robalino, Jose M. Romero, Friederike Rother, Jonathan Stöterau, Felix Weidenkaff, and Marc Witte. 2019. "Do youth employment programs improve labor market outcomes? A quantitative review." *World Development* 114 (February): 237–53.
- Kogan, Leonid, Dimitris Papanikolaou, Lawrence D. W. Schmidt, and Bryan Seegmiller. 2021. "Technology, Vintage-Specific Human Capital, and Labor Displacement: Evidence from Linking Patents with Occupations." Working Paper Series 29552, Cambridge.
- Konstandini, Genti, Elton Mykerezzi, and Cesar Escalante. 2014. "The Impact of Immigration Enforcement on the U.S. Farming Sector." *American Journal of Agricultural Economics* 96 (1): 172–92.
- Kostøl, Fredrik B. and Elin Svarstad. 2023. "Trade Unions and the Process of Technological Change." *Labour Economics* 84.
- Koolwal, Gayatri and Dominique van de Walle. 2013. "Access to Water, Women's Work, and Child Outcomes." *Economic Development and Cultural Change* 61(2):369-405.
- Koomen, Miriam, and Uschi Backes-Gellner. 2022. "Occupational Tasks and Wage Inequality in Germany: A Decomposition Analysis." Discussion Paper 15702, Institute of Labor Economics, Bonn.
- Korinek, Anton, Martin Schindler, and Joseph E. Stiglitz. 2021. "Technological Progress, Artificial Intelligence, and Inclusive Growth." Working Paper 166, International Monetary Fund, Washington, D.C.
- Krenz, Astrid, Klaus Prettnner, and Holger Strulik. 2021. "Robots, Reshoring, and the Lot of Low-Skilled Workers." *European Economic Review* 136.
- Krenz, Astrid, and Holger Strulik. 2021. "Quantifying Reshoring at the Macro Level-Measurement and Applications." *Growth and Change* 52 (3): 1200–29.

- Kugler, Adriana D., Maurice Kugler, Laura Ripani, and Rodimiro Rodrigo. 2020. "U.S. Robots and their Impacts in the Tropics: Evidence from Colombian Labor Markets." Working Paper 28034, National Bureau of Economic Research, Cambridge.
- Lachaud, Michee Arnold, Boris E. Bravo-Ureta, and Carlos E. Ludena. 2017. "Agricultural Productivity in Latin America and the Caribbean in the Presence of Unobserved Heterogeneity and Climatic Effects." *Climate Change* 143: 445–60.
- Lamb, Creig. 2016. "The Talented Mr. Robot: The Impact of Automation on Canada's Workforce." Research Paper, Brookfield Institute for Innovation and Entrepreneurship, Toronto.
- Lassébie, Julie, and Glenda Quintini. 2022. "What Skills and Abilities Can Automation Technologies Replicate and What Does It Mean for Workers? New Evidence." Social, Employment and Migration Working Paper 282, Organisation for Economic Co-operation and Development, Paris.
- Lederman, Daniel, Julián Messina, Samuel Pienknagura, and Jamele Rigolini. 2014. *Latin American Entrepreneurs: Many Firms but Little Innovation*. Washington, DC.: World Bank.
- Lekfuangfu, Warn N., Suphanit Piyapromdee, Ponpoje Porapakkarm, and Nada Wasi. 2020. "On Covid-19: New Implications of Job Task Requirements and Spouse's Occupational Sorting." Discussion Paper Series 12/20, Centre for Research & Analysis of Migration, London.
- Levin, Victoria Indhira Vanessa Santos, Michael Weber, Syedah Aroob Iqbal, Ashwani Aggarwal, Paul John Comyn, Hiromichi Katayama, Margo A. Hoftijzer. *Building Better Formal TVET Systems: Principles and Practice in Low- and Middle-Income Countries*. Washington, DC.: World Bank Group.
- Lewandowski, Piotr, Karol Madoń, and Deborah Winkler. 2023. "The Role of Global Value Chains for Worker Tasks and Wage Inequality." Policy Research Working Paper 10433, World Bank, Washington, DC.
- Lewandowski, Piotr, Albert Park, Wojciech Hardy, Yang Du, and Saier Wu. 2022. "Technology, Skills, and Globalization: Explaining International Differences in Routine and Nonroutine Work Using Survey Data." *The World Bank Economic Review* 36 (3): 687–708.
- Lewis, Ethan. 2011. "Immigration, Skill Mix, and Capital Skill Complementarity." *The Quarterly Journal of Economics* 126: 1029–69.
- Licetti, Martha Martinez, Tanja Goodwin, Dennis Sanchez Navarro, and Noelia Carreras Schabauer. 2021. *Fixing Markets, Not Prices: Policy Options to Tackle Economic Cartels in Latin America and the Caribbean*. Washington, DC.: World Bank.
- Lin, Jeffrey. 2011. "Technological Adaptation, Cities, and New Work." *The Review of Economics and Statistics* 93 (2): 554–574.
- Lo Bello, Salvatore, Maria Laura Sánchez-Puerta, and Hernan Winkler. 2019. "From Ghana to America: The Skill Content of Jobs and Economic Development." World Bank Policy Research Working Paper 8758, World Bank, Washington, DC.
- Loukos, Panos, and Leslie Arathoon. 2021. "Landscaping the Agritech Ecosystem for Smallholder Farmers in Latin America and the Caribbean." Technical Note 2084, IDB, Washington, DC.
- Madariaga, Javier, Cesar Buenadicha, Erika Molina, and Christoph Ernst. 2019. "Platform Economy and Employment: What Is It Like to Work for an App in Argentina." Executive Summary, enter for the

- Implementation of Public Policies for Equity and Growth, Inter-American Development Bank, and International Labour Organization, Buenos Aires.
- Maloney, William F. 2002. "Missed Opportunities: Innovation and Resource-Based Growth in Latin America." Policy Research Working Paper 2935, World Bank, Washington, DC.
- Maloney, William F., and Carlos Molina. 2016. "Are Automation and Trade Polarizing Developing Country Labor Markets, Too?" Policy Research Working Paper 7922, World Bank, Washington, DC.
- Maloney, William F., and Carlos Molina. 2019. "Are Automation and Trade Polarizing Developing Country Labor Markets, Too?" Policy Research Working Paper Series 7922, World Bank, Washington, DC.
- Mandelman, Federico S., and Andrei Zlate. 2022. "Offshoring, Automation, Low-Skilled Immigration, and Labor Market Polarization." *American Economic Journal: Macroeconomics* 14 (1): 355–89.
- Manyika, James, Michael Chui, Mahdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst. 2017a. *A Future that Works: Automation, Employment, and Productivity*. Washington, DC.: McKinsey Global Institute.
- Manyika, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabh Sanghvi. 2017b. *Jobs Lost, Jobs Gained: Workforce Transitions In A Time Of Automation*. Washington, DC.: McKinsey Global Institute.
- Martínez-Plumed, Fernando, Songül Tolan, Annarosa Pesole, José Hernández-Orallo, Enrique Fernández-Macías, and Emilia Gómez. 2020. "Does AI Qualify for the Job? A Bidirectional Model Mapping Labour and AI Intensities." *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*, February 2020, 94–100.
- Martins-Neto, Antonio, Nanditha Mathew, Pierre Mohnen, and Tania Treibich. 2021. "Is There Job Polarization in Developing Economies? A Review and Outlook." Working Paper 9444, CESifo Institute, Munich.
- Mas, Alexandre, and Amanda Pallais. 2017. "Valuing Alternative Working Arrangements." *American Economic Review* 107 (12): 3722–59.
- Mas, Alexandre, and Amanda Pallais. 2020. "Alternative Working Arrangements." Working Paper Series 02138, National Bureau of Economic Research, Cambridge.
- Maurizio, Roxana. 2021. "Challenges and Opportunities of Teleworking in Latin America and the Caribbean." Labour Overview Series, Latin America and the Caribbean 2021, International Labour Organization, Geneva.
- McKenzie, David. 2017. "How Effective are Active Labor Market Policies in Developing Countries? A Critical Review of Recent Evidence." *World Bank Research Observer* 32 (2): 127–54.
- McKenzie, David. 2021. "Small Business Training To Improve Management Practices in Developing Countries: Re-assessing the Evidence for 'Training Doesn't Work'." *Oxford Review of Economic Policy* 37 (2): 276–301.
- Mealy, Penny, R. Maria del Rio-Chanona, and J. Doyne Farmer. 2018. "What You Do at Work Matters: New Lenses on Labour." Mimeo.
- Meindl, Benjamin, Morgan R. Frank, and Joana Mendonça. 2021. "Exposure of Occupations to Technologies of the Fourth Industrial Revolution." Working Paper, arXiv.org.

- MEPyD (Ministerio de Economía, Planificación y Desarrollo). 2022. *Encuesta Nacional para la Detección Necesidades de Habilidades y Cualificaciones en el Empleo*. Santo Domingo: National Statistics Office - Ministry of Economy, Planning and Development.
- Meschi, Elena, Erol Taymaz, and Marco Vivarelli. 2011. "Trade, Technology and Skills: Evidence from Turkish Microdata." *Labour Economics* 18: S60–70.
- Meschi, Elena, Erol Taymaz, and Marco Vivarelli. 2016. "Globalization, Technological Change, and Labor Demand: A Firm-Level Analysis for Turkey." *Review of World Economics* 152: 655–80.
- Messina, Julián, and Joana Silva. 2018. *Wage Inequality in Latin America: Understanding the Past To Prepare for the Future*. Washington, DC.: World Bank.
- Messina, Julián, and Joana Silva. 2021. "Twenty Years of Wage Inequality in Latin America." *The World Bank Economic Review* 35 (1): 117–47.
- Michaels, Guy, Ashwini Natraj, and John Van Reenen. 2014. "Has ICT Polarized Skill Demand? Evidence from Eleven Countries over Twenty-Five Years." *Review of Economics and Statistics* 96 (1): 60–77.
- Michaels, Guy, Ferdinand Rauch, and Stephen J. Redding. 2019. "Task Specialization in U.S. Cities from 1880 to 2000." *Journal of the European Economic Association* 17 (3): 754–98.
- Michel, Veronica, and Ian Walker. 2019. *Honduras: Jobs Diagnostic*. Jobs Series. Washington, DC.: World Bank.
- Minnesota Population Center. 2020. Integrated Public Use Microdata Series, International: Version 7.3 (dataset). Censuses of Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. Integrated Public Use Microdata Series-International, Minneapolis. <https://doi.org/10.18128/D020.V7.3>.
- Mondolo, Jasmine. 2021. "The Composite Link between Technological Change and Employment: A Survey of the Literature." *Journal of Economic Surveys* 36: 1027–68.
- Mongey, Simon, Laura Pilossoph, and Alexander Weinberg. 2021. "Which Workers Bear the Burden of Social Distancing?" *The Journal of Economic Inequality* 19: 509–26.
- Montenovo, Laura, Xuan Jiang, Felipe Lozano-Rojas, Ian Schmutte, Kosali Simon, Bruce A. Weinberg, and Coady Wing. 2022. "Determinants of Disparities in Early COVID-19 Job Losses." *Demography* 59 (3): 827–855.
- Montobbio, Fabio, Jacopo Staccoli, Maria Enrica Virgillito, and Marco Vivarelli. 2022. "The Empirics of Technology, Employment and Occupations: Lessons Learned and Challenges Ahead." Discussion Paper 15731, Institute of Labor Economics, Bonn.
- Morris, Michael, Ashwini Rekha Sebastian, and Viviana Maria Eugenia Perego. 2020. "Future Foodscapes: Re-imagining Agriculture in Latin America and the Caribbean." Report, World Bank, Washington, DC.
- Moroz, Harry, and Indhira Santos. 2022. "Platform Work Globally and in Latin America and the Caribbean: Overview and Directions in Labor Regulation and Social Protection Policy." Report, World Bank, Washington, DC.
- Nayyar, Gaurav, and Marcio Cruz. 2018. "Developing Countries and Services in the New Industrial Paradigm." Policy Research Working Paper 8659, World Bank, Washington, DC.

- Nayyar, Gaurav, Marcio Cruz, and Linghui Zhu. 2018. "Does Premature Deindustrialization Matter? The Role of Manufacturing versus Services in Development." Policy Research Working Paper 8596, World Bank, Washington, DC.
- Nayyar, Gaurav, Mary Hallward-Driemeier, and Elwyn Davies. 2021. *At Your Service? The Promise of Services-Led Development*. Washington, DC.: World Bank.
- Nedelkoska, Ljubica, and Glenda Quintini. 2018. "Automation, Skills Use and Training." Working Paper 202, Organisation for Economic Co-operation and Development, Paris.
- Nicoletti, Giuseppe, Christina von Rueden, and Dan Andrews. 2020. "Digital Technology Diffusion: A Matter of Capabilities, Incentives or Both?" *European Economic Review* 128.
- Noy, Shakked, and Whitney Zhang. 2023. "Experimental Evidence on the Productivity Effects of Generative Artificial Intelligence." *Science* 381: 187–192.
- Nyman, Sara, and Rodrigo Barajas. 2021. *Antitrust and Digital Platforms: An Analysis of Global Patterns and Approaches by Competition Authorities*. Washington, DC.: World Bank.
- Ñopo, Hugo. 2012. "Gender Differences in Education in Latin America and the Caribbean: Girls Outpacing Boys." In *New Century, Old Disparities Gender and Ethnic Earnings Gaps in Latin America and the Caribbean*, edited by Hugo Ñopo, 21–36. Washington, DC.: IDB.
- OECD (Organisation for Economic Co-operation and Development). 2017a. *Multidimensional Review of Panama: Volume 1: Initial Assessment*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2017b. *OECD Employment Outlook 2017*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2017c. *OECD Reviews of Labour Market and Social Policies: Costa Rica*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2018a. *Bridging the Digital Gender Divide: Include, Upskill, Innovate*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2018b. *How Immigrants Contribute to the Dominican Republic's Economy*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2020a. *Latin American Economic Outlook 2020: The Digital Transformation for Building Back Better*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2020b. *Production Transformation Policy Review of the Dominican Republic Preserving Growth, Achieving Resilience*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2021. *The Digital Transformation of SMEs*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2022a. *Multidimensional Review of the Dominican Republic: Towards Greater Well-being for All*. Paris: OECD.
- OECD (Organisation for Economic Co-operation and Development). 2022b. *Skills for the Digital Transition: Assessing Recent Trends Using Big Data*. Paris: OECD.

- OECD (Organisation for Economic Cooperation and Development). 2023. *Skills in Latin America: Insights from the Survey of Adult Skills (PIAAC)*. OECD Skills Studies. OECD. <https://doi.org/10.1787/5ab893f0-en>.
- Oesch, Daniel. 2013. *Occupational Change in Europe: How Technology and Education Transform the Job Structure*. Oxford: Oxford University Press.
- Oesch, Daniel, and Jorge Rodríguez Menés. 2011. “Upgrading or Polarization? Occupational Change in Britain, Germany, Spain, and Switzerland, 1990-2008.” *Socio-Economic Review* 9: 503–31.
- Oettinger, Gerald S. 2011. “The Incidence and Wage Consequences of Home-Based Work in the United States, 1980-2000.” *The Journal of Human Resources* 46 (2): 237–60.
- Oyer, Paul. 2020. “The Gig Economy: Non-traditional Employment Is a Great Opportunity for Many, But It Won’t Replace Traditional Employment.” *IZA World of Labor* 471.
- Peng, Sida, Eirini Kalliamvakou, Peter Cihon, and Mert Demirel. 2023. “The Impact of AI on Developer Productivity: Evidence from GitHub Copilot.” Research Paper, arXiv.org.
- Posadas, Josefina, and Mauro Testaverde. 2022. “Investing in Labor Market Information Systems: Why and How?” Presentation at the World Bank Brown Bag Lunch online series, December 2, 2022.
- Pouliakas, Konstantinos. 2018. “Determinants of Automation Risk in the EU Labour Market: A Skills-Needs Approach.” IZA Discussion Papers 11829, Institute of Labor Economics, Bonn.
- PwC. 2018. *Will Robots Really Steal Our Jobs? An International Analysis of the Potential Long-Term Impact of Automation*. London: PwC.
- Quirós, Carlota Tarín, Juan Pablo Villar García, Julio Blázquez Soria, Juan Cruz Trecet, Antonio Tena de la Nuez. 2022. “La dimensión de género en la transformación digital empresarial de América Latina y el Caribe.” IDB, Washington, DC.
- Rahman, Ahmed S. 2021. “Why Can’t Everybody Work Remotely? Blame the Robots.” *COVID Economics Vetted and Real-Time Papers* 36 (10): 105–28.
- Reijnders, Laurie S.M., and Gaaitzen J. de Vries. 2018. “Technology, Offshoring and the Rise of Non-Routine Jobs.” *Journal of Development Economics* 135: 412–32.
- Rodrik, Dani. 2016. “Premature Deindustrialization.” *Journal of Economic Growth* 21: 1–33.
- Ross, Matthew B. 2017. “Routine-Biased Technological Change: Panel Evidence of Task Orientation and Wage Effects.” *Labour Economics* 48: 198–214.
- Sanchez, Daniel Garrote, Nicolas Gomez Parra, Caglar Ozden, Bob Rijkers, Mariana Viollaz, and Hernan Winkler. 2021. “Who on Earth Can Work from Home?” *World Bank Research Observer* 36: 67–100.
- Schlogl, Lukas, and Andy Sumner. 2018. “The Rise of the Robot Reserve Army: Automation and the Future of Economic Development, Work, and Wages in Developing Countries.” Working Paper 487, Center for Global Development, Washington, DC.
- Schroeder, Kateryna, Julian Lampietti, and Ghada Elabed. 2021. *What’s Cooking: Digital Transformation of the Agrifood System*. Washington, DC.: World Bank.

- Schultheiss, Tobias, and Uschi Backes-Gellner. 2022a. "Different Degress of Skill Obsolescence across Hard and Soft Skills and the Role of Lifelong Learning for Labor Market Outcomes." *Industrial Relations* 62: 257–87.
- Schultheiss, Tobias, and Uschi Backes-Gellner. 2022b. "Does Updating Education Curricula Accelerate Technology Adoption in the Workplace? Evidence from Dual Vocational Education and Training Curricula in Switzerland." *The Journal of Technology Transfer*.
- Sebastian, Raquel, and Federico Biagi. 2018. "The Routine Biased Technical Change Hypothesis: A Critical Review." JRC Technical Reports, European Commission, Luxembourg.
- Shafiq, M. Najeeb, Amanda Devercelli, and Alexandria Valerio. 2018. "Are There Long-Term Benefits from Early Childhood Education in Low- and Middle-Income Countries?" *Education Policy Analysis Archives* 26 (122).
- Sinha, Rishabh. 2020. "Talent Allocation and Post-Reform Growth in Central America." Policy Research Working Paper 9380, Washington, D.C., World Bank.
- Sinha, Rishabh. 2022. "Central America's Deindustrialization." Policy Research Working Paper 10203, World Bank, Washington, DC.
- Sousa, Liliana D., and Andrés García-Suaza. 2018. "Remittances and Labor Supply in the Northern Triangle." Policy Research Working Paper 8597, World Bank, Washington, DC.
- Spiezia, Vincenzo. 2012. "ICT Investments and Poductivity: Measuring the Contribution of ICTs to Growth." *OECD Journal: Economic Studies* 2012 (1): 199–211.
- Spitz-Oener, Alexandra. 2006. "Technical Change, Job Tasks, and Rising Education Demands: Looking outside the Wage Structure." *Journal of Labor Economics* 24 (2): 235–70.
- Stemmler, Henry. 2019. "Does Automation Lead to De-Industrialization in Emerging Economies? Evidence from Brazil." Discussion Paper 382, Center for European, Governance and Economic Development Research, Göttingen.
- Stöterau, Jonathan. 2019. "Job training programs for youth in low income countries." PEGNet Policy Brief 15/2019, Kiel Institute for the World Economy, Kiel.
- Tapia, Catalina Rodriguez. 2023. "From Informality to Inclusion: Harnessing Public-private Partnerships to Enhance Social Protection Coverage of Online Gig Workers." *Working Without Borders: The Promise and Peril of Online Gig Work Short Note Series* Issue 4, World Bank, Washington, DC.
- Tolan, Songül, Annarosa Pesole, Fernando Martínez-Plumed, Enrique Fernández-Macías, José Hernández-Orallo, and Emilia Gómez. 2021. "Measuring the Occupational Impacts of AI: Tasks, Cognitive Abilities and AI Benchmarks." *Journal of Artificial Intelligence Research* 71: 191–236.
- Ulku, Hulya, and Gabriel Zaourak. 2021. *Unleashing Central America's Growth Potential*. Washington, DC.: World Bank.
- UNCTAD (United Nations Conference on Trade and Development). 2023. *Technology and Innovation Report 2023: Opening Green Windows: Technological Opportunities for a Low-Carbon World*. New York: UNCTAD.
- UNESCO (United Nations Educational, Scientific and Cultural Organization). 2017a. *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM)*. Paris: UNESCO.

- UNESCO (United Nations Educational, Scientific and Cultural Organization). 2017b. *Digital Skills for Life and Work. Report by the Broadband Commission for Sustainable Development*. Paris: UNESCO.
- UNESCO (United Nations Educational, Scientific and Cultural Organization). 2020. *Global Education Monitoring Report – Gender Report: A New Generation: 25 Years of Efforts for Gender Equality in Education*. Paris: UNESCO.
- UNESCO (United Nations Educational, Scientific and Cultural Organization). 2022. *Global Education Monitoring Report* Paris, UNESCO.
- Urquidi, Manuel, and Miguel Chalup. 2023. “The Gender Earnings Gap in Latin America and the Caribbean: An Analysis of Its Components.” Technical Note 2650, Inter-American Development Bank, Washington, DC.
- USAID (United States Agency for International Development). 2017a. “Guatemala Labor Market Assessment.” USAID, Washington, DC.
- USAID (United States Agency for International Development). 2017b. “Honduras Labor Market Assessment.” USAID, Washington, DC.
- USAID (United States Agency for International Development). 2017c. “Proyecto de USAID Puentes para el Empleo: Evaluación del Mercado Laboral.” USAID, Washington, DC.
- USAID (United States Agency for International Development). 2020. “Dominican Republic Labor Market Assessment.” USAID, Washington, DC.
- USDA (United States Department of Agriculture). 2023. *International Agricultural Productivity Data Product*. U.S. Department of Agriculture, Economic Research Service, Washington, DC.
- Vegas, Emiliana, and Lucrecia Santibáñez. 2009. *The Promise of Early Childhood Development in Latin America*. Washington, DC.: World Bank.
- Vivarelli, Marco. 2014. “Innovation, Employment and Skills in Advanced and Developing Countries: A Survey of the Economic Literature.” *Journal of Economic Issues* 48 (1): 123–54.
- Vona, Francesco, Giovanni Marin, and Davide Consoli. 2019. “Measures, Drivers and Effects of Green Employment: Evidence from US Local Labor Markets, 2006–2014.” *Journal of Economic Geography* 19 (5): 1021–48.
- Voorend, Koen, Daniel Alvarado, and Luis Ángel Oviedo. 2021. “Future Demand for Migrant Labor in Costa Rica.” KNOMAD Working Paper 40, World Bank, Washington, DC.
- Webb, Michael. 2020. “The Impact of Artificial Intelligence on the Labor Market.” *SSRN Electronic Journal*.
- WEF (World Economic Forum). 2018a. *The Future of Jobs Report 2018*. Cologny/Geneva: WEF.
- WEF (World Economic Forum). 2018b. *Towards a Reskilling Revolution: A Future of Jobs for All*. Cologny/Geneva: WEF.
- Weinberger, Catherine J. 2014. “The Increasing Complementarity between Cognitive and Social Skills.” *The Review of Economics and Statistics* 96 (5): 849–61.

- Weller, Jürgen, Sonia Gontero, and Susanna Campbell. 2019. “Riesgos de la sustitución tecnológica del trabajo humano y desafíos de la generación de nuevos puestos de trabajo.” Working Paper 201, Comisión Económica para América Latina, Santiago.
- Winkler, Hernan, and Miriam Montenegro. 2021. *Jobs Diagnostic: Dominican Republic*. Jobs Series. Washington, DC.: World Bank.
- Wood, Alex J. 2019. “Good Gig, Bad Gig: Job Quality and New Sources of Insecurity in the Gig Economy.” Oxford Internet Institute, Oxford.
- World Bank. 2012a. *A Gender (R)evolution in the Making*. Washington, DC.: World Bank.
- World Bank. 2012b. *Better Jobs in Nicaragua: The Role of Human Capital*. Washington, DC.: World Bank.
- World Bank. 2016. *World Development Report 2016: Digital Dividends*. Washington, DC.: World Bank.
- World Bank. 2018. *World Development Report 2018: Learning To Realize Education’s Promise*. Washington, DC.: World Bank.
- World Bank. 2021a. *Digital Skills: The Why, the What, and the How: Part 1*. Washington, DC.: World Bank.
- World Bank. 2021b. *Digital Skills: The Why, the What, and the How: Part 2*. Washington, DC.: World Bank.
- World Bank. 2022a. *A Roadmap for Climate Action in Latin America and the Caribbean, 2021–2025*. Washington, DC.: World Bank.
- World Bank. 2022b. “Central America Human Capital Review Phase 1: Costa Rica, Dominican Republic, Guatemala, and Panama.” World Bank, Washington, D.C.
- World Bank. 2022c. *Digital Economy for Latin America and the Caribbean Country Diagnostic: El Salvador*. Washington, DC.: World Bank.
- World Bank. 2022d. “My Skills, My Career Superpowers: How ‘SkillCraft’ Helps Jobseekers to Self-Assess, Identify and Develop Skills for Jobs in South Africa.” World Bank, Washington, DC.
- World Bank. 2022e. *Two Years After: Saving a Generation*. Washington, DC.: World Bank.
- World Bank. 2022f. “Understanding Migration in North Central American Countries: El Salvador, Guatemala, Honduras, and Nicaragua.” World Bank, Washington, DC.
- World Bank. 2023a. *Country Climate Development Report: Dominican Republic*. Washington, DC.: World Bank.
- World Bank. 2023b. *Country Climate Development Report: Honduras*. World Bank, Washington, DC.
- World Bank, UNESCO (United Nations Educational, Scientific, and Cultural Organization), and ILO (International Labor Organization). 2023. *Building Better Formal TVET Systems: Principles and Practice in Low- and Middle-Income Countries*. Washington D.C.: The World Bank.
- World Bank and WTO (World Trade Organization). 2023. *Trade in Services for Development: Fostering Sustainable Growth and Economic Diversification*. Washington, DC: World Bank and WTO.
- Yusuf, Shahid. 2017. “Automation, AI, and the Emerging Economies.” CGD Notes, Center for Global Development, Washington, DC.

