AUTOMATION | LATIN AMERICA

New technologies and the future of jobs in Latin America

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1. Executive Summary

Automation and digitalization are new technologies that boost productivity, growth, and wealth, but also disrupt labor market structures. This policy brief reports results from four related studies that explore the labor market consequences of automation in Latin America from different angles, with different combinations of data, and with different empirical strategies. The studies explore the effects of robot penetration, characterize the vulnerability of demographic groups according to their tasks and occupations, and assess future risk of automation for different income groups.

2. Introduction

Automation and digitalization are new technologies that boost productivity, growth, and wealth, but also disrupt labor market structures. The major concern is that new technologies may displace a significant share of workers out of the labor market resulting in unemployment and loss of income. These effects may be particularly pervasive in the short and medium run, when adjustment of labor markets is slow.

A large literature for developed countries documents that recent technological change replaces labor routine tasks that are heavily concentrated in the middle of the skills distribution. However, not so much is known about the effects of new technologies in developing countries. This policy brief reports results from four related studies that explore the labor market consequences of automation in Latin America from different angles, with different combinations of data, and with different empirical strategies. The studies explore the effects of robot penetration, characterize the vulnerability of demographic groups according to their tasks and occupations, and assess future risk of automation for different income groups.

3. Research overview and findings

The empirical analysis that we describe in this policy brief is based on Brambilla et al (2021a, 2021b, 2021c) and Gasparini et al (2021). The first topic is the potential replacement of workers by robots and its impact on welfare. We construct measures of robot adoption and study their effects on employment and wages. The second topic is the task-based approach. We build an index of routinization based on the description of tasks performed at each occupation. We identify workers that perform routine tasks and study how employment has evolved according to their degree of routinization. Finally, the third topic deals with what the future holds for workers in Latin America. Based on job characteristics, we analyze the risks of being displaced by technology in the near future for different income groups.

Throughout this chapter we use harmonized microdata from the SEDLAC database (a joint collaboration between CEDLAS-UNLP and the World Bank) for the six largest Latin American economies—Argentina, Brazil, Chile, Colombia, Mexico and Peru, which represent 79% of total population and 86% of total GDP of the region—for the period 1992--2016. This large sample allows us to provide a global perspective of the structure of jobs in Latin America.

Direct evidence based on robot adoption

During the last fifteen years, robot adoption has made a big jump in Latin America. The International Federation of Robotics (IFR) compiles data on the stock of robots by industry. Between 2005 and 2016 robot adoption jumped from virtually zero to 2,000 in Argentina; from 1,900 to 11,000 in Brazil; and from 3,000 to a whopping 20,000 in Mexico. In Brambilla et al (2021a), we look at direct evidence of robot adoption on labor market outcomes. The focus of the paper is to study the impact of robot penetration in Argentina, Brazil and Mexico.

We construct measures of worker exposure to robots, defined as the stock of industrial robots per thousand workers, at the district level. The International Federation of Robotics provides data on robots at the industry level, not at the district level. However, within countries, different districts experienced heterogeneous exposure to industrial robots according to their initial distribution of employment across industries.

Industries like automotive, metal products, rubber and plastic products, and industrial machinery adopted industrial robots at a rate well above the average, making local labor markets specialized in these industries to be highly exposed to automation. On the other hand, local labor markets with a large share of industries like textiles, wood and furniture, or paper products remain much less exposed to the penetration of robots. We thus define district robot penetration as a weighted average of robots per worker in each industry where the shares of industry in total district employment are used as weights.

We combine this information with data from household surveys that provide socio-economic information at the district level, namely the unemployment rate, the informality rate, and average labor income. We then run district-level regressions to estimate the effect of robot penetration on labor market outcomes. We follow an instrumental variable approach approach similar to Acemoglu and Restrepo (2020) to estimate the causal effects of robot adoption. To control for unobservables, we include year and industry-country fixed effects, and preexisting trends.

Table 1 reports regression results. The first column shows that there is a positive and significant effect of robot adoption on unemployment. An increase in the ratio of robots to workers of 0.10 results in an increase in district-level unemployment of 0.29 percentage points.

Table 1. The impact of robots on job market outcomes

	Unemployment rate (1)	Informality rate (2)	Labor income (3)
Robot penetration	0.029**	0.114**	-0.261***
	(0.013)	(0.049)	(0.096)
Observations	963	963	963

Source: authors' calculations based on IFR and national household surveys.
Notes: All regressions include year and district fixed effects and control for preexisting trends in unemployment, employment and routinization.
Robust standard errors in parenthesis.
*Significance at the 1, 5 and 10 percent levels are denoted by ***, ** and *.*

These results are in line with findings of Graetz and Michaels (2018), who study the effects of industrial robots across 17 developed countries from 1993 to 2007, and Acemoglu and Restrepo (2020), who analyze the effects of the increase in industrial robot adoption between 1990 and 2007 on US labor markets.

The informality rate, reported in column 2, is the share of employed individuals that are not contributing to a pension fund. The informality rate goes up as a result of exposure to robots, which implies that among individuals that do not lose their jobs due to robots, there is a loss in job quality. The estimated coefficient for informality is almost three times larger in magnitude than the coefficient for unemployment (0.114 vs. 0.029), which is in line with recent evidence for developing countries pointing out that the informal sector can work as a buffer for displaced workers. In the absence of a large informal sector that is able to absorb part of the displaced labor force, the effect of robots and technological change on unemployment would be much larger. Similar arguments have been made for the effects of trade and globalization (Dix-Carneiro, Goldberg, Meghir, and Ulyssea (2021); Cesar, Falcone, and Gasparini (2021)).

The last column in Table 1 reports the effect on total labor income. An increase in the ratio of robots to workers of 0.10 results in a decrease of average district labor income of 2.6 percent. The implication is that robot-displaced workers reallocate to lower paying jobs. Similar results are obtained for the hourly wage (not shown in the table). We conclude that robot adoption indeed has a negative short-run impact on unemployment, informality and average labor earnings at the district level.

Indirect evidence based on routinization (task-based approach)

A large share of the literature on the effects of technology on labor markets has highlighted that workers performing routine repetitive tasks are by definition at a higher risk of being replaced by digitalization or automation than workers that perform tasks that require creativity, problem solving and interpersonal communication. This is called the task-based approach (Autor et al., 2003; Spitz-Oener, 2006; Autor, Katz and Kearney (2006, 2008); Acemoglu and Autor, 2011, Autor and Dorn, 2013). Brambilla et al (2021b, 2021c) and Gasparini et al (2021) are based on this hypothesis.

In Brambilla et al (2021b), we exploit recent surveys for several Latin American countries from the Programme for the International Assessment of Adult Competencies (PIAAC) from the OECD, which collect worker-level information on job tasks. We identify tasks that relate to high flexibility and low risk of automation and relate these measures to demographic characteristics.

Individuals that perform flexible job tasks are less prone to being replaced by robotization and digitalization.

Table 2 estimates probability primes for performing flexible tasks on observable demographics. Results show that women are 8.1 percent less likely than men to perform flexible tasks (column 1). The difference between men and women persists even after controlling for occupation (column 2), although the effect is reduced to 6.8 percent. Low or medium-skilled workers are 12.6 less likely to perform flexible tasks than workers with some tertiary education. While workers above 25 years of age are approximately 6 percent more likely to perform flexible tasks than workers below 25 years old. In sum, women, the unskilled and the semi-skilled, and young workers below 25 are the groups more likely to be hurt by automation technology.

Table 2. Probability of performing flexible tasks

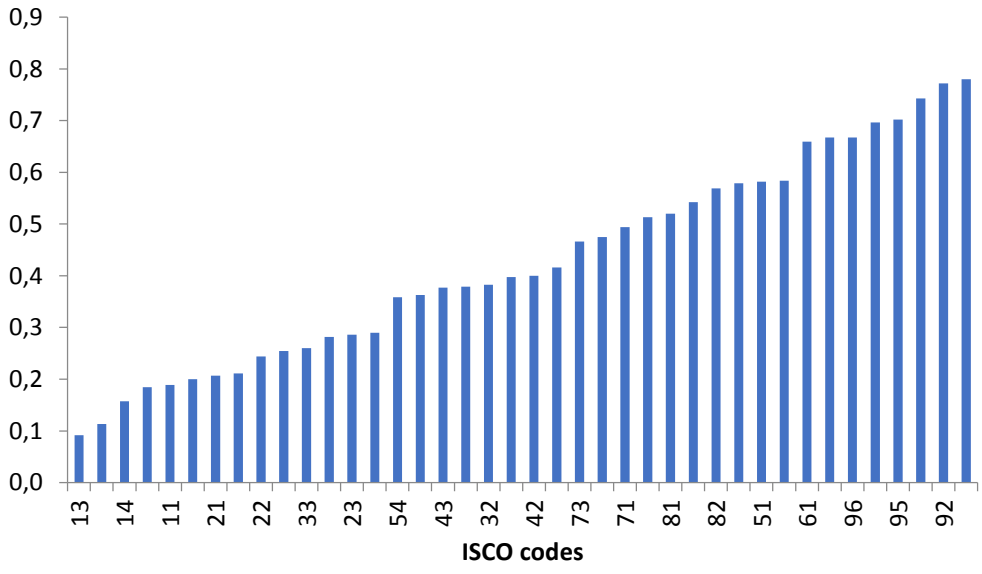
	Probability of performing flexible tasks	
	(1)	(2)
Female	-0.081***	-0.068***
	(0.007)	(0.007)
Low or medium skilled	-0.126***	-0.064***
	(0.008)	(0.009)
Age 25-40	0.060***	0.049***
	(0.011)	(0.011)
Age 41-65	0.058***	0.040***
	(0.011)	(0.011)
R-squared	0.125	0.165
Observations	13,157	13,157

Source: authors' calculations based on PIAAC.
Notes: Column (2) includes occupation fixed effects .
Robust standard errors in parenthesis.
*Significance at the 1, 5 and 10 percent levels are denoted by ***, ** and *.*

In Brambilla et al (2021c) we combine the task data from PIAAC with household surveys from Argentina, Brazil, Chile, Colombia, Mexico and Peru. From the combination of data we construct indexes of routinization at the occupation level (RTC index) and we look at the evolution of employment across occupations.

There is large variance in the routinization content across occupations, with indexes ranging from 0.09 to 0.78 as depicted in Figure 1. Highly flexible occupations (low routinization index) include highly skilled cognitive occupations such as managers, engineers, professors, doctors. In the middle of the flexibility range there are occupations related to the provision of services such as child care, personal care, personal services, security, electrical repairs, customer services, sales, secretaries. It also includes middle skill jobs in manufacturing, construction and transport such as welders, mechanics, builders, machine operators, assemblers, drivers. Most tasks in these jobs require job-specific knowledge, practical experience and, in the case of services, interpersonal abilities. Occupations with a high routine content (high routinization index) are low-skilled jobs in agriculture, industry or services such as day laborers, elementary workers, assistants, street sellers, cleaners and helpers. Most of these jobs involve manual tasks related to essential activities such as cropping and farming, food preparation, cleaning, and community tasks that are physically intensive and very repetitive.

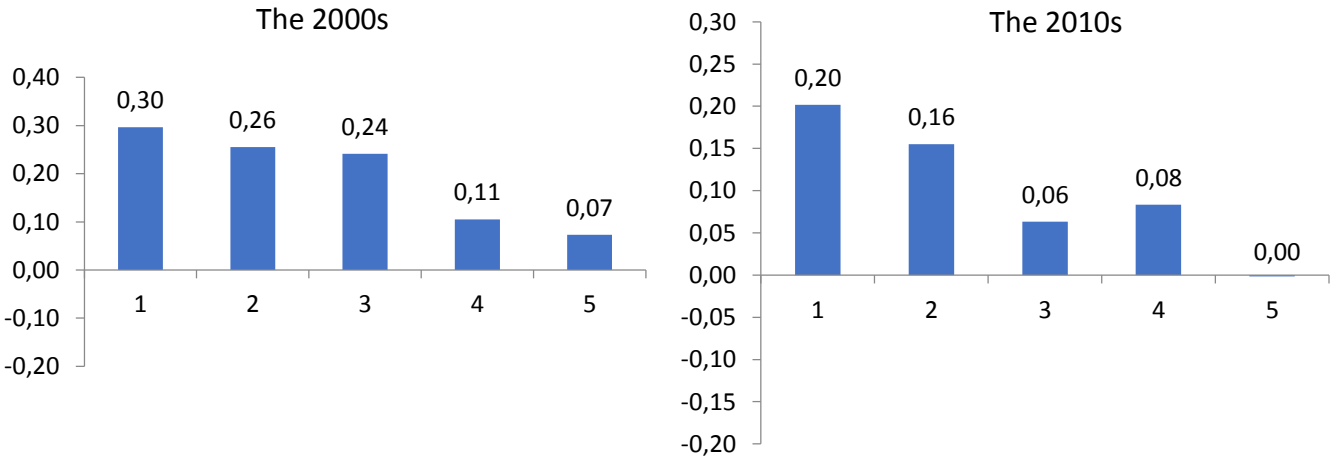
Figure 1. Index of routinization by occupation



Source: authors' calculations based on PIAAC.
Notes: The vertical axis shows the routinization (RTC) index for each occupation.

Routinization and automation have implications of labor markets. The Latin American economies experienced significant changes over the two decades under analysis. In South America economic growth was robust in the 2000s and weaker or inexistent in the 2010s. We relate changes in the structure of employment on routinization of occupations. In Figure 2 occupations are sorted in the horizontal axis by quintiles of the degree of routinization. In both periods the change in employment is decreasing in the RTC quintiles. In the 2000s gains in jobs were generalized but less significant among those occupations with high routinization. Whereas the number of workers in occupations with the lowest risk of automation (bottom quintile of routinization) grew 30 percent in the 2000s, the increase was much more modest in high routine task occupations: 7 percent. In the 2010s this asymmetric pattern was similar, although with lower changes in employment. In fact, the number of workers in occupations in the top routinization quintile went down by -0.2 percent. These results highlight that there is a shift in employment towards flexible occupations and that individuals specialized in routine tasks are more likely to be displaced by technology.

Figure 2. Growth rate in number of workers by quintiles of routinization



Source: authors' calculations based on PIAAC and national household surveys.
Notes: Occupations in the horizontal axis are sorted by quintiles of the RTC index.
The vertical axis shows the growth in number of employed individuals.

Assessment of future risks in Latin America

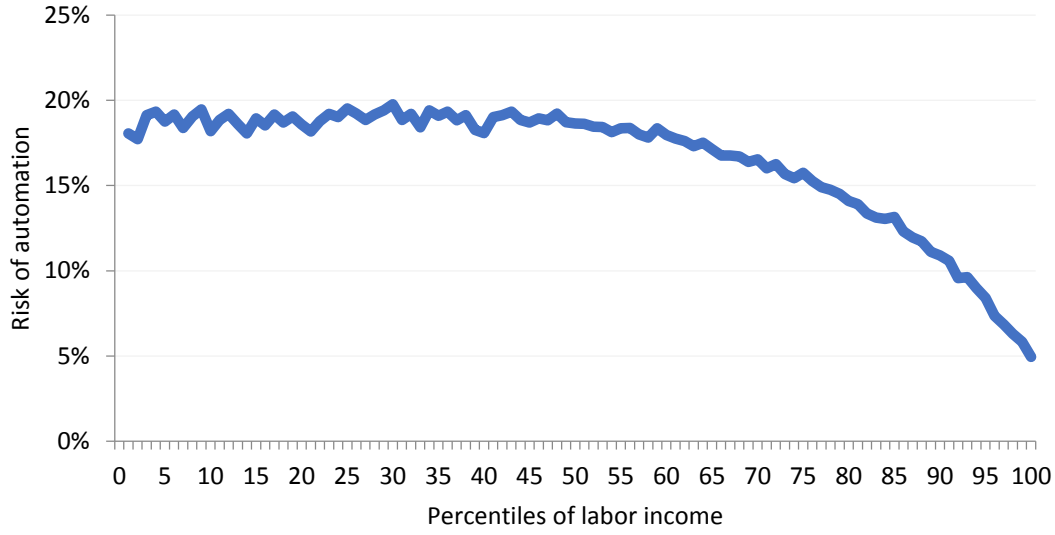
Given what we already know about routinization and automation, how is the risk of automation going to evolve in Latin America? In Gasparini et al (2021) we characterize workers' vulnerability to automation in the near future according to their demographics and income group. We rely on two different measures of risk of future automation recently developed by Frey and Osborne (2017) and Arntz et al. (2016, 2020). These measures are computed from the 2010 version of O*NET, a database of information on the task content of 903 occupations in the US, constructed from the assessments of labor market analysts, experts and workers. Each occupation is assigned a probability of automation.

We impute the occupation-level risk indexes of Arntz et al. (2016) to individuals in the household surveys and calculate the risks for different demographic groups. We find that the ongoing process of automation is likely to affect the structure of employment. In particular, unskilled and semi-skilled workers are likely to bear a disproportionate share of the adjustment

costs, since the automatability of their occupations is higher compared to skilled workers. Women are at higher risk than men, as well as young workers under 25 years old.

These demographic characteristics correlate negatively with income. Figure 3 depicts the risk of automation by labor income percentile. The threat is high for the first four deciles of the income distribution, with a risk of losing jobs to automation of about 18 to 20 percent, and slowly starts to decrease, showing that low-income workers are the most vulnerable. The risk plummets for the richest 20 percent. Given that it affects low-income workers disproportionally, automation poses a risk for income inequality.

Figure 3. Proportion of jobs with high risk of automation, by earnings percentiles



Source: authors' calculations based on Arntz et al (2016, 2020) and national household surveys.
Notes: The horizontal axis shows percentiles of labor income.

4. Policy recommendations

It is worth nothing that this is not the first time that automation and new technologies have threatened a large number of jobs. A well-known case is the first industrial revolution when machines replaced textiles artisans. Certainly, technological change affects some jobs and tasks in specific industries and undermines some employment opportunities. However, firms also create new tasks as others get automated, leading to structural transformation that involves both job creation and job destruction. Moreover, as countries become richer and more productive, they increase demand for goods and services, which also creates new jobs. In the long run, the most important determinant of unemployment and labor market dynamics seems to be the general level of demand for goods and services.

While we think about new technologies as a great opportunity to boost productivity and welfare, it needs to be taken into consideration that, like any disruptive shock, new technologies bring about enormous distributive consequences. While some individuals have the required education and skills to complement technology to create value, others do not. Wages may also grow differently because industries incorporate technologies at different rates, and labor is not perfectly mobile across sectors, regions, or occupations, at least in the short-run. These frictions may create human capital losses with long lasting effects for specific groups. In this context, the key policy challenge is to smooth the transition to new jobs for the displaced workers, to take into account the distributive effects, and to promote the acquisition of skills required by the new economic environment.

To attend these concerns, policy makers need to understand the scope of substitution and complementarity between jobs and new technologies, trying to identify the specific characteristics of winners and losers. We know that computers and robots can substitute for many routine and codifiable tasks, but are far from solving tasks that require problem-solving, intuition, creativity and communications ability, usually performed by workers with high education and analytical capacity (e.g. professionals, technicians, and managers). Our study sheds light on which groups are more threatened by technology in Latin America.

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ABOUT FOWIGS

The Future of Work in the Global South (FoWiGS) is an initiative supported by the International Development Research Centre (IDRC) and coordinated by the Center for the Implementation of Public Policies Promoting Equity and Growth (CIPPEC). It aims at understanding the implications of technological change on jobs from a Global South perspective bringing data, knowledge, and policy frameworks to build evidence-based narratives on the future of work in developing countries.