
FUTURE OF WORK(ERS) RESEARCH PROJECT

# INNOVATION, DIGITAL PLATFORM TECHNOLOGIES AND EMPLOYMENT: AN OVERVIEW OF KEY ISSUES AND EMERGING TRENDS IN SOUTH AFRICA

*Karmen Naidoo*
*Department of Economics, University of Massachusetts Amherst*

December 2020

SCIS Working Paper | Number 9

The Southern Centre for Inequality Studies
University of the Witwatersrand
South Africa

www.wits.ac.za/scis

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SOUTHERN CENTRE FOR INEQUALITY STUDIES

## About the author

Karmen Naidoo is currently a doctoral candidate in Economics at the University of Massachusetts Amherst. Her research interests are development economics and labour economics. In particular, she is interested in the impacts of trade and technology on the labour market. She is also a research assistant at the Political Economy Research Institute, working on capital flight and governance in South Africa. Previously, Karmen was a senior researcher at the Development Policy Research Unit (University of Cape Town), where she worked on projects related to labour markets, poverty and inequality in Africa.

## Acknowledgements

The Future of Work(ers) Research Project at the Southern Centre for Inequality Studies is supported by the International Development Research Centre (IDRC), the Ford Foundation and the Friederich Ebert Stiftung South Africa.

## About the Southern Centre for Inequality Studies

The Southern Centre for Inequality Studies (SCIS) is the first research institute of its kind in the global South. It draws on the intellectual resources of the University of the Witwatersrand and partner institutions in South Africa and beyond, to host an interdisciplinary research and policy project focused on understanding and addressing inequality in the global South. Research foci include wealth inequality, black economic empowerment, the gender pay gap, Covid-19 and the future of work(ers). The Future of Work(ers) research project explores how digital technologies are reshaping the world of work and the impact of these changes on inequality. The project defines work broadly to include both productive and reproductive activities in the formal and informal economy. It conceives of the development and application of digital technologies as a contested terrain. It is particularly interested in how collectives of workers shape what digital technologies are developed, how and to what end; and the economic and social policies that have been leveraged in response. In order to capture the diversity of the global South the project has selected the following case countries: Colombia, Ethiopia, India, Mozambique and South Africa.

Visit our website: www.wits.ac.za/scis

## Recommended citation

Naidoo, K. 2020. Innovation, Digital Platform Technologies and Employment: An Overview of Key Issues and Emerging Trends in South Africa. Future of Work(ers) SCIS Working Paper Number 9. Southern Centre for Inequality Studies, Wits University.

## Abstract

*This paper provides an analytical profile of the South African labour market, along with a descriptive overview of the nature and extent of digital platform labour in the country. The paper also discusses the conceptual links between different types of innovation and employment, before reflecting on the implications of new forms of digital labour relations on labour organization and regulation. The literature on South Africa's digital platform labour is nascent. Some estimates suggest that there are about 135 000 platform workers in the country. There are, however, important concerns about the quality of platform work, and recent research suggests that many platforms do not provide workers with a living wage or decent working conditions. There are several challenges to regulating platform work, in part due to workers being classified as independent contractors. Despite this, there are new emerging forms of worker organization amongst precarious workers in South Africa that go beyond traditional trade unions to incorporate broader worker associations.*

## Introduction

Various schools of economic thought have emphasized that investment and technological change are at the centre of long-run economic growth. However, the ways in which capital accumulation and technological change affect the labour market are complex. The issue of the substitution of capital for labour has therefore been a longstanding debate in political economy, but it has come to the fore in contemporary times, framed around the new technologies associated with the Fourth Industrial Revolution (4IR). This paper aims to conceptualize the channels through which innovation, digital technologies and those associated with the 4IR could impact the South African labour market, taking into account the structure of the labour market and recent evidence on the changing nature of work.

Classical theories of development have emphasized the importance of structural transformation and industrial upgrading to spur long-run growth and employment creation. However, one of the concerns for developing countries is the already evident trend towards premature deindustrialisation (Tregenna, 2016). How advancements in digital and automation technologies impact different sectors – manufacturing, traditional services and modern services – will affect both the current state of the labour market and the dynamics of structural transformation into the future. The ways in which technological advancements might affect both labour displacement (that

is, productivity gains) and compensating effects (that is, direct and indirect demand enlargement) might differ by sector given their various characteristics, such as the tradeable nature or the linkages with other sectors.

South Africa faces the combined challenges of high unemployment, poverty and inequality. Even though there are several detailed reviews of the South African labour market (Bhorat, Naidoo, Oosthuizen, and Pillay, 2016), there is less research on contemporary issues about the impact of digital and other technological advancements. Capital intensity has risen in some sectors of the South African economy, such as parts of mining and manufacturing, over a long time-horizon, with a shift towards more skills-intensive methods of production, which is seen to be one of the sources of the persistently high levels of unemployment (Edwards, 2004; Black, Craig and Dunne 2016). This has contributed to concerns about the impact of automation and robotization on employment in South Africa.

Beyond automation, the 'gig economy' is also reshaping work arrangements in key service sectors – making the informal-formal dualism, which is common in labour markets of developing countries, more complex. These work arrangements range from online labour markets for task-based work conducted remotely and managed digitally, to on-demand platform work such as food deliveries and transportation (Heeks, 2017). It is difficult to estimate the size of the gig economy workforce, but initial work suggests that it involves about 60 million workers in the global South (Heeks, 2017). Similar to the increase in the number of workers employed through temporary employment services (or labour brokers) in South Africa (Cassim and Casale, 2018), this form of 'platform capitalism' is changing the employer-employee relationship and has important implications for employment benefits, working conditions, the ability of labour to organize, and labour regulation.

The aims of this paper are threefold. First, to provide an analytical overview of the South African labour market and to outline the key macro-structural trends affecting the labour market. Second, to provide a conceptual framework of innovation-employment linkages as well as a descriptive overview of the nature and extent of digital platform labour in South Africa. Related to this, the paper discusses how we can better identify and measure the nature and size of the digital labour market. Finally, the paper reflects on the implications of new forms of digital labour relations on the quality of work, labour organization and labour regulation.

This paper is structured as follows. The next section provides an overview of the South African labour market. The third section discusses the conceptual linkages between innovation and

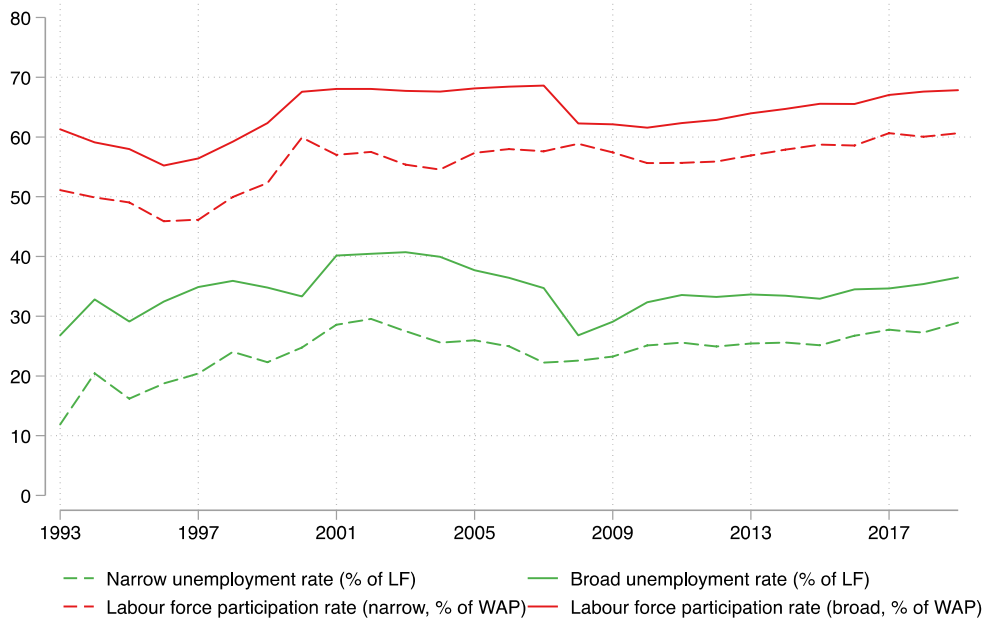
employment, along with the impact of innovation, automation and robotization in the South African context. The fourth section presents an overview of the nature and scale of digital platform labour in South Africa. The fifth section reflects on the implications of the digital platform economy for labour regulation and worker organization, and the sixth section concludes.

## The South African labour market profile

The South African economy is characterised by persistently high rates of unemployment over the post-apartheid period.[1] As shown in **Figure 1**, going by the official definition, the unemployment rate has increased from 20% in 1994 to 29% by 2019. When including discouraged work-seekers – the broad definition of unemployment – the unemployment rate is seen to rise from 33% in 1994 to 37% in 2019. As economic growth increased in the 2000s, the unemployment rate also showed a declining trend. However, the 2008/09 global financial crisis precipitated a net reduction of almost 800 000 jobs. Since then, unemployment has been on the rise. Overall, the employment to population ratio has increased from 24% in 1994 to a peak of 30% in 2008, after which the rate has remained just below 30%.

The rise in unemployment in the late 1990s was partly underpinned by rising labour force participation rates. Using the strict definition of labour force participation, the rate increased by about 10 percentage points, from 50% in 1994 to a peak of 60% in 2000. Labour force participation rates declined to 55% in the immediate post-recession period, after which they have slowly retuned to pre-crisis levels.

**Figure 1:** *Labour force participation and unemployment rates, 1993-2019*




**Source**: Heintz and Naidoo (forthcoming) using PALMS.
**Notes**: LF denotes the labour force and includes those aged 15 to 64 who are economically active. WAP stands for working age population, defined as all those aged 15 to 64. Narrow labour force participation and narrow unemployment rates exclude discouraged work-seekers from the labour force.

Unemployment rates in South Africa vary meaningfully by demographic group, as presented in **Table 1**. Unemployment rates amongst women has remained exceptionally high throughout the post-apartheid period, having reached 45% in 2005, and thereafter declining to 40% by 2019. Amongst men, unemployment rates have increased sharply from 22% in 1995 to 33% in 2019. As a legacy of apartheid, race[2] remains an important determinant of employment outcomes in South Africa. Africans experience the highest rates of unemployment, reaching 41% in 2019, followed by Coloureds at 27%. Furthermore, unemployment is experienced more acutely by those in rural areas than those in urban areas.

The lack of employment generating growth in South Africa over time has a disproportionate impact on the youth. The youth unemployment rate has increased from 28% in 1995 to 49% in 2019. The unemployment rate for older cohorts (50 to 64 years old) has not increased considerably over the period. Finally, individuals with lower levels of formal education – with a high school completion or less – experienced considerably higher rates of unemployment compared to those with a post-school qualification, such as a diploma or degree.

**Table 1:** *Broad unemployment rates*

| (%) | 1995 | 2005 | 2015 | 2019 |
|---|---|---|---|---|
| **Women** | 38.16 | 44.75 | 36.74 | 40.28 |
| **Men** | 21.74 | 30.90 | 29.60 | 33.19 |
| | | | | |
| **African** | 36.18 | 43.51 | 36.98 | 41.10 |
| **Coloured** | 21.73 | 30.69 | 28.04 | 26.68 |
| **Indian** | 13.68 | 22.31 | 17.84 | 13.36 |
| **White** | 5.27 | 7.96 | 7.60 | 8.95 |
| | | | | |
| **Age 15-34** | 38.07 | 50.31 | 43.77 | 48.75 |
| **Age 35-49** | 21.08 | 26.09 | 24.07 | 27.82 |
| **Age 50-64** | 15.48 | 16.71 | 15.60 | 18.07 |
| | | | | |
| **High school completion or less** | 34.89 | 41.48 | 36.80 | 40.71 |
| **Post-high school qualification** | 22.97 | 12.13 | 15.45 | 18.60 |
| | | | | |
| **Urban** | 24.49 | - | 29.55 | 32.55 |
| **Rural** | 36.07 | - | 41.68 | 46.84 |

**Source**: Author's calculations using PALMS.
**Notes**: Broad unemployment rates include the non-searching unemployed.

### *Underemployment, temporary workers and informality*

According to standardized data from the International Labor Organization (ILO), there have not been substantial changes in the share of the employed that are underemployed, presented in **Table 2**. Underemployment amongst women has remained higher than for men over the 2008 to 2019 period, but has shown a declining trend over time. Underemployment rates amongst workers aged 15 to 24 are currently just under 6% of the employed for both men and women, and for men and women aged 25 and more, the rate stands at 7% and 4% of the employed respectively.

While underemployment does not seem to be pervasive in the South African labour market, the rates of informality in employment do suggest that a large segment of employment is in low quality jobs. In 2010, informal employment made up close to 40% of women's employment and 30% for men (**Figure 2**). By 2017, this figure declined to 30% for women but remained at similar levels for men over time. The share of employment outside the formal sector has not shown marked change

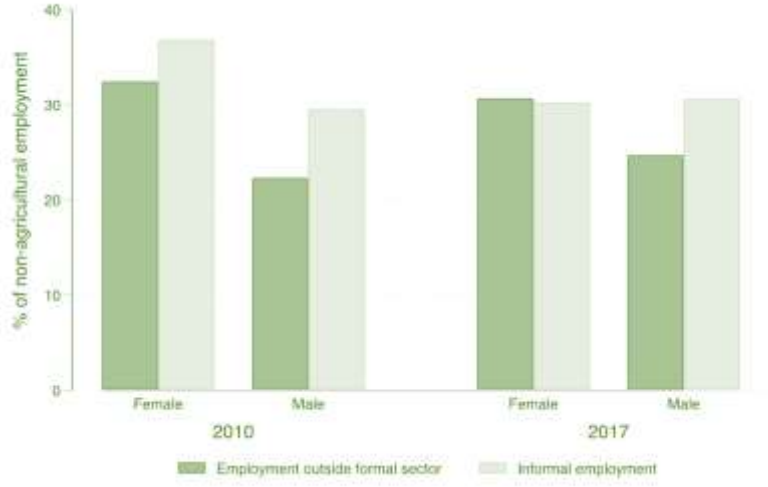
over this period but increased slightly for men. This suggests that the share of women in informal employment might have declined due to the smaller share of domestic work; however, the considerable share of employment outside the formal sector has remained an important feature of the labour market.

**Table 2:** *Time-related underemployment (% of employed)*

| Year | Ages 15 to 24 | | Ages 25+ | |
|---|---|---|---|---|
| | **Female** | **Male** | **Female** | **Male** |
| **2008** | 8.09 | 5.84 | 7.03 | 3.87 |
| **2009** | 7.66 | 5.42 | 7.68 | 4.00 |
| **2010** | 7.42 | 4.54 | 6.56 | 3.52 |
| **2011** | 5.29 | 5.09 | 5.87 | 3.20 |
| **2012** | 6.32 | 5.31 | 6.30 | 3.47 |
| **2013** | 6.31 | 4.80 | 6.44 | 3.59 |
| **2014** | 5.36 | 5.11 | 5.96 | 3.52 |
| **2015** | 6.16 | 4.85 | 6.77 | 3.82 |
| **2016** | 7.14 | 5.13 | 6.68 | 3.94 |
| **2017** | 6.20 | 4.50 | 6.69 | 3.95 |
| **2018** | 5.90 | 4.68 | 6.50 | 4.02 |
| **2019** | 5.54 | 5.62 | 6.72 | 3.96 |

**Source**: Author's calculations using ILOstat.
**Notes**: Time-related underemployment measures the proportion of the employed who are willing and available to work more hours.

**Figure 2:** *Informality (% of non-agricultural employment)*




**Source**: Author's calculations using ILOstat.
**Notes**: Informal employment includes workers who do not have social security coverage, paid vacation or paid sick leave (in the informal or formal sector). Employment outside the formal sector includes those working in businesses that are considered informal.

Finally, a related trend in the casualization of work is the growing number of workers employed through third-party labour brokers, also known as the temporary employment sector (TES). Although there is agreement that the number of workers employed through temporary employment agencies in South Africa is large and growing, it has been historically difficult to accurately measure this workforce (Budlender, 2013). Budlender (2013) triangulates data from large temporary employment agencies in South Africa and arrives at an estimate of more than 800 000 TES workers in 2012. Prior research attempted to use StatsSA's Labour Force Surveys to identify TES workers, using the 'Business Activities Not Elsewhere Classified' industry category, and estimated that there were about 600 000 TES workers in 2007 (Benjamin, Bhorat and Van der Westhuizen, 2010). Budlender (2013) outlines several critiques of this method, in that it captures a broader group of workers than just TES workers, such as outsourced workers.

Recent research has used the South African Revenue Service (SARS) tax administrative data, which includes all company and individual tax returns, along with an indicator of whether the firm is a labour broker. Using this data, it is estimated that the number of TES workers increased from about 400 584 in 2011 to 436 323 by 2015, which was nearly 5% of all formally employed workers in South Africa (Cassim and Casale, 2018). TES workers are more likely to be under the age of 30, male and employed in very large firms (1000+ employees). Notably, the wage penalty associated with TES employment is large and robust to the inclusion of relevant control variables: on average, a TES worker in a similar job to a non-TES worker earns about 30% less, which is mostly due to

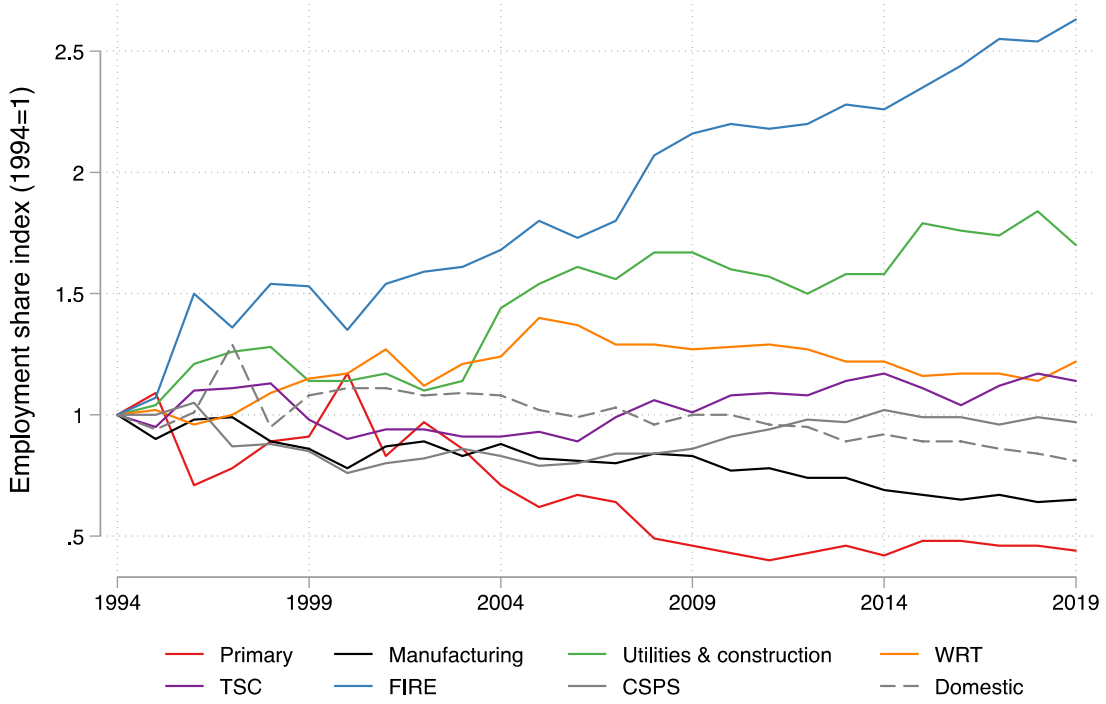
lower benefit contributions such as pension, medical aid and UIF (Cassim and Casale, 2018). While there is still debate on the absolute size of the TES sector, prior research has also found that TES workers report lower earnings than non-TES workers (Budlender, 2013).

### *Industrial and occupational structure*

There has been marked structural change in the South African labour market over time. In 1994, agriculture and mining made up 14% and 3% of employment respectively (**Table A1**, Appendix). By 2019, these sectors made up 5% and 2% of employment. Similarly, the share of manufacturing in employment declined from 17% in 1994 to 11% by 2019. The share of utilities and construction in employment, while small in 1994 at 5%, almost doubled over the period. This indicates that South Africa has been deindustrializing over the past 25 years.

The tertiary sector already made up 60% of employment in 1994 but this increased to 72% in 2019 (**Table A1**, Appendix). The fast growing sectors within the tertiary sector, as illustrated in **Figure 3**, have been the financial sector and the wholesale and retail trade sector. The share of community, social and personal services (largely made up by the public sector), which declined from 23% of employment in 1994 to 17% in 2000, has since increased in size. The share of workers in domestic work declined from 9% in 1994 to 7.5% in 2019.

**Figure 3:** *Growth of sectoral shares of employment (Index, 1994=1)*




**Source**: Author's calculations using PALMS.
**Notes**: The primary sector includes agriculture and mining. WRT denotes the wholesale and retail trade sector; TSC is transport, storage and communications; FIRE is finance, insurance and real estate; CSPS is community, social and personal services (largely made up of public sector employment); and domestic refers to domestic workers employed in households.

There have also been changes in the occupational structure of the labour market over time. Most notable is the reduction in the share of low skill and medium skill occupations within the primary and secondary sectors (**Table 3**).[3] Overall, the occupations that have increased their share of total employment most rapidly over time are high skill occupations in the secondary sector, followed by those in the primary sector. The tertiary sector has absorbed a slightly higher share of workers in low skill occupations over time. While this partly reflects that the labour force is becoming more skilled over time, there is evidence to suggest that this also reflects a skills-biased labour demand pattern in South Africa.

**Table 3:** *Occupational structure by sector (% of employed)*

| | Primary | Secondary | Tertiary |
|---|---|---|---|
| | *1995* | | |
| **High skill** | 2.26 | 11.68 | 28.78 |
| **Medium skill** | 36.12 | 69.34 | 43.85 |
| **Low skill** | 61.62 | 18.98 | 27.37 |
| | *2005* | | |
| **High skill** | 5.07 | 14.08 | 26.48 |
| **Medium skill** | 53.63 | 66.03 | 41.07 |
| **Low skill** | 41.3 | 19.89 | 32.44 |
| | *2015* | | |
| **High skill** | 5.32 | 14.49 | 26.66 |
| **Medium skill** | 36.82 | 63.36 | 44.44 |
| **Low skill** | 57.85 | 22.14 | 28.9 |
| | *2019* | | |
| **High skill** | 5.07 | 18.51 | 26.98 |
| **Medium skill** | 34.68 | 62.77 | 44.83 |
| **Low skill** | 60.24 | 18.72 | 28.19 |
| | *1995-2019 (change % pts.)* | | |
| **High skill** | 2.81 | 6.83 | -1.8 |
| **Medium skill** | -1.44 | -6.57 | 0.98 |
| **Low skill** | -1.38 | -0.26 | 0.82 |

**Source: a**uthor's calculations using PALMS.
**Notes**: High skill occupations are defined as legislators, senior officials, professionals and technical and associate professionals. Medium skill occupations are defined as clerks, service workers, skilled agricultural and fishery workers, and plant and machine operators. Low skill occupations include elementary occupations and domestic workers.

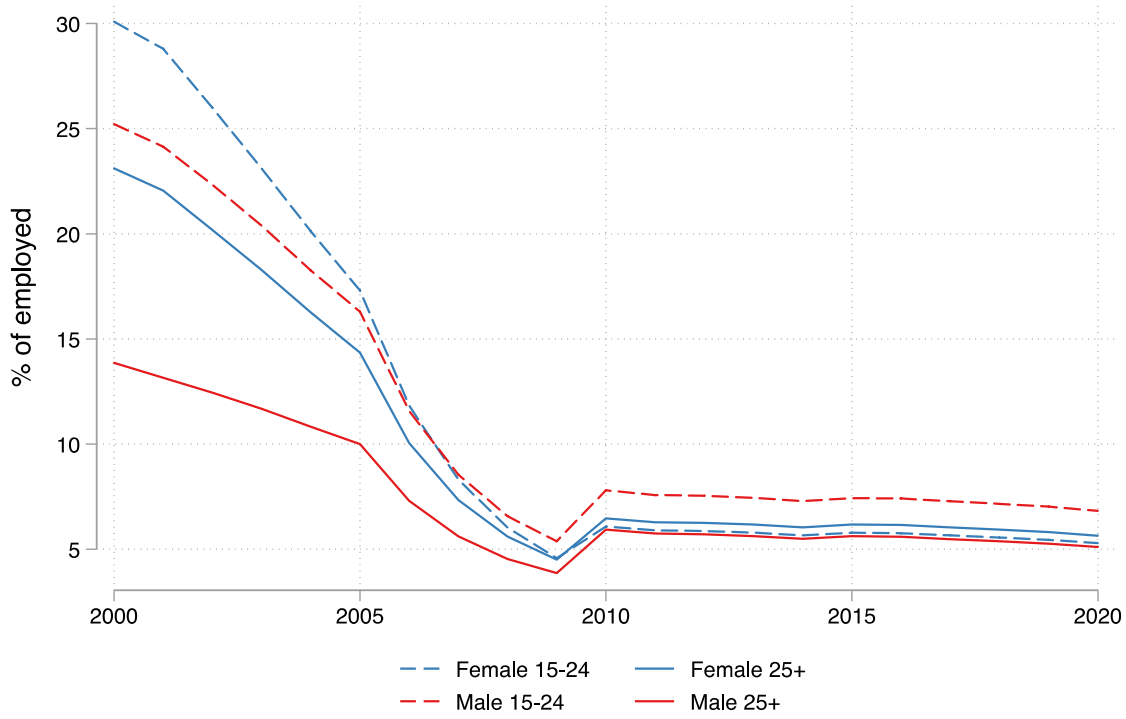
### *Working poverty and wage inequality*

Since the turn of the century, there has been a rapid reduction in the proportion of the employed living below US$1.90 a day (measured in purchasing power parity [PPP] dollars), which is the international poverty line associated with extreme poverty. As illustrated in **Figure 4**, the gender gap in working poverty rates has also declined over time, along with the gap between the poverty rates of employed youth (ages 15 to 24) and older cohorts.

In 2000, the extreme poverty rate amongst working women aged 15 to 24 was 30% and 23% for working women aged 25 and over. By 2019, this figure stood at 5.3% and 5.6% for each age group respectively. For men, extreme working poverty rates were lower in 2000, at 25% for youth and 14% for the older group. By 2019, extreme poverty rates for men had declined to 7% for the youth group and 5% for the older cohort.

Therefore, while the youth face elevated rates of unemployment compared to older groups, they are not considerably more likely to be living in extreme poverty upon employment. Overall, the rates of working poverty in South Africa remain low as measured by the extreme poverty line. As has been discussed earlier, at the national poverty line, poverty rates across all households in South Africa remain high.

**Figure 4:** *Percentage of the employed living below US$1.90 PPP a day*




**Source**: Author's calculations using ILOstat.

## Innovation-employment linkages

There is a large theoretical and empirical literature on the effects of innovation on employment (Vivarelli, 2014; Calvino and Virgillito, 2018). Innovation studies at the level of the firm distinguish between two broad types of innovation: product innovation and process innovation. Product innovation includes new or improved goods and services, whereas process innovation relates to

new or improved methods of production, delivery methods, equipment and software. Product innovation – usually measured by R&D or patent counts – is typically found to be employment generating as it is associated with greater output through market expansion. However, if product innovation replaces existing products, then there is some degree of negative offsetting via a business-stealing effect since new products will displace existing products in the market (Calvino and Virgillito, 2018).

Process innovation that is associated with productivity improvements has a more ambiguous relationship with employment growth, which depends on a number of factors. For example productivity improvements may pass through to lower prices, which can stimulate demand and in turn growth in output and employment, but that depends on the competitive nature of the market and the price elasticity of the affected product (Calvino and Virgillito, 2018). The size of the demand-expansion component depends on the size of the local market (which is affected by any change in wages) or access to larger foreign markets. Therefore, there are complex interactions that ultimately determine the impact of technological change on employment growth. Further, it varies at the firm and sector level.

Firm-level studies on the relationship between product innovation and employment growth confirm a positive relationship (Harrison, et al. 2014; Vivarelli, 2014). However, the relationship between process innovation within firms – associated with productivity enhancing investments such as automation – and employment growth in general does not provide consistent estimates across countries. As summarized in **Table A2**, the impact of process innovation on employment is estimated to be positive in South Africa and either positive or insignificant in other developing countries (Cirera and Sabetti, 2019; Crespi, Tacsir and Pereira, 2019; Naidoo, Bengoa, Kraemer-Mbula and Tregenna, 2019; Okumu, Bbaale and Guloba, 2019). Cirera and Sabetti (2019), studying firms in a range of African countries, further disaggregate process innovation into automation-related and non-automation-related and find that automation has no significant effect on firm employment growth in manufacturing but has a negative effect on firm employment growth in services.

Sectoral-level studies find that product innovation positively impacts employment growth, particularly in high-innovation sectors, and process innovation has negative or limited effects on employment growth (Mastrostefano and Pianta, 2009; Bogliacino and Vivarelli, 2012). The magnitude of the effects is smaller than at the firm-level, owing to intra-sectoral firm dynamics. Demand growth and wages are also important, where demand expands employment and higher

wages negatively impact on employment growth (Mastrostefano and Pianta, 2009; Bogliacino and Pianta, 2010).

In summary, the evidence suggests that process innovation within firms stimulates employment growth at the expense of other firms, whereas product innovation is more expansionary at the sectoral level.

### *Automation and robotization*

In the innovation-employment framework discussed above, automation is closely related to process innovation. Recent research has focused on the degree to which different occupations are vulnerable to the technologies most associated with automation, namely robotization and artificial intelligence. This research takes a 'task-based' approach to classifying different types of jobs and estimates the degree to which occupations can be automated or otherwise substituted by technology. The occupations most vulnerable to automation typically involve jobs that have a high proportion of routine manual and cognitive tasks, whereas such technologies complement jobs that consist largely of higher-level problem solving and complex tasks (Autor, Levy and Murnane, 2003; Frey and Osborne, 2013, 2017; Brynjolfsson and McAfee, 2014). Process innovations are also likely to affect occupations across the industrial structure of an economy.

The existing evidence also points towards a polarizing effect of technology on the labour market, as some occupations and industries are negatively affected while others find complementarities with these technological innovations (Autor and Dorn 2013; Goos, Manning and Salomans, 2014; Autor, 2015; Pajarinen, Rouvinen, and Ekeland, 2015; De La Rica, Gortaza, and Lewandowski, 2020). Evidence from the US shows that workers move from middle-level manufacturing jobs that are more easily automated to low-income service occupations (Autor and Dorns, 2013). Low-income service occupations are less easily automated because of the higher degree of manual dexterity and physicality required. Therefore, computerisation and automation are associated with higher employment growth in high skill and low skill occupations but lower employment growth in middle skilled occupations. Similar evidence has been found for Britain and Europe (Goos and Manning, 2007; Goos, Manning and Salomons, 2014).

Along with job polarization, wage polarization linked to technological change is found to increase wage inequality. Earnings in the US are seen to rise more rapidly in low and highly educated occupations rather than in middle educated occupations (Acemoglu and Autor, 2011). Therefore, changes in wages are driven increasingly by occupation in recent decades rather than merely by

educational attainment. This emphasizes that technological change also affects how education is rewarded in the labour market in terms of earnings.

Relatedly, recent work on the impact of industrial robots – associated with more mechanical tasks – on the labour market in the US also shows that increasing use of robots reduces employment and wages across the skills spectrum (Acemoglu and Restrepo, 2020). Data from the US and Europe show that the use of industrial robots has increased four-fold from 1993 to 2007, with the rise being highest in the automotive sector - which leads by a wide margin – followed by plastics and chemicals, metal products, basic metals, electronics and food and beverages (Acemoglu and Resrepo, 2020). In emerging countries, robots are also found to have a negative impact on manufacturing employment but there are positive spill-overs in non-manufacturing employment (Carbonero et al., 2020).

### *Investment, automation and robotization in South Africa*

There is a small but growing body of literature that aims to analyse the impact of 4IR technologies on the South African labour market. There are a variety of estimates of the vulnerability of South African jobs to automation, using the task-based approach discussed above. In one study, it is found that approximately 5.7 million jobs or 35% of the South African workforce are at risk from automation, including both blue and white-collar jobs (le Roux, 2018). The occupations highlighted to be most at risk of automation are booking and auditing clerks, moulding and casting machine setters and operators, and manual workers in freight and stocking. Using McKinsey data, Chui, Manyika and Miremadi (2017) rank 46 countries in terms of the potential for widespread automation of jobs, measured as the percentage of work activities that can be automated by using or adapting current technologies. Interestingly, South Africa ranks near the bottom (meaning the lowest percentage of work that is automatable) at 41%. Frey, Osborne and Holmes (2016) compare countries' susceptibility to automation and estimate that 67% of South African jobs are at risk of automation.

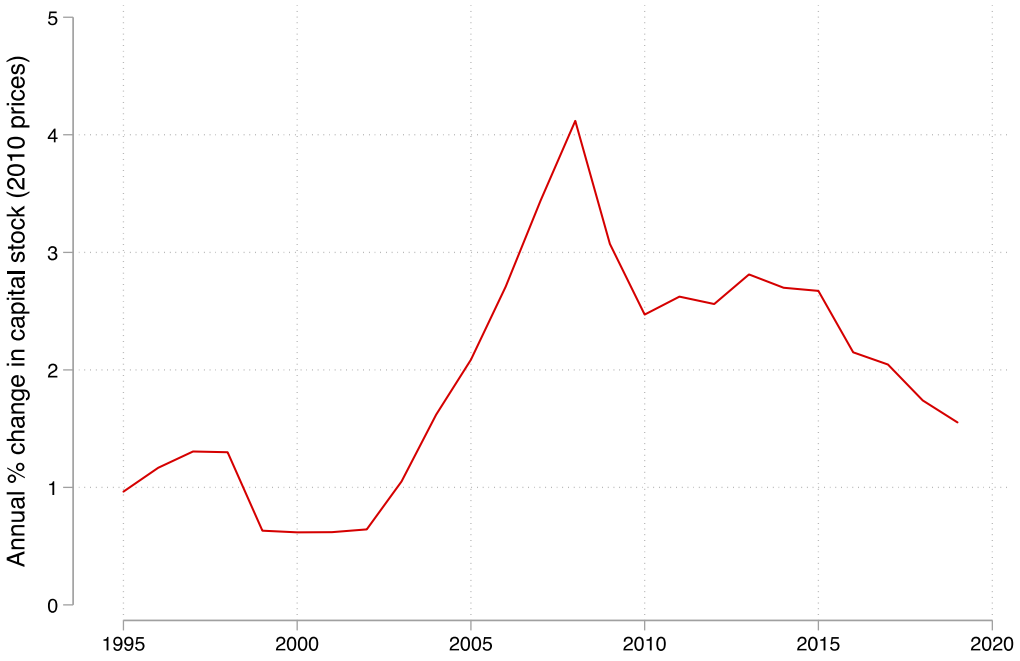
There are several critiques of the task-based automation literature. First, an important critique is that the literature does not fully consider that the potential for jobs to be automated doesn't automatically mean that it will occur, in part because jobs usually involve a variety of tasks which makes automating an entire job a complex process (Arntz, Gregory and Zierahn, 2017). Second, issues of labour costs and profitability are central to firms' decisions to adopt new technologies. As such, the relative costs of labour and capital should be integrated into any framework to estimate the potential for jobs to be automated. Third, organized labour may also have the

opportunity to shape firms' decisions on technology adoption, or to reorient the additional surplus toward helping workers adapt to a changing labour market (Degryse, 2016). There is, in general, no consensus on how the recent trends in technological innovation will affect job displacement, job creation, the quality of work and wages.

In South Africa, the low rates of investment could represent a constraint on the adoption of robotics and other 4IR technologies. A recent qualitative study by Parschau and Hauge (2020) on automation in the South African apparel industry involved 25 interviews with several apparel manufacturers, local equipment suppliers, consultants, and government and labour union representatives. One of the main constraints that firms identified to incorporating automation technologies was the large initial investment costs and difficulties in accessing finance. Importantly, the study highlights that job susceptibility to automation does not automatically translate into lost jobs – there are other factors shaping the pattern of automation.

One of the structural features of South Africa's post-apartheid economy has been low rates of capital accumulation, which represent a major constraint on output and employment growth. Compared to historical rates of investment, the late 1980s and 1990s were characterized by very low rates of net investment (Heintz and Naidoo, forthcoming). There was a recovery in the mid-2000s but this was disrupted by the 2007/08 global financial crisis, after which net investment rates did not recover (**Figure 5**). Notably, net investment in the manufacturing sector as a whole has been negative over the past decade (**Figure A1**, Appendix). At the same time, however, parts of the economy rely on capital-intensive production technologies that limit the rate of employment creation. Black et al. (2016) show that the South African manufacturing sector is still dominated by capital-intensive or heavy industries and that the capital-to-worker ratio has risen across a number of manufacturing sub-sectors over the 1990-2011 period.

**Figure 5:** *Net aggregate investment (1994-2019)*




**Source**: Author's elaboration using data from the South African Reserve Bank Online Statistics.

In summary, the structure of South Africa's economy suggests that there are selected sectors that will be more likely to adopt robotics and automation technologies, such as the faster growing heavy industries that are already on a low employment growth trajectory. Furthermore, sectors such as the automotive sector are fast growing and linked to foreign investment; it is a sector in which there is a rapidly growing global adoption of fit-for-purpose robots. There are also possibilities for incorporating automation technologies in services sectors, which still need further exploration. While this does not mean that all jobs in these sectors are at risk, there could be some degree of job displacement in occupations directly related to routine manual or cognitive work that are easier to automate.

## Digital platform labour in South Africa

Digital platform labour involves the outsourcing of work through internet-based platforms, either to a geographically dispersed crowd (crowdwork) or through location-based apps (location-based) (Berg et al., 2018). Crowdwork involves advertising specific work tasks that are then fulfilled by eligible workers who are quickest to respond to the advert or contested by eligible workers (Heeks, 2017). An example of this type of labour platform is Amazon Mechanical Turk (MTurk), where a range of work can be advertised such as filling out questionnaires, transcribing receipts or labelling photographs. Crowdwork is also associated with online freelancing, where work is given to

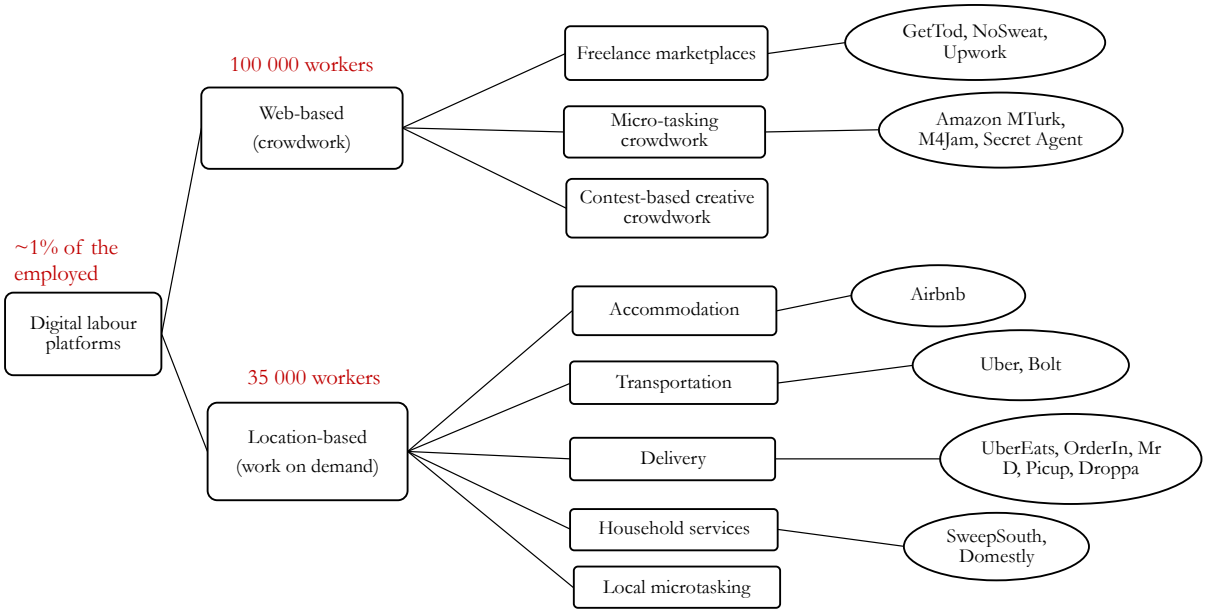
specified individuals and could involve software development, data analytics, administrative support or design and marketing (Heeks, 2017). Location-based apps are related to on-demand work that is geographically specific and are mostly associated with delivery services, transport and household cleaning services.

A common feature of the labour relations governing this type of work is that platform workers are considered independent contractors and therefore are not protected by many of the labour regulations covering employees. In South Africa, this means that these independent contractors do not enjoy the rights of the Labour Relations Act (LRA) and Basic Conditions of Employment Act. As a result, a major concern is that even if digital platforms become a growing source of new employment creation, will they adhere to the standards of 'decent employment'? We discuss the early evidence for South Africa below, which suggests an uneven standard of employment across different types of digital platforms

It is difficult to measure the size of the digital-platform labour force, but some estimates suggest that it involves about 60 million workers in the global South, concentrated in India, Pakistan, Bangladesh and the Philippines, with limited presence in sub-Saharan Africa (Heeks, 2017). In South Africa, it has been estimated that there are about 100 000 workers in web-based crowdwork and about 35 000 in location-based platform work (Fairwork, 2020).

**Figure 6** provides an overview of the dominant web- and app-based platform work in South Africa. There is still no clear evidence of the distribution of workers across each platform, nor available data on the characteristics of digital platform workers, their hours of work, or their earnings. While there seem to be a greater number of location-based apps, there are more workers involved in web-based crowdwork in South Africa.

**Figure 6:** *Overview of digital labour platforms in South Africa*




**Source**: Author's elaboration, adapted from Schmidt (2017).

Fairwork (2020) is leading a collaborative project to track the performance of digital labour platforms according to a range of decent employment measures, of which selected measures are presented in **Table 4**. In South Africa, the apps that score better on these measures are GetTod and NoSweat Work. These platforms are associated with freelance work and skilled trade work. For example, GetTod is an app that allows households to book an electrician or landscaper to complete a specified job related to home maintenance and upgrading. NoSweat is a freelancer app that posts job adverts for marketing and media, IT and software developing; registered workers can vie for the job if eligible. Both these platforms ensure a living hourly wage is paid to workers, have measures in place to ensure worker safety, and accept that workers are free to associate with a labour organization of their choice.

Most of the existing digital platforms in South Africa perform poorly on fair work standards. These are associated with food delivery services (MrD, UberEats, OrderIn), transportation (Uber, Bolt), general delivery services (Picup) and domestic services (Domestly). Many of these platforms do not provide a living hourly wage to workers, the work contract does not adequately reflect the relationship between the platform and the worker, and the platforms do not acknowledge the rights of workers to associate with a trade union or to engage in collective bargaining.

**Table 4:** *Platform ratings*

| Platform | Pays minimum wage | Pays minimum wage + costs (living wage) | Measures to mitigate job risks (health/ safety) | Contract reflects nature of relationship | Due process on decisions affecting worker | Freedom of association and worker voice |
|---|---|---|---|---|---|---|
| **etTod** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **NoSweat** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **SweepSouth** | ✓ | ✓ | ✓ | | ✓ | ✓ |
| **M4Jam** | ✓ | ✓ | ✓ | | ✓ | ✓ |
| **Picup** | ✓ | ✓ | | | ✓ | ✓ |
| **Domestly** | ✓ | | ✓ | | ✓ | |
| **Uber** | ✓ | | ✓ | | | |
| **OrderIn** | ✓ | | | | | ✓ |
| **Uber Eats** | ✓ | | ✓ | | | |
| **Bolt** | ✓ | | ✓ | | | |
| **MrD** | | | | | | |

**Source**: Fairwork (2020)

This overview of digital platform labour in South Africa has provided some insights into the scale and nature of this labour force. However, there is still much we do not know. The current Statistics South Africa Quarterly Labour Force Surveys do not accurately capture gig economy workers. Although they are likely to be classified as self-employed, there is no clear distinction between gig economy workers and, for example, professional self-employed individuals or informal workers. Even in tax records, platform workers may be registered as provisional tax payers and therefore the parent company of the digital platform may not be recorded.

## Reflecting on worker organization and regulation of digital platform labour

Along with concerns about the negative impact of digital and automation technologies on employment, there are important considerations about how new forms of work impact on labour organizing and associated protections, as well as the ability to regulate these forms of work. To the extent that the digital platforms raise the demand for the services being offered – such as the delivery of food – then they might be associated with employment creation. However, there are

early indications that wages and the conditions of work may not meet the minimum standards that are laid out in domestic labour legislation or the decent work guidelines provided by the ILO.

Digital platforms have changed the employment relationship and, as a result, undermine worker rights. By classifying workers as independent contractors, companies bypass the rights of workers that are found in more traditional employment contracts (Webster, 2020). Despite this, the worker is still subject to considerable control by the platform or parent company and their performance is central to the company's core business (Aloisi and De Stefano, 2020). Workers are essentially managed through the online platform (or app), where they clock in by logging into the app and then become subject to algorithmic allocations of tasks to be performed, at predetermined pay rates (Webster, 2020).

Some parallels can be drawn with regulating work in the temporary employment sector in South Africa. As discussed by Webster and Englert (2019), when the Labour Relations Act (LRA) was introduced in 1995 to extend rights to all workers in South Africa, employers took advantage of a legal loophole to bypass these new rights. This took the form of externalizing the employment of workers to third party labour brokers, thereby making workers employees of the labour broker and not of the company at their place of work (Webster and Englert, 2019). Collective worker organization is further challenged by the fragmentation of production, where workers in different parts of the production and distribution chain are divided according to skill levels and type of employment contract and conditions, thereby ensuring that these different groups of workers fall under different bargaining councils (Webster and Englert, 2019).

In recent years, there has been progress in strengthening the LRA with respect to part-time, temporary and TES workers, namely the Labour Relations Amendment Act No. 6 of 2014. The amendment aimed to extend employees' benefits to temporary and TES workers earning below a threshold amount, while limiting the length of these contracts to three months without the option for continual renewal (Cassim, 2020). There is some evidence to suggest that, as a result of the amendment, more TES workers exited formal employment than moved to the non-TES sector (Cassim, 2020). However, for the 20% of TES workers who moved to the non-TES sector as a result of the amendment, it is estimated that they had a higher probability of receiving higher wages than workers who were not targeted by the amendment (that is, those over the earnings threshold) (Cassim, 2020). Therefore, in this case, early evidence suggests that the regulation had its intended effect on a subset of TES workers, but some workers may have been displaced from formal

employment. Further work is required to understand the extent to which employers are able to bypass this amendment and the implications for labour market regulation in future.

There are also challenges to worker organization in the digital platform era and, relatedly, to regulating digital platform labour (Webster and Forrest, 2019; Webster 2020). First, some of the apps are registered internationally and do not consider themselves to be directly employing workers in the countries in which they operate. For example, Uber South Africa is registered as a technology company whose parent company Uber is registered in the Netherlands. In a recent case in South Africa, Uber drivers filed a case against Uber South Africa, in an attempt to be recognized as employees, which was struck down because it was assessed by the court that the case should be brought against Uber BV (Netherlands). In the USA in August 2020, however, a California court ruled in favour of Uber and Lyft drivers that the companies reclassify their drivers as employees with benefits (Allyn, 2020). While this judgement is being contested by the two companies, it represents progress in efforts to get gig economy workers recognized as essential to the functioning of these technology companies.

A second challenge to worker organization is the spatial separation of workers, especially those not engaged in place-based forms of digital platform work. Evidence has shown that place-based workers have engaged in a greater variety of strategies to gain improvements in their working conditions than crowd-workers (Johnston, 2020). Place-based platform workers can engage in strategies that affect their particular jurisdictions and the existing culture of industrial relations (Johnston, 2020). Webster and Englert (2019) also discuss how, in South Africa, precarious workers are creating new forms of organization in the form of worker committees or councils at the plant level, as traditional trade unions fail to represent these groups of workers. In South Africa, a legal-aid NGO, the Casual Workers' Advice Office, played an important role in the LRA amendment in 2014 by offering TES workers assistance to access their new rights. These are examples of precarious (location-based) workers changing the nature of worker organization and relying on different coalitions, such as NGOs and broader worker associations.

## Conclusion

This paper has provided a background to the South African labour market, highlighting the fundamental challenge of high rates of structural unemployment, particularly for women, Africans, youth and those who have not completed high school. There are some indications of increasing casualization of work in South Africa, captured by the scale of the informal sector and the rising trend in workers employed in the temporary employment sector and platform labour.

Employment is concentrated in the services sector, whereas the share of employment in the primary and manufacturing sectors has declined as a share of employment in post-apartheid South Africa.

There is still much to learn about the impact of innovation, automation and robotization on the labour market in South Africa. Initial research has suggested that there is a positive link between firm-level innovation and employment growth. This includes process innovation, which is associated with productivity enhancing production technologies such as automation. This does not necessarily reflect the impact of innovation and automation on employment at the sectoral or aggregate level, which remains an area of future research. The evidence for other countries suggests that automation technologies will have an uneven impact on labour displacement and wages across industries and occupations. The Covid-19 pandemic is also likely to accelerate the use of digital technologies and, at the same time, the associated economic downturn has already had an uneven negative impact on the labour market.

The current estimate of the size of the digital-platform labour market is about 135 0000 workers, or 1% of the employed. The existing labour force survey data in South Africa does not allow for a better understanding of the types of workers involved in these jobs, their earnings and the quality of employment. More refined categories for self-employed workers are required in order to identify gig economy workers in this data. The ability to measure the size of this labour force and the nature of work will allow more insight into the need for labour regulation in the digital platform economy.

There are many avenues for future research in the South African context. First, the literature on the vulnerability of jobs to automation needs to address the issue of which types of automation are economically viable, not only which are technically possible. The current literature based on the task-based methodology does not provide a complete picture of the potential for jobs to be automated in South Africa. The framework of assessment would benefit from including the relative costs of labour and capital, along with worker bargaining power within specific sectors. Second, less attention has been paid to the quality of jobs that will not be subject to automation, or those jobs that will be created as a result. As discussed by Aloisi and De Stefano (2020), the scale of recent technological change may empower capital over labour in ways that make worker organization more difficult in general and put downward pressure on the value of work that remains available. There are also areas of the economy in which innovation can help to spur growth and decent employment creation. More research is needed on the firm- and sectoral-level employment impacts of investment in innovation. The existing national innovation surveys need

to be scaled up to cover a broader range of sectors and to be implemented more frequently. Third, there is much we don't know about the scale and nature of platform labour in South Africa owing to the lack of data. Research on the types of workers in this sector, their motivations for engaging in platform work, earnings, working conditions and ability to organize would provide valuable insights into this emerging segment of the labour market. A final avenue of research is on the possibilities for regulating platform-based labour markets. The brief overview in the previous section highlighted that labour regulation needs to be adapted to better reflect the underlying exchange in the employment relationship between the platform and the worker, which some labour law scholars and organizations such as the ILO have started to explore (ILO, 2019; Aloisi and De Stefano, 2020).

[1] This labour market profile is primarily based on the author's calculations using the Post-Apartheid Labour Market Series (PALMS) dataset (Kerr, Lam, and Wittenberg, 2019), unless otherwise indicated. PALMS is a standardized dataset using the official Statistics South Africa survey data for the following years: Project for Statistics on Living Standards and Development (PSLSD) (1993), October Household Survey (1994 to 1999), Labour Force Survey (2000 to 2008), and Quarterly Labour Force Survey (2009 to 2019).
[2] This paper makes use of the standard racial classification groups in South Africa: African, Coloured, Indian and White. 'Black South Africans' refers to the combined population group of Africans (ethnically Black), Coloureds (mixed-race) and Indians (of Indian ancestry).
[3] The occupational categories are defined in the notes for Table 3.

## References


Acemoglu, D. and Restrepo, P. (2020) Robots and jobs: Evidence from US labor markets, *Journal of Political Economy*, 128(6), 2188-2244

Acemoglu, D. and Autor, D. (2011) Skills, tasks and technologies: Implications for employment and earnings, in Ashenfelter, O. and Card, D. (eds.) *Handbook of Labor Economics*, Cambridge: Elsevier

Allyn, B. (2020) California judge orders Uber and Lyft to consider all drivers employees, *NPR*, 10 August 2020. Available at https://www.npr.org/2020/08/10/901099643/california-judge-orders-uber-and-lyft-to-consider-all-drivers-employees (Accessed: 1 October 2020)

Aloisi, A. and De Stefano, V. (2020) Regulation and the future of work: The employment relationship as an innovation facilitator, *International Labour Review*, 159(1)

Arntz, M., Gregory, T. and Zierahn, U. (2017) Revisiting the risk of automation, *Economics Letters*, 159, 157-160

Autor, D. H. (2015) Why are there still so many jobs? The history and future of workplace automation. *Journal of Economic Perspectives*, 29(3), 3-30

Autor D. H. and Dorn, D. (2013) The growth of low-skill service jobs and the polarization of the U.S. labor market *American Economic Review, 103*(5), 1533-1597

Autor, D. H., Levy, F., and Murnane, R. J. (2003) The skill content of recent technological change: an empirical exploration. *The Quarterly Journal of Economics*, 118(4), 1279-1333

Benjamin, P., Bhorat, H. and van der Westhuizen, C. (2010) *Regulatory Impact Assessment of Selected Provisions of the Labour Relations Amendment Bill, 2010, Basic Conditions of Employment Amendment Bill, 2010, Employment Equity Amendment Bill, 2010, Employment Services Bill, 2010.* Pretoria: Department of Labour and the Presidency

Berg, J., Furrer, M., Harmon, E., Rani, U., Silberman, M. S., (2018) *Digital labour platforms and the future of work: Towards decent work in the online world*, Geneva: International Labour Organization

Bhorat, H., Naidoo, K., Oosthuizen, M. and Pillay, K. (2016) Demographic, employment and wage trends in South Africa, in Bhorat, H. and Tarp, F. (eds.) *Africa's Lions*, Helsinki: UNU-WIDER and Brookings University Press

Bhorat, H., Naidoo, K. and Yu, D. (2015) Trade unions in an emerging economy: the case of South Africa, in Monga, C. and Lin, J. (eds.) *Handbook of Africa and Economics*, Oxford: Oxford University Press

Black, A., Craig, S., Dunne, P. (2016), Capital intensity, industrial policy and employment in the South African manufacturing sector, *REDI3x3 Working Paper 23*, The Southern African Labour and Development Research Unit (SALDRU), Cape Town: University of Cape Town

Bogliacino, F. and Pianta, M. (2010) Innovation and employment: a reinvestigation using revised Pavitt classes, *Research Policy*, 39(6), 799-809

Bogliacino, F. and Vivarelli, M. (2012) The job creation effect of R&D expenditures, *Australian Economic Papers*, 51(2), 96-113

Brynjolfsson, E., and McAfee, A. (2014) *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. New York: WW Norton & Company

Budlender, D. (2013) Private employment agencies in South Africa. *Sector Working Paper No. 291*, Geneva: International Labour Office:

Calvino, F., and Virgillito, M. E. (2018) The innovation-employment nexus: A critical survey of theory and empirics, *Journal of Economic Surveys*, 32(1), 83–117

Carbonero, F., Ernst, E., Weber, E. (2020) Robots worldwide: The impact of automation on employment and trade, IAB-Discussion Paper, No. 7/2020, Institut für Arbeitsmarkt- und Berufsforschung (IAB), Nürnberg

Cassim, A. and Casale, D., (2018) How large is the wage penalty in the labour broker sector? evidence for South African using administrative data, *UNU-WIDER Working Paper 2018/48,* Helsinki: UNU-WIDER

Cassim, A. (2020) The impact of employment protection on the temporary employment services sector: Evidence from South Africa using data from tax records, *UNU-WIDER Working Paper 79,* Helsinki: UNU-WIDER

Chui, M., Manyika, J., and Miremadi, M. (2017) The countries most (and least) likely to be affected by automation, *Harvard Business Review*, April 12. Available at https://hbr.org/2017/04/the-countries-most-and-least-likely-to-be-affected-by-automation

Cirera, X., and Sabetti, L. (2019) The effects of innovation on employment in developing countries: evidence from enterprise surveys, *Industrial and Corporate Change*, 28(1), 161–176

Crespi, G., Tacsir, E., Pereira, M. (2019) Effects of innovation on employment in Latin America, *Industrial and Corporate Change*, 28(1), 139–159

De La Rica, S., Gortaza, L. and Lewandowski (2020) Job tasks and wages in developed countries: evidence from PIAAC, *Labour Economics*, 65.

Degryse, C. (2016) Digitalisation of the economy and its impact on labour markets, *Working Paper 2016.2*, Brussels: European Trade Union Institute

Edwards, L. (2004) A firm level analysis of trade, technology and employment in South Africa, *Journal of International Development*, 16(1), 45–61.

Fairwork (2020) *Fairwork South Africa Ratings 2020: Labour Standards in the Gig Economy*. Available at https://fair.work/wp-content/uploads/sites/97/2020/04/Fairwork-South-Africa-2020-report.pdf

Francis, D. and Valodia, I., (2018) Minimum wage for South Africa: A question of power, *South African Journal of Social and Economic Policy*, 71

Frey, C. B. and Osborne, M. (2013) *The future of employment: How susceptible are jobs to computerisation?* (Technical report), Oxford: Oxford Martin School

Frey, C. B., and Osborne, M. A. (2017) The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254-280

Frey, C. B., Osborne, M. A. and Holmes, C. (2016) Technology at work v2.0: The future is not what it used to be, Citi GPS Global Perspectives and Solutions (Technical report), Oxford: Oxford Martin School.

Goos, M., and Manning, A. (2007) Lousy and lovely jobs: The rising polarization of work in Britain, *The Review of Economics and Statistics*, 89(1), 118-133

Goos, M., Manning, A., and Salomons, A. (2014) Explaining job polarization: routine-biased technological change and offshoring, *American Economic Review*, *104*(8), 2509-2526

Heels, R. (2017) Decent Work and the Digital Gig Economy: A D Developing Country Perspective on Employment Impacts and Standards in Online Outsourcing, Crowdwork, etc. Development Informatics Working Paper Series, Paper No. 71, Global Development Institute, University of Manchester, U.K.

Heintz, J. and Naidoo, K. (forthcoming) Unemployment in South Africa, in Oqubay, A., Tregenna, F. and Valodia, I. (eds.) *The Oxford Handbook of the South African Economy,* Oxford: Oxford University Press

ILO (2019) *Work for a brighter future. Report by the Global Commission on the Future of Work*, Geneva: International Labour Organization

Johnston, H. (2020) Labour geographies of the platform economy: understanding collective organizing strategies in the context of digitally mediated work, *International Labour Review*, 159(1)

Le Roux, D. B. (2018) Automation and employment: the case of South Africa, *African Journal of Science, Technology, Innovation and Development*, 10(4), 507-517

Mastrostefano, V. and Pianta, M. (2009) Technology and jobs. *Economics of Innovation and New Technology*, 18(8), 729-741

Naidoo, K., Bengoa, M., Kraemer-Mbula, E. and Tregenna, F. (2019) How does innovation affect employment? Firm-level evidence from South Africa, paper presented at the Community of Practice in Innovation and Inclusive Industrialisation conference, 28-29 November 2019, Pretoria

Okumu, I. M., Bbaale, E., Guloba, M. M. (2019) Innovation and employment growth: evidence from manufacturing firms in Africa, *Journal of Innovation and Entrepreneurship*, 8(7)

Pajarinen, M., Rouvinen, P. and Ekeland, A., (2015) Computerization threatens one-third of Finnish and Norwegian employment, *ETLA Brief No. 34*. Available at http://pub.etla.fi/ETLA-Muistio-Brief-34.pdf

Parschau, C. and Hauge, J. (2020) Is automation stealing manufacturing jobs? Evidence from South Africa's apparel industry, *Geoforum*, 115, 120-131

Schmidt, F. A. (2017) Digital labour markets in the platform economy: mapping the political challenges of crowd work and gig work (Technical Report), Berlin: Friedrich-Ebert-Stiftung.

Tregenna, F. (2016) Deindustrialization and premature deindustrialization, in Gosh, J., Kettel R. and Reinert, E. (eds) *Elgar Handbook of Alternative Theories of Economic Development,* Surrey: Edward Elgar Publishing

Vivarelli, M. (2014) Innovation, employment and skills in advanced and developing countries: a survey of economic literature, *Journal of Economic Issues*, 48(1), 123–154

World Bank (2016) *World Development Report: Digital Dividends*. Washington DC

Webster, E. and Englert, T. (2019) New dawn or end of labour? From South Africa's East Rand to Ekurhuleni, *Globalizations*, 17(2), 279-293

Webster, E. and Forrest, K. (2019) Precarious work: experimenting with new forms of representation: South African labour responds, *International Journal of Labour Research*, 9(1/2)

Webster, E. (2020) The Uberisation of work: the challenge of regulating platform capitalism: A commentary. *International Review of Applied Economics*, 34(4) 512-521

## Appendix

**Table A1:** *Sectoral shares of employment*

| | 1994 | 2019 | 1995-2019 (change %pts.) |
|---|---|---|---|
| **Agriculture** | 14.18 | 5.06 | -9.12 |
| **Mining** | 2.75 | 2.31 | -0.44 |
| **Manufacturing** | 16.86 | 10.96 | -5.9 |
| **Utilities** | 0.95 | 0.93 | -0.02 |
| **Construction** | 4.51 | 8.33 | 3.82 |
| **Wholesale and retail trade** | 17.38 | 21.15 | 3.77 |
| **Transport, storage and communications** | 5.32 | 6.06 | 0.74 |
| **Finance, insurance and real estate** | 5.93 | 15.62 | 9.69 |
| **Community, social and personal services** | 22.79 | 22.02 | -0.77 |
| **Domestic work** | 9.33 | 7.56 | -1.77 |

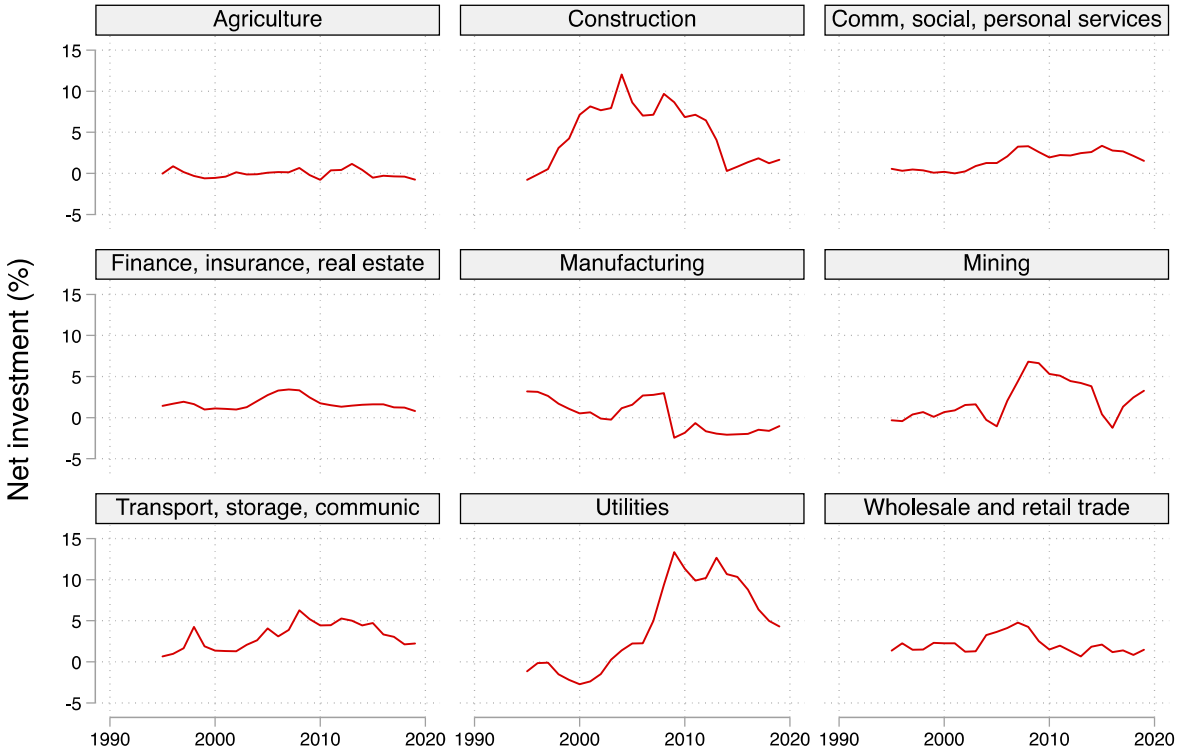
**Source**: Author's calculations using PALMS.

**Table A2:** *Estimates of the firm-level employment effects of process innovation in developing countries*

| Authors | Country | Sector | Process innovator (d) |
|---|---|---|---|
| **De Elejalde *et al*. (2015)** | Argentina | Manufacturing | 1.252<br>(1.612) |
| **Crespi, Tacsir & Pereira (2019)** | Argentina | Manufacturing | -2.947<br>(1.874) |
| **Crespi *et al*. (2019)** | Chile | Manufacturing | 0.33<br>(2.572) |
| **Crespi *et al*. (2019)** | Costa Rica | Manufacturing | 18.413*<br>(10.076) |
| **Crespi *et al*. (2019)** | Uruguay | Manufacturing | -2.716*<br>(1.10) |
| **Okumu, Bbaale and Guloba (2019)** | 27 African countries | Manufacturing | 0.03<br>(0.0627) |
| **Cirera and Sabetti (2019)** | 53 developing countries | Manufacturing | -0.008<br>(0.02) |
| **Cirera and Sabetti (2019)** | 53 developing countries | Services | -0.007<br>(0.02) |
| **Naidoo et al. (2019)** | South Africa | Manufacturing | 4.910***<br>(0.454) |
| **Naidoo et al. (2019)** | South Africa | Services | 3.520***<br>(0.376) |
| **Aboal *et al*. (2015)** | Uruguay | Services | 1.209<br>(2.149) |

**Source**: Adapted from Naidoo et al. (2019)
**Notes**: Standard errors are shown in parenthesis. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

**Figure A1:** *Net investment by sector (1994-2019)*




**Source**: Author's elaboration using data from the South African Reserve Bank Online Statistics.

SOUTHERN CENTRE FOR INEQUALITY STUDIES | FACULTY OF COMMERCE, LAW AND MANAGEMENT, North Lodge, Wits University Parktown Campus, 2 St David's Place, Johannesburg, 2050
**T** +27 (0) 11 717 8274, **W** www.wits.ac.za/scis/