UNIVERSITY OF CAPE TOWN

FACULTY OF COMMERCE

School of Economics

Labour Market Participation and Access to the Internet During COVID-19 Lockdown: Case of South Africa

Minor Dissertation submitted to the University of Cape Town in partial fulfilment of the requirements for the degree of Master of Commerce in Economic Science.

Student: Relebohile Mariti MRTREL001

Supervisor: Prof. Lukasz Grzybowski

Plagiarism declaration

1. I know that plagiarism is wrong. Plagiarism is to use another's work and to pretend that it is one's own.
2. I have used the Harvard Convention for citation and referencing. Each significant contribution to and quotation in this report form the work or works of other people has been attributed and has been cited and referenced.
3. This dissertation is my own work.
4. I have not allowed and will not allow anyone to copy my work with the intention of passing it as his or her own work.

Student Number	MRTREL001
Name and Surname	RELEBOHILE MARITI
Date	10-12-2023
Signature	Signed by candidate

Table of Contents

1. Abstract

The labour markets have become digitalised with the rise of the internet. As economies undergo industrial revolutions, various aspects of the labour market have been greatly impacted by internet use and access to information and communication technologies worldwide. Among others, the internet has affected labour market transparency, job search and matching. In addition, the recent pandemic (COVID-19) has also highlighted the crucial role that information and communication technologies as well as internet access play in the labour market. In this study, we investigate how internet access at home influences labour market attachment at the extensive margin in South Africa. Using the data from the 2020 and 2021 General Household Surveys administered by Statistics South Africa, and three identifications strategies (instrumental variable strategy, panel data methods and propensity score matching), the study finds a desirable effect of household internet connection on both the probability of being employed and the likelihood of being economically active.

Moreover, the estimation results from the supplemental analysis indicate that household internet connection has a positive influence on likelihood of being employed for males and there is no sufficient evidence to suggest a corresponding effect on labour market attachment of females. Unless otherwise stated, the strict definition of unemployment is used to measure labour force participation in this study. The main findings of this study suggest that internet diffusion in recent years enabled productive South Africans to participate in the labour market. Hence policies aimed at redressing digital inequality by promoting awareness of benefits of using the internet and how to use the internet as well as subsidising data to enhance the adoption and use of internet at home are necessary to stimulate labour supply.

2. Introduction

Labour markets have long been characterised by information asymmetry. The rise of the internet can potentially influence the functioning of the labour market. Also, the recent COVID-19 pandemic has highlighted the paramount role of internet and information and communication technologies in the labour market. Among others, the aspects of the labour market that the rise of the internet has impacted include labour market transparency, job search and matching. Theoretically, the ultimate effect of internet use at home on labour force participation is indeterminable. Besides increasing the speed at which information is disseminated, internet use has also reduced the cost of information acquisition and dissemination, subsequently improving labour market transparency and reducing search frictions (Alam & Mamun, 2017; Khan *et al.*, 2017; Hjort & Poulsen, 2019).

In addition, firms post vacancies online and job seekers search and apply for jobs online. The internet also facilitates telework enabling individuals to pursue job opportunities from local and international labour markets. Lower job search costs and better employment prospects from international labour markets will likely lower reservation wages[1], leading to an increased labour supply at the extensive margin. Furthermore, lower search frictions may result in effective and efficient matching of workers and firms. Again, the internet is a technological innovation that tends to reduce the time invested in home production which permits individuals to engage in both firm and home production (Dettling, 2017; Atasoy, 2013; Stevenson, 2008; Autor, 2000).

On the other hand, lower search costs and the convenience of placing job applications online will increase the volume of applications that firms will have to screen. Consequently, this can lead to prolonged search durations and lower job arrival rates, which may discourage individuals from supplying their labour to the market (Freeman, 2002; Autor, 2000). Also, internet access may amplify leisure activities increasing reservation wages and adversely affecting labour force participation (Zuo, 2021; Dettling, 2017; Dwayne *et al.*, 2012). Therefore, the influence of home internet on labour supply at the extensive margin largely depends on which of these competing effects dominates.

[1] "Reservation wage, which is defined as the wage rate at which an individual would be indifferent between participating and not participating in the labour force" (Dwayne *et al.,* 2012, p.45).

Various empirical studies have investigated the relationship between internet access at home and labour market attachment. Dettling (2017) found that exogenously determined access to high-speed internet at home stimulated female labour supply, particularly among highly educated married women in the United States. Thus, the author concludes that home internet use enables women to allocate their time between home production and firm production. Correspondingly, the impact evaluation of Internet Essentials and broadband stimulus packages revealed that the programs increased the likelihood of employment. Navigating the digitalised labour market was easier for low-income Americans with these resources at their disposal (Zuo, 2021; Atasoy, 2013).

Furthermore, high internet diffusion in US cities is positively associated with the likelihood of being economically active and results in intensified job search (Beard *et al.*, 2012; Stevenson, 2008). Internet job search has also been effective, in particular, following job destruction, internet job seekers secure employment faster than comparable job seekers who use traditional search methods (Kuhn & Mansour, 2014). Efobi *et al.*, (2018) noted that internet use enhanced the efficiency and effectiveness of information dissemination and acquisition in African labour markets, stimulating female labour market attachment at the extensive margin.

Moreover, ICT diffusion, as measured by internet and mobile phone use by individuals and households, stimulated female labour force participation in Africa (Ngoa & Song, 2021). Hjort and Poulsen (2019) found that firm entry, increased export base and productivity were the channels through which the arrival of the fast internet influenced employment prospects in Africa. Finally, Khan *et al.*, (2017) found a positive correlation between mobile phone use and employment probability in South Africa, Kenya, and Botswana. The internet did not significantly impact earnings and hours worked in South Africa. Although the nexus between household internet connection and labour force participation has been studied in detail in developed economies, insufficient attention has been paid to non-developed economies.

Limited studies have been conducted in Africa and these studies fail to isolate household internet take-up from firm internet take-up. Specifically, Khan *et al.*, (2017) examined the correlation between labour market outcomes and internet and mobile phone use in African countries, including South Africa. However, the study fails to identify inactive workers and hence uses the

broad definition of labour force participation. In addition, the potential bias that may result due to endogeneity has not been dealt with in their study.

Prior to the pandemic, the South African labour market had been characterised by upward trends in key indicators of the labour market. Even though the economy has experienced positive employment growth, unemployment has been rising in the country since the end of apartheid. Employment growth has been dominated by expansion in labour market attachment at the extensive margin, which explains the positive trend in unemployment. Furthermore, the effects of apartheid are persistent and have served to benefit Whites at the cost of Africans. Relative to women, men have better labour market returns in South Africa (Adams & Yu, 2022; Burger & Woolard, 2005; Casale, 2004; Casale *et al.*, 2021; Festus *et al.*, 2016; Oosthuizen & Bhorat, 2005; Ranchhod, 2010).

Over the period 2005 to 2019, the proportion of households with internet access has been increasing worldwide but significantly more so in developed economies. There is a digital divide between and within countries. More than half of households in developing countries need internet access. The proliferation of the internet in recent years has changed many aspects of the economy and some researchers have proposed it as a fundamental human right (Øverby & Audestad, 2021). In addition, internet adoption increased in South Africa between 2018 and 2022. Despite the upward trend in internet take-up, only about one-third of South Africans have internet access at home. While the knowledge gap is a primary barrier precluding adoption, for those actively participating in the internet market, high data costs are the significant factor that impedes extensive internet use (Partridge, 2022).

Furthermore, the study also synthesises the empirical evidence on the labour market effects of the recent pandemic. The studies investigating the repercussions of COVID-19 on labour market have consistently found that the groups that mainly were adversely affected were vulnerable groups such as younger workers, women, non-unionised workers, individuals at the bottom of the income distribution, those with low levels of education, occupations not suitable for telework and workers in the informal sector, (Lemieux *et al.*, 2020; Schotte *et al.*, 2021; Coibion *et al.*, 2020; Guven *et al.*, 2020). COVID-19 increased the possibility of job destruction and experiencing a decrease in wages in Burkina Faso, Mali, and Senegal (Balde *et al.*, 2020).

Several recent studies have shown that the COVID-19 lockdown had asymmetric effects in South Africa. While young job seekers transitioned from marginal attachment to the labour market into employment during the pandemic, most older job seekers became economically inactive during the same period. Demographic groups such as women, Africans and less educated people were the hardest hit by the impact of COVID-19, (Espi-Sanchis *et al.*, 2022; Ranchhod & Daniels, 2021). Moving on, one of the main lessons learned from the recent pandemic is that household internet connection is a crucial part of the labour market; it has an indispensable impact on the effectiveness and efficiency of matching and resilience of the labour market.

Lastly, this study is the first to address the endogeneity of household internet connection in South African context. To overcome the potential bias, this study uses propensity score matching techniques and instrumental variable strategy. The study finds a favourable effect of at-home internet access on both the probability of being employed and the likelihood of being economically active. Moreover, the estimation results from the supplemental analysis indicate that household internet connection has a positive influence on the likelihood of being employed for males. There is no sufficient evidence to suggest a corresponding effect on the labour market attachment of females. This study has demonstrated that internet access at home is crucial for labour market attachment.

3. Literature Review

This study is related to the literature on the labour market and the internet as well as labour market and COVID-19. There is a growing body of knowledge on this subject. The impact of home internet use is theoretically indeterminable. Mainly because at-home internet access has two competing effects on factors that affect labour market attachment. Internet use and information and communication technology innovations in the fourth industrial revolution have substantially altered the labour market in various ways. These include, but are not limited to, matching between workers and firms, delivery of services in labour markets and labour demand (Autor, 2000). It has also resulted in new forms of employment like platform work.

Labour markets are predominantly featured by imperfect information. Besides increasing the speed at which information is disseminated, internet use has also reduced the cost of information acquisition in labour markets. Thus, internet is key in lowering information frictions and improving labour market transparency (Hjort & Poulsen, 2019). Information disseminated over the internet reaches many viewers quickly and at a lower cost, reducing the cost of job search and screening. Hence, the internet reinforces labour force participation by making it convenient for job seekers to search and apply for jobs and communicate with potential employers (Alam & Mamun, 2017; Khan *et al*., 2017).

Job seekers can place their applications and contact employers without incurring travel costs. Theoretically, lower job search costs will lower reservation wages, resulting in increased job search and expansion in labour force. In addition, internet access at home can also be used to complement other search methods, such as sending emails and resumes to social networks or employment agencies. Access to the internet at home also enables individuals to pursue international job opportunities at low cost (Stevenson, 2008; Atasoy, 2013). If the decline of the expenses of job search results in improved efficiency and effectiveness of job matching, this would give rise to shorter unemployment durations, significantly increasing labour force participation (Beard *et al*., 2012).

Moreover, the internet facilitates telework enabling individuals to pursue opportunities from local and international labour markets. More significant and lucrative job opportunities will pull wages above the reservation wages and draw more individuals to the labour market (Efobi *et al.*, 2018). Access to the internet at home enables individuals to execute some tasks remotely. This

affords other demographic groups, such as married women with families, who otherwise would not be able to participate in firm production, a chance to work part-time from home. In addition, telework reduces the time and costs of travelling to work lowering reservation wages (Autor, 2000; Dettling, 2017). Also, using ICTs results in more integrated and inclusive labour markets and reduces the cost of acquiring education and new knowledge. Online courses have made it affordable for individuals, specifically women, to advance their education. Higher levels of education lead to better job prospects, increasing labour market attachment (Ngoa & Song, 2021).

Furthermore, internet recruitment and resume database sites provide career and job-seeking guidance making it easy to apply for jobs, increasing labour supply. Increased labour supply will mean a greater pool of workers from which firms can hire, resulting in increased job-finding rates and efficient matching (Freeman, 2002). Home internet use is a technological advancement that reduces time spent in home production. Consequently, reducing reservation wages and increasing labour supply (Dwayne *et al.,* 2012).

Nevertheless, access to the internet may amplify leisure activities. Better leisure activities will increase reservation wages and decrease labour force participation (Dettling, 2017; Dwayne *et al.,* 2012; Zuo, 2021). Additionally, reduced job-seeking costs will increase the volume of applications that firms must review. Consequently, raising the time requirements of the screening process and prolonged search durations may discourage individuals from being economically active (Freeman, 2002; Autor, 2000). Hence, the ultimate effect of internet use at home on labour market participation largely hinges on the degree to which decision makers utilise it for various pursuits outlined above. Therefore, the nexus between internet use and labour force participation merits empirical attention in the digital era.

Dettling (2017) studied the causal effect of high-speed household internet connection on labour supply in the United States. Using micro-level data from the Current Population Survey (CPS hereafter) of 2000-2009, American Time Use Survey, Ordinary Least Squares and instrumental variable strategy (the instrument was the share of the state's residents that lived in a housing unit identified as multiple dwelling unit in 2000), the author found that exogenously determined high-speed household internet connection enhanced married women's labour market attachment at the extensive margin by reducing the number of hours spent on home production by 1.78 hours.

There was no evidence of a significant effect on the labour supply of men and single women. The impact of household internet connection on labour market attachment was highest among highly educated married women, which suggests that the internet enables married women to achieve work-family balance.

In another study, Zuo (2021) evaluated the effect of Internet Essential (commercial broadband discount program) on the labour market outcomes of low-income Americans. The data sources for this study include CPS, the American Community Survey and the National Telecommunication and Information Administration. The intent-to-treat and local average treatment on the treated were estimated using triple difference and standard difference-in-difference for 2009-2015, which revealed that the program stimulated internet use among eligible households. This translated into a favourable employment impact. The results suggest that the program enhanced the likelihood of being employed by 0.9 percentage points. Hence the author concludes that internet access is crucial for navigating the digitalised labour market.

Moreover, in a related study, Beard *et al.,* (2012) used observational data from the Internet and Computer Supplement Survey of 2007 and CPS in the United States. The authors used multinomial logit and propensity score matching techniques to study the nexus between internet use and job search. They discovered that internet use reduced the probability of an individual who is not employed being economically inactive by 50%. Hence, at-home internet access stimulated job search. Therefore, internet use increases labour market participation through advanced job search. The sample consisted of the working-age population that was not employed. In this case, internet use refers to broadband use at home and internet accessibility in a public place such as a public library.

Accordingly, evidence from CPS of 1998, 2000 and 2001 and multiple regression presented by Freeman (2002) postulates that workers use the internet to search for jobs and internet use is positively associated with labour supply at the intensive margin and wages. Again, about 50% of Americans who had access to internet at home used it for job searches and today, more than ever, firms list vacancies online, highlighting that the internet has revolutionised how firms and workers search for each other. Furthermore, Alam & Mamun (2017) used survey data from 391 randomly selected households from Queensland to examine the causal influence of access to the

internet at home on labour market outcomes. Contrary to existing literature, the propensity score matching estimates indicate that home internet use did not affect employment status.

Empirical evidence from analysis of National Longitudinal Survey of Youth data from 2005 to 2008 suggests that internet job search is positively associated with job arrival rate to young unemployed individuals who use this search method in the United States. Following job destruction, internet job seekers experience shorter unemployment durations and secure employment faster than comparable job seekers who use traditional search methods. Using online job search to complement traditional search methods increased employment prospects, and access to the internet at home was found to be one of the crucial drivers of internet job search (Kuhn & Mansour, 2014).

Atasoy (2013) used data from various sources including, the Bureau of Labour Statistics and CPS, to investigate whether a causal link exists between broadband access and US labour market indicators. The empirical evidence from the impact assessment suggests that broadband access had a favourable and substantial influence on labour market outcomes. This study focused on broadband availability in an area as opposed to take-up by individuals or firms. Using county and year fixed effects indicates that employment effects were more significant in counties and industries with a disproportionately larger share of college graduates or skilled labour. In addition, the author found sufficient evidence against reverse causality. Hence concludes that broadband is good as a lead in the nexus between broadband access and labour market outcomes.

By the same token, Stevenson (2008) provides evidence from CPS that shows workers believe that the internet is highly functional in assisting them in finding work. Estimates from traditional regression methods and probit with state and year fixed effects suggest that higher internet diffusion in U.S. cities is positively associated with the likelihood of communicating with employers and results in intensified job search. The results further suggest that among the employed, those who search for jobs online are more likely to transition from one employer to another. Lastly, the interaction of rates of automatic washing machine ownership and telephones in 1960 and year fixed effects was used as an instrument for internet access.

The evidence from studies conducted in Africa corroborates the findings from other regions. Efobi *et al.,* (2018) used panel data from International Labour Organization Indicators of the Labour Market and World Development Indicators from 1990-2014. The OLS, fixed effects, and

Generalized Method of Moments (GMM) estimates show that mobile phones, the internet, and fixed broadband penetration amplified female labour supply at extensive margin at macro level in 48 African countries, including South Africa. They argue that internet use enhanced the efficiency and effectiveness of information flow in African labour markets.

In the same vein, using data from 48 African countries (excluding South Africa) over the period 2001 to 2017, in line with the existing body of literature, Ngoa and Song (2021) found that ICT diffusion through internet and mobile phone operation had a desirable and statistically significant influence on female labour force participation. This effect was more pronounced in the industrial sector. Human capital accumulation and financial development mediated the nexus between ICT use and female labour market attachment. The study utilised World Bank Development Indicators data and employed a fixed effects model and system GMM combined with an instrumental variable strategy. The lagged differences of the variables were used as instruments. However, the study was conducted at the continental level, not the country level.

Still on this issue, Hjort and Poulsen (2019) investigated the causal relationship between employment and fast internet in 12 African countries over the period 2006-2014. This was accomplished by exploiting the availability of submarine internet cables in various geographic areas in each country. The generalized difference-in-difference, OLS, and GMM estimates disclosed that fast internet substantially impacted employment in connected areas in Africa. The availability of fast internet improved employment by 3.1% in South Africa. The key data sources for this study included Demographic and Health Surveys, Afro-barometer surveys, and Quarterly Labour Force Surveys administered by Statistics South Africa and the World Bank Enterprise Survey. In conformity with empirical macrolevel studies on this issue, the study discovered that fast internet affects employment through firm entry, productivity, and export base.

Similarly, Khan *et al.,* (2017) assessed the correlation between labour market outcomes and mobile phone and internet use in 12 African countries. Logit and multinomial logit results estimated using data from the Research ICT Africa survey of 2011/2012 revealed that while internet use had no significant impact on labour market outcomes in South Africa, mobile phone use was positively associated with employment probability in South Africa, Kenya, and Botswana. Nonetheless, the study does not identify the inactive workers. Hence, the non-employed individual in this study were the unemployed and economically inactive workers.

Accordingly, as noted by (Dettling, 2017; Zuo, 2021), studies that exploit geographical variation in supply constraints of internet infrastructure do not isolate household internet take-up from firm internet take-up and tend to focus more on the demand-side of the labour market.

No studies on household internet connections, labour market attachment at the extensive margin, and coronavirus exist. Thus, in addition to reviewing the literature on internet access and labour supply, the study will further review the literature that focuses on the repercussions of COVID-19 on labour market participation. The transition matrices, unconditional and conditional means estimated using the first wave of NIDS-CRAM[2] revealed that COVID-19 had substantial adverse repercussions on employment in South Africa. The effect was heterogeneous, and demographic groups such as Africans, women and the less educated were the most hard hit by the impacts of COVID-19 (Ranchhod & Daniels, 2021).

Similarly, a descriptive analysis of the South African labour market carried out by Espi-Sanchis *et al.*, (2022) indicates that various age groups were impacted heterogeneously by COVID-19 measures. Evidence from NIDS-CRAM and QLFS[3] for period spanning from February 2020 to March 2021 suggests that conventional transitions in labour market activity were the transition from discouraged work seeking into employment and from discouraged work seeking into not economically active for younger and older workers, respectively. Furthermore, difference-in-differences estimates of the causal impact of the COVID-19 lockdown on employment outcomes revealed that the lockdown had negative impacts on earnings and the probability of being employed in Ghana.

A similar study was also conducted by Balde *et al.,* (2020) for Burkina Faso, Mali and Senegal. In consonance with much of the literature on this subject, the authors found that COVID-19 positively impacted the probability of experiencing a job loss and a decrease in earnings. The study made use of probit and heckprobit models. In addition, the unfavourable effects of the response to coronavirus on the labour market were not uniformly distributed between the formal and informal sectors. The latter were more likely to experience job loss and decreased earnings.

Correspondingly, Coibion *et al.*, (2020) established that measures implemented to combat the spread of the virus resulted in job loss, a rise in unemployment, and a decline of seven

[2] NIDS-CRAM: National Income Dynamics Study- Coronavirus Rapid Mobile Survey
[3] QLFS: Quarterly Labour Force Survey

percentage points in labour force participation in America. In conformity with other studies, the study's findings indicate that women, the self-employed and those in the informal sector suffered disproportionately from the effects of COVID-19 (Schotte *et al.*, 2021).

One of the main lessons learned from COVID-19 is that household internet connection is a crucial part of the labour market, it has an indispensable impact on the resilience of the labour market, and the fast and efficient matching of workers and employers. Consistent with empirical literature on this issue, Lemieux *et al.*, (2020) found that the effects of the pandemic were asymmetric in Canada. Most adversely affected were vulnerable groups such as younger workers, women with younger children, non-unionised workers, and low-income earners. The author used the April Labour Force Survey and difference-in-difference estimation technique.

Lastly, COVID-19 and the associated national lockdown had detrimental and asymmetric effects on the labour market in Australia. While unemployment increased by 1.1%, labour force participation and hours worked per week decreased by 2.1% and 1.1%, respectively. The most severely impacted demographic groups in Australia were individuals in occupations unsuitable for remote work, individuals with low levels of education and least job tenure and immigrants. Interestingly, the effects were lower for respondents with childcare-aged kids, indicating that free childcare implemented during the pandemic had positive impact on labour market outcomes, (Guven *et al.*, 2020). The study used OLS accounting for individual time-invariant effects and the Longitudinal Labour Force Survey. By and large, the consensus from the literature is that COVID-19 and the measures implemented to reduce the number of infections of the deadly virus resulted in adverse effects on labour force participation.

Although the nexus between household internet connection and labour force participation has been studied in detail in developed economies, more attention needs to be given to non-developed economies. Few studies have been conducted in Africa, such as those of Ngoa and Song (2021) and Hjort and Poulsen (2019). These studies exploit geographical variation in supply constraints of internet infrastructure and hence fail to isolate household internet take-up from firm internet take-up and tend to focus more on the demand-side of the labour market. Khan *et al.*, (2017) examined the internet and labour supply in Africa. However, the study uses the broad definition of labour force participation and did not address the potential bias that may result due to endogeneity.

4. South African Labour Market

The post-apartheid South African economy has been characterised by stubbornly high levels of unemployment. As new data sets became available, various researchers invested significant time in rigorous analysis of how the labour market has evolved. The study of Casale (2004) is among the most notable works on this issue. The author analysed critical trends in the labour market between 1995 and 2001. The empirical evidence from the study indicates that the rise in female labour market attachment had adverse effects on labour market outcomes. Specifically, this resulted in high unemployment levels. While labour supply at the extensive margin increased for both males and females, the growth in labour supply was highest in the latter group. Most of the expansion in unemployment during this period is attributed to the rise in labour supply and inadequate employment growth. In addition, the persistent effects of racial segregation posed by apartheid tend to have detrimental effects on the labour market outcomes of Africans.

Moreover, the data also shows gender disparity in labour market returns. This mainly derives from a result that relative to men, women constituted a significant proportion of low-paying and less secure jobs over this period. In the same vein, Oosthuizen and Bhorat (2005) provide a rigorous analysis of labour market transitions between 1995 and 2002. During this period, employment growth remained stagnant while the labour market experienced a hasty increase in labour market attachment at an extensive margin. These two contrasting trends, the proliferation of labour force participation coupled with sluggish employment growth over this period, translated into an upward trend in unemployment. The study's key findings include a high unemployment rate among job seekers with at least a matric, and there was no sufficient evidence to suggest that the economy was characterised by jobless growth. Instead, the authors argue that labour supply growth dominated employment growth increasing unemployment level, particularly among Africans.

Consistent with the studies mentioned above, Burger and Woolard (2005) present evidence against jobless growth during the study period. The findings of the study suggest that there was an upward trend in a population aged 15 to 64 and labour market attachment at the extensive margin. Both broad and strict unemployment rates increased. Approximately 57% of unemployed were females. Furthermore, empirical evidence from the study suggests that globalization and the industrial revolution gave rise to structural shifts. The shift towards capital-

intensive production methods benefitted White individuals, the group that constitutes a significant share of the skilled workforce, at the cost of other population groups. Like Oosthuizen and Bhorat, (2005), the estimates presented by the authors indicate that Africans remain the most marginalised population group in South Africa post-apartheid. Finally, the downward trend in mining and agricultural sector employment shares exacerbated the race disparity.

In line with the majority of the studies that analyse the key trends in the South African labour market, Ranchhod (2010) presents evidence from the first wave of NIDS that the effects of apartheid are persistent in the labour market. Estimates of the study indicate pronounced disparities in the distribution of labour market attachment by race, gender, and geographical location. Africans, females and those living in rural areas had the highest probability of being economically inactive and had the lowest likelihood of being employed despite their low participation rates. Additionally, job destruction is more prevalent among youth and prime-aged adults as the cause of job separation from their recent work. Self-reported health status tends to substantially impact labour market attachment and employment prospects of older adults.

A significant number of policies have been implemented to redress the persistent labour market inequality in South Africa. Both graduate and youth unemployment experienced an upward trend between 1995 and 2015. There has also been an expansion in the labour force; the rise in economically active Africans explains a more significant share of the increase during the reference period. In addition, unemployment remained high, with only 65% of new labour market entrants being able to secure employment. While the labour force declined in rural areas, it more than doubled in urban areas. Furthermore, the labour market has undergone a structural shift, and the effect of education on the likelihood of being employed was more pronounced during this period. In line with empirical literature, the researchers also presented evidence against the theory of jobless growth. Race, age, and province remain strong predictors of unemployment (Festus *et al.*, 2016).

Additionally, female labour force participation has been growing since the end of apartheid. A comprehensive analysis of the Post-Apartheid Labour Market Series (PALMS, subsequently) indicates that female labour supply improved from 40% in 1994 to 54% in 2019. Women tend to be secondary workers and are overrepresented in low-paying jobs. The labour market is highly racialized, with the most vulnerable group being Africans. Again, both the working-age

population and labour force participation have been rising in South Africa, and women's labour market attachment grew faster than male labour supply at the extensive margin (Casale *et al.*, 2021).

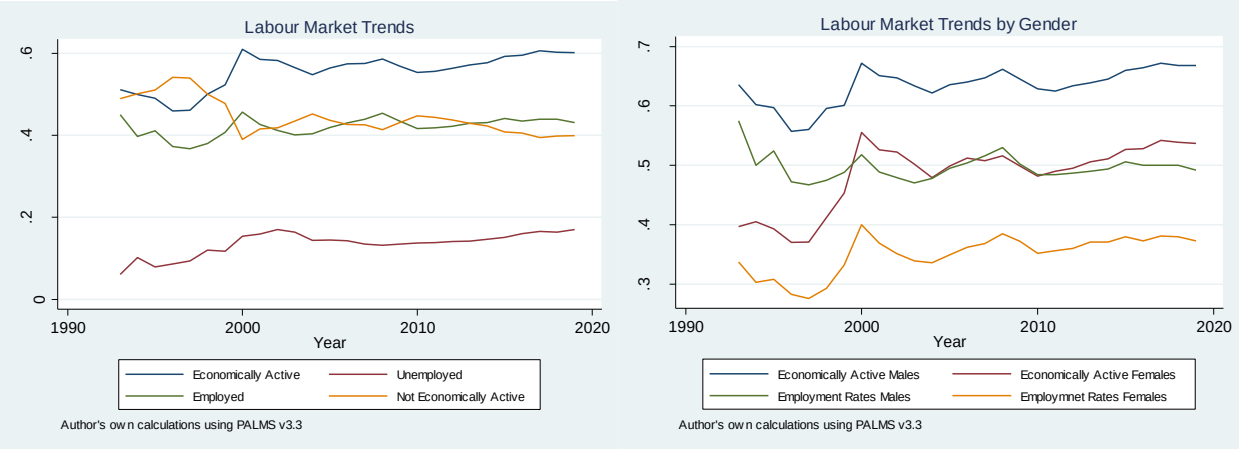
A meticulous examination of the Quarterly Labour Force Survey over the period 2009 to 2019 implies that there was an upward trend in labour market attachment in South Africa. In line with the growing literature on this issue, the estimates indicate that a significant share of the overall increase in labour supply at the extensive margin is attributed to growth in African female labour market attachment during the reference period. Also observed in the labour market was a substantial increase in unemployment over the same period. Small and medium enterprises and the manufacturing sector had no significant impact on job creation between 2009 and 2019. Also, the study provided further evidence in support of gender and racial disparity in labour market outcomes, in which females and Africans remain the most vulnerable to unemployment, thus implying that the increase in female labour force participation exacerbated the unemployment rate (Adams & Yu, 2022).

In summary, various studies have thoroughly analysed fundamental shifts in labour supply since the end of apartheid. The key takeaway is that there has been an improvement in female labour supply. Over this period, expansion in unemployment is attributed to a rise in overall labour supply and slowing employment growth. Furthermore, the effects of apartheid are persistent and have served to benefit Whites at the cost of Africans. Relative to women, men have better labour market returns. In general, labour supply increased more than job creation, translating into rising unemployment.

Some of the key trends discussed in this section are replicated in Figure 1 below. We use version 3.3 of PALMS to graphically analyse some of the main trends outlined in this section. Based on a narrow definition of the labour market attachment, the left panel of Figure 1 demonstrates a downward trend in the proportion of the working-age population that is marginally attached to the labour market. Overall, the share of the population between the ages of 15 and 64, classified as economically active, has been increasing since the mid-2000s. A similar trend is also observed in both unemployment levels and employment levels. The labour market in South Africa has since been characterised by low absorptive capacity; the rise in unemployment can be explained by the apparent gap between labour supply and employment between 1993 and 2019.

Furthermore, the right panel of Figure 1 presents labour market attachment at the extensive margin and employment rates for males and females separately. As extensively discussed in previous studies, males constitute the substantial share of the economically active population and have relatively better employment prospects than females.

Figure 1



5. Methodology

5.1 Data

The primary data sources of this study are the 2020 and 2021 General Household Surveys (GHS, hereafter). The survey data includes rich individual- and household-level information on labour market participation and internet access. The GHS is the annual household survey administered by Statistics South Africa. Among others, it gathers detailed information on labour market activity, information and communication technologies, and demographic characteristics of the respondents. Under normal circumstances, the data is collected through computer-assisted personal interviews. Due to COVID-19 restrictions, the 2020 and 2021 surveys were administered by means of computer-assisted telephone interviews.

The sample in each period constitutes households interviewed in 2019 whose telephone numbers were operational in both periods. Hence the GHS followed the same households over the three years. The samples characterise the general population at the provincial and metro levels. The empirical analysis of the study will mainly utilise version 1 of 2020 GHS and version 1 of 2021 GHS which were collected from September to December 2020 and 2021, respectively. In addition, each survey consists of the household file (the questionnaire administered to the household head) and the person file (the questionnaire administered to a household member). The data is publicly available on DataFirst. The surveys drew on a stratified two-stage sampling technique and is representative of the population at the provincial level (Statistics South Africa, 2022).

As already alluded to, due to restrictions imposed by COVID-19, in 2020 and 2021, the General Household Survey followed the same households that were interviewed from the 2019 survey. Also, in all the person files of the data, person one is always the household head. To this end, the study exploits these features of the data to construct a panel of individuals for two years. Furthermore, the data is presented in a long format, and the unbalanced panel used in this study consists of 10,043 unique individuals of whom around 46% of respondents were observed in both periods. Approximately 30% of the individuals in the sample were only observed in 2021, while nearly 25% of respondents were only observed in 2020.

Variable	Description
Labour force participation (Narrow/strict definition)	An indicator variable equal to one if an individual is employed and zero if unemployed. Based on strict definition of unemployment. This is the dependent variable in our main specification.
Labour force participation (Broad definition)	Indicator variable equal to one if an individual is economically active (i.e. employed or unemployed) and zero otherwise, draws on broad definition of unemployment. Used in robustness checks only.
Internet access at home	Indicator variable equal to one if an individual responded yes to the question "Do members of this household use internet connection in the household?" and zero otherwise.
Married dummy	Indicator for marital status: equal to one if an individual is married and zero otherwise.
Race	Four race categories: African, Coloured, Indian, and White
Age	Dummy variables for various age groups.
Area type	Dummy variables for urban, tradition and farms.
Province	The province that an individual lives in.
Female dummy	Indicator variable for gender, it is one if an individual is female and zero if male.
Education	Dummy variables for different education levels based on years of schooling: no schooling, less than primary, secondary, post-secondary and tertiary

5.2 Descriptive Statistics

The sample consists of 24,770 economically active individuals aged 15 to 64, of whom 12,866 were interviewed in 2021, see Table 2 below. Table 1 below compares the demographic and socio-economic variables used in this study between individuals living in households with household internet connection and those who do not have internet access at home. In general, individuals with internet access at home tend to be superior. On average, 88% of those with internet at home were employed, whereas only 58% of individuals without household internet connection were employed. This difference is mirrored in unemployment rates among these two

groups. Over 38% of those who reported internet availability at home were White. A significant proportion, around 90% of those without internet at home, were African.

In addition, a greater proportion of respondents in the sample who have internet shared by all household members were married (60%) and reported living in a household with a computer or tablet (92%). These proportions fall to only 25% and 21%, respectively, among comparable respondents without household internet connection. There is an indistinguishable difference in internet access by gender. Males constitute 51% of those with shared internet connection at home. Individuals with the internet intended for use by all individuals in the household tend to be wealthier, older, and live in relatively smaller households. The household income of those with internet connection was more than triple that of individuals living in households without shared internet connection. Overall, there are noticeable imbalances in the attributes of the two groups.

Table 1: Descriptive statistics

	Pooled sample		2020		2021	
Variable	Internet	No internet	Internet	No internet	Internet	No internet
Employed	88%	58%	84%	58%	90%	58%
Unemployed	12%	42%	16%	42%	10%	42%
African	36%	90%	40%	90%	32%	90%
Coloured	20%	7%	17%	7%	22%	7%
Indian	5%	1%	3%	1%	7%	1%
White	38%	2%	40%	2%	38%	2%
Female	49%	51%	49%	51%	49%	50%
Married	60%	25%	59%	27%	62%	24%
Electricity	99%	96%	99%	96%	99%	96%
Own computer/tablet	92%	21%	90%	22%	93%	21%
Other variables						
Age	41	38	41	38	42	37
Household size	4	5	4	5	4	5
Income	37727	10718	35093	10480	39716	10939
Economically active	2	1	2	1	2	1
Cell phones	3	3	3	3	3	3

Source: Author's own calculations

Table 2: Individuals in the sample

Survey	Households	Individuals
2020	6759	11904
2021	7366	12866

Source: Author's own calculations

Table 3: Transition in employment status

Variable	Variation		
	Overall	Between	Within
Unemployed	22.94	26.27	89.89
Employed	77.06	79.04	96.64
No Internet Access	92.84	93.50	98.90
Internet Access	7.16	8.57	87.94

Source: Author's own calculations

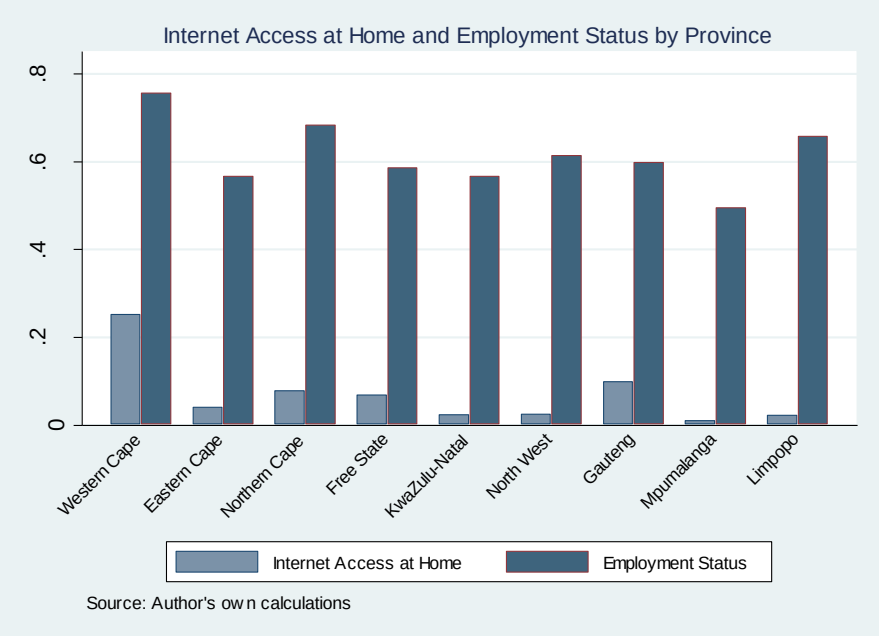
Furthermore, close to 97% of all participants in the pooled sample had access to electricity. Nearly 99% of internet users in the pooled sample and the two subsamples had access to electricity, compared to 96% of those who did not have a household internet connection. There are negligible differences between years. From 2020 to 2021 the proportion of individuals who had internet access and reported being employed increased from 84% to 90%. In 2020, 40% of individuals who reported having internet access at home also reported being African, which decreased to 32% in 2021.

On the other hand, the share of those respondents who lived in households with a communal internet connection who reported being Coloured or Indian increased. The fraction of individuals who did not have access to a shared internet connection at home who classifies as Indians remained stable over the two years. In addition, in 2021, about 62% of home internet users were married, whereas only 24% of those without internet at home were married. The former was an increase of 4 percentage points from 58% to 62%, while the latter was a decrease of 3 percentage points from 27% to 24%. In addition, the average household size and the share of economically active household members remained relatively constant over the two years.

Lastly, the descriptive statistics in Table 3 indicate that 89.9% of respondents who reported being unemployed at one point were unemployed throughout the reference period. The possible explanations for this include attrition, an individual finding a job or dropping out of the labour force. In contrast, 96.6% of the respondents who reported being employed at one point were employed throughout the two years under consideration. Similarly, the potential drivers of this

variation include attrition, job separation or job destruction. This indicates a high level of job retention. Additionally, 98.9% of participants who had no access to a shared internet connection at home in one of the periods reported lack of internet access in all periods in which they were observed. On the contrary, 87.9% of those who reported having access to the internet at home, their participation in the internet market did not change over time.

Graph 1

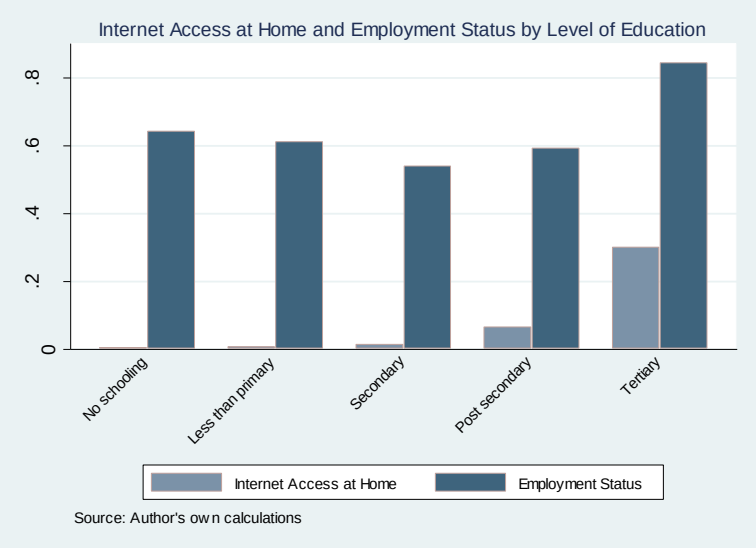


Graph 1 above presents access to the internet at home and employment status disaggregated by province. Access to the internet at home varies significantly across provinces. The estimates indicate that around 25% and 10% of individuals from the Western Cape and Gauteng in the sample reported living in households with internet connection used by all household members, respectively. Families from Mpumalanga, Northwest, and Limpopo barely had a household internet connection; these provinces need to catch up with other areas in household internet use. While internet access at home differs markedly across provinces, there is negligible variation in employment level. The employment rate is highest in the Western Cape (nearly 80%) and lowest in Mpumalanga, around 50%.

Furthermore, Graph 2 presents internet access at home and employment level disaggregated by level of education. Internet access is highly prevalent among individuals with tertiary education or better. On average, almost all individuals with secondary education or less reported not having access to the internet at home. While there is indistinguishable variation in employment across

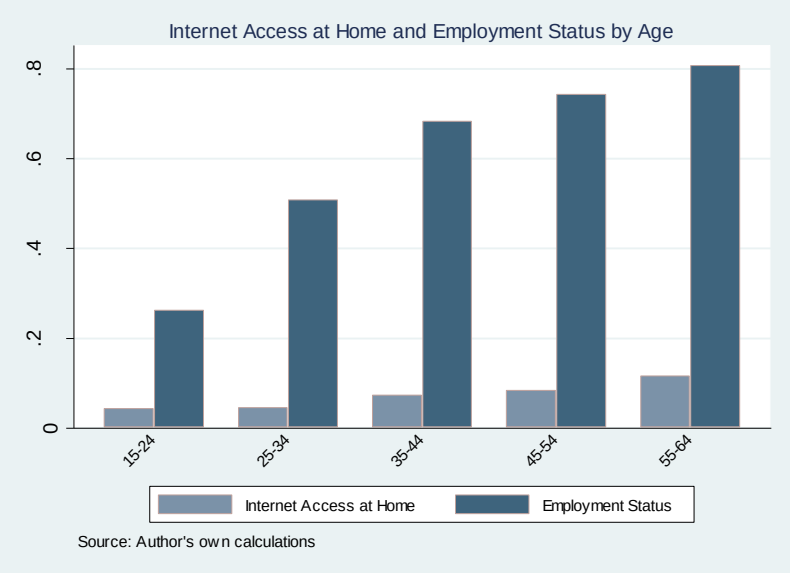
various levels of education, the employment rate is highest among tertiary graduates and surprisingly least among individuals with secondary schooling.

Graph 2



Finally, based on Graph 3, access to the internet at home is predominantly common among individuals 45 years or older. Surprisingly, less than 5% of individuals between 15 and 24 or between 25 and 34 report having internet access at home. A significant proportion of individuals aged 45 or older reported being employed, while less than 25% of those between 15 and 24 reported being employed.

Graph 3



5.3 Model Specification

The empirical procedure of the study is based on logistic regression of the following form:

$$x_i^* = \boldsymbol{z_i\beta} + \varepsilon_i \qquad (1)$$

$$x_i = \mathbf{1}(x_i^* > 0)$$

$$\Pr(x_i = 1|\boldsymbol{z_i}) = F(\boldsymbol{z_i\beta})$$

In this model, x_i^* is the unobserved variable which drives participation in the labour market, and x_i is the observed outcome that depends on x_i^*. x_i is an indicator for employment status, equal to one if an individual has a job ($x_i^* > 0$) and zero if the respondent has been actively searching for a job or made attempts to start a business in the last four weeks before the interview ($x_i^* \leq 0$). $\boldsymbol{z_i}$ is a vector of measured demographic and socio-economic variables. The key explanatory variable is internet access at home. It is an indicator for household internet connection: is one if the participant responded yes to the question "Do members of this household use internet connection in the household?" and zero otherwise. F is a cumulative distribution function that follows standard logistic distribution, and ε_i is the disturbance term with a symmetric statistical distribution and has the cumulative distribution function given by F. The influence of household internet connection on employment status is determined by the average partial effect, which is defined as the partial derivative of $F(\boldsymbol{z_i\beta})$ with respect to internet access.

However, identification is the foremost hurdle facing empirical work on the nexus between internet access and labour force participation at both micro and macro levels. These single equation models treat the decision to invest in internet access at home as exogenous. If household internet adoption is more likely among employed individuals relative to comparable individuals who are unemployed, the single equation models presented above would overstate the impact of household internet take-up. Since both the outcome and key explanatory variables are dichotomous, this study uses bivariate probit model to account for endogeneity (Evans & Schwab, 1995). Under bivariate probit models, the decision to participate in the internet market and the decision to take part in the labour market are treated as interdependent.

In addition, the study uses the propensity score matching technique and instrumental variable method to address the potential bias. In the regression analysis, propensity score matching

assigns more weight to participants in the control group who are very similar to those in the treatment group based on observable characteristics. However, the major drawback of statistical matching techniques like propensity score matching is that they assume that participation in the program (i.e. access to the internet in this case) is due to chance. It requires that there are no unobservable factors correlated with non-participation in the internet market which may affect labour force participation. Hence, unobservable factors are a critical concern (Glennerster & Takavarasha, 2013). Access to electricity is used as an instrument for household internet adoption.

Based on near universality of electricity access mainly driven by rural electrification project, economically active individuals with access to electricity are no more likely to be employed than comparable individuals without access to electricity. Another potential problem with identification may be due to unobserved fixed individual or household characteristics that influence internet adoption, we perform analysis involving panel data methods to account for this heterogeneity among individuals. The empirical analysis of the study which uses panel data, is carried out with the aid of the following specification:

$$y_{it}^{*} = \boldsymbol{x_{it}\beta} + \varepsilon_{it}\ ,\ \varepsilon_{it} = a_i + u_{it} \qquad (2)$$

$$y_{it} = \mathbf{1}(y_{it}^{*} > 0)$$

$$\Pr(y_{it} = 1 | a_i, \boldsymbol{x_{it}}) = F(a_i + \boldsymbol{x_{it}\beta})$$

In this case, u_{it} is the idiosyncratic error term and, $a_i$is an unobserved time-invariant individual-specific effect. Equation (2) is estimated using xtlogit and xtprobit commands available in Stata. These strategies are also adopted to accommodate statistical dependency among repeated observations within subjects as there is persistence in the data. Put differently, for individuals observed in both periods, there is a correlation between observations over time. As before, y_{it}^{*} is the latent variable, and y_{it} is the observed outcome for individual i in year t. The value of y_{it} is one if an individual is employed in year t ($y_{it}^{*} > 0$) and zero if the individual is unemployed in year t. $\boldsymbol{x_{it}}$ is a vector of explanatory variables.

6. Results

6.1 Cross-section data analysis

The results in Table 4 below are estimated using different models but yield qualitatively similar results. Estimates from the probit model are presented in the first column of Table 4. The results suggest that household internet connection is positively associated with the likelihood of being employed. This is in line with more empirical studies on this issue. Dettling (2017) reported that internet use at home reduced hours spent in home production, increasing labour force participation among married women in America. Internet Essentials also made it easy for low-income Americans to navigate the digitalised labour market, resulting in an increased probability of employment, and the internet at home increased labour supply through advanced job search (Beard *et al.*, 2012; Zuo, 2021). In addition, internet access at home has also been found to enhance labour force participation through improved labour market transparency, amplifying job search and female labour market attachment in African countries, including South Africa (Efobi *et al.*, 2018; Ngoa & Song, 2021).

Consistent with human capital theory, see Dwayne *et al.*, (2012), the results indicate that education matters for employment; relative to other levels of education, individuals with a high level of education are the most likely to be employed. No education and lower levels of education imply fewer prospects for employment, where the least likely to be employed are individuals with a primary education or less. Moreover, relative to those aged 15 to 24, respondents who are 25 years or older are more likely to be employed; this finding complements the high levels of youth unemployment rates reported in South Africa and the low absorptive capacity of the labour market ((Festus *et al.*, 2016; Oosthuizen & Bhorat, 2005).

Predominantly, living in the Western Cape and a male-headed household increases employment prospects relative to other provinces and female-headed households. This can be explained by the fact that the Western Cape is one of the most highly developed provinces in the country. Again, regarding gender, this could be reflecting the role of social norms and gender roles in the labour market. Also, males tend to have robust social networks and are not averse to risk as females. In addition, the historical gender imbalances in home production are still evident in South Africa (Casale *et al.*, 2021). On the whole, participants from areas classified as farms are more likely to be employed than comparable individuals from areas classified as urban or

traditional. The results further suggest that an increase in household size substantially negatively impacts the likelihood of being employed.

In addition, the biprobit model was estimated to address the selection bias outlined in the previous section. The estimates for this model are presented in columns 2 and 3 with the dependent variables being employment status and internet access at home, respectively. The Wald test of zero correlation between disturbance terms is rejected at a 5% significance level. Thus, the unobserved characteristics that influence individuals' decision to participate in the labour market positively correlate with unobserved characteristics that stimulate participation in internet markets. However, the biprobit model does not give correct predictions when the model is recursive when estimated using Stata. As discussed by (Altonji *et al.*, 2005), under the biprobit model, the identification of parameters is likely to be driven primarily by the nonlinearity of the model. Thus, this paper follows the earlier literature and estimates recursive models using the Stata command rbiprobit, where access to electricity is used as an instrument for household internet take-up.

As reported in column 4 of Table 4, having access to a shared internet connection at home has a positive but statistically insignificant impact on the likelihood of being employed. Similar to this finding is the empirical evidence presented by (Alam & Mamun, 2017; and Khan *et al.*, 2017), who reported that the internet had a positive but insignificant impact on labour force participation. Additionally, we fail to reject the null hypothesis of zero correlation between the error terms of employment status and at-home internet access. Hence, the insignificant positive effect of internet access on employment status estimated using rbiprobit is exogenous. Therefore, access to electricity induces exogenous variation in access to the internet at home.

Finally, the individual-level regression results of weighted least squares are reported in the last column of Table 4. The weights are defined by propensity scores (Imbens & Rubin, 2015). These results suggest that about 28.3% of the variation in employment status is explained by the covariates in the model. Overall, cross-section analysis results broadly corroborate results from other empirical studies. All in all, the evidence suggests that internet access at home has a favourable influence on employment prospects.

Table 4: Main regression results

Variables	(1) Probit	(2) Biprobit_ES	(3) Biprobit_IA	(4) rbiprobit_ES	(5) rbiprobit_IA	(6) IPW
Internet	0.392***			0.278		0.115***
	(0.0494)			(0.173)		(0.0321)
No schooling	-0.755***	-0.794***	-1.550***	-0.771***	-1.543***	-0.156***
	(0.0816)	(0.0823)	(0.276)	(0.0844)	(0.313)	(0.0371)
Less than primary	-0.726***	-0.767***	-1.393***	-0.742***	-1.390***	-0.149***
	(0.0568)	(0.0564)	(0.145)	(0.0609)	(0.139)	(0.0454)
Secondary	-0.739***	-0.786***	-1.424***	-0.756***	-1.431***	-0.194***
	(0.0447)	(0.0440)	(0.0640)	(0.0502)	(0.0663)	(0.0520)
Postsecondary	-0.513***	-0.552***	-0.773***	-0.526***	-0.773***	-0.0597***
	(0.0420)	(0.0413)	(0.0430)	(0.0457)	(0.0423)	(0.0198)
Age 25-34	0.632***	0.627***	-0.111*	0.631***	-0.119**	0.286***
	(0.0294)	(0.0291)	(0.0589)	(0.0294)	(0.0590)	(0.0615)
Age 35-44	1.041***	1.038***	-0.0311	1.041***	-0.0407	0.453***
	(0.0309)	(0.0305)	(0.0599)	(0.0309)	(0.0604)	(0.0467)
Age 45-54	1.172***	1.167***	-0.0609	1.172***	-0.0763	0.465***
	(0.0339)	(0.0338)	(0.0629)	(0.0339)	(0.0649)	(0.0474)
Age 55-64	1.414***	1.407***	0.0585	1.413***	0.0398	0.508***
	(0.0446)	(0.0450)	(0.0752)	(0.0446)	(0.0759)	(0.0536)
Coloured	0.149	0.141	-0.220	0.147	-0.210	-0.398**
	(0.158)	(0.159)	(0.260)	(0.158)	(0.224)	(0.167)
Indian	0.408	0.424	0.253	0.416	0.267	-0.0880
	(0.416)	(0.409)	(0.486)	(0.416)	(0.481)	(0.130)
White	0.668**	0.743**	0.565*	0.692**	0.574*	-0.138
	(0.331)	(0.323)	(0.321)	(0.333)	(0.312)	(0.122)
Female dummy	-0.165***	-0.164***	0.0345	-0.164***	0.0342	0.0648**
	(0.0184)	(0.0186)	(0.0332)	(0.0184)	(0.0329)	(0.0322)
Married dummy	0.225***	0.236***	0.371***	0.228***	0.377***	0.0616**
	(0.0238)	(0.0236)	(0.0387)	(0.0243)	(0.0397)	(0.0266)
Eastern Cape	-0.0466	-0.0653	-0.403***	-0.0527	-0.402***	-0.0917
	(0.0461)	(0.0472)	(0.0648)	(0.0470)	(0.0687)	(0.0573)
Northern Cape	0.0925*	0.0696	-0.346***	0.0851	-0.354***	-0.00640
	(0.0543)	(0.0558)	(0.0755)	(0.0553)	(0.0752)	(0.0352)
Free State	-0.241***	-0.253***	-0.176**	-0.245***	-0.172**	0.0315
	(0.0546)	(0.0555)	(0.0776)	(0.0548)	(0.0816)	(0.0309)
KwaZulu Natal	0.0900**	0.0687	-0.628***	0.0834*	-0.620***	0.0801
	(0.0447)	(0.0456)	(0.0730)	(0.0457)	(0.0712)	(0.0503)
Northwest	0.0335	0.0110	-0.802***	0.0257	-0.800***	-0.0304
	(0.0549)	(0.0559)	(0.113)	(0.0560)	(0.117)	(0.0622)
Gauteng	-0.227***	-0.227***	0.0419	-0.229***	0.0471	-0.0372
	(0.0422)	(0.0435)	(0.0514)	(0.0422)	(0.0530)	(0.0260)
Mpumalanga	-0.126***	-0.145***	-0.650***	-0.133***	-0.646***	0.0714
	(0.0482)	(0.0497)	(0.107)	(0.0492)	(0.101)	(0.0609)

Limpopo	0.332***	0.311***	-0.321***	0.325***	-0.317***	0.176***
	(0.0510)	(0.0512)	(0.0856)	(0.0518)	(0.0923)	(0.0475)
Urban	-0.131**	-0.134**	0.466***	-0.128**	0.466***	-0.0477
	(0.0517)	(0.0520)	(0.109)	(0.0519)	(0.107)	(0.0430)
Traditional	-0.517***	-0.524***	-0.154	-0.515***	-0.149	-0.116***
	(0.0526)	(0.0527)	(0.128)	(0.0527)	(0.128)	(0.0413)
Household size	-0.0596***	-0.0600***	-0.00431	-0.0596***	-0.00542	-0.0333***
	(0.00328)	(0.00349)	(0.00685)	(0.00328)	(0.00769)	(0.00565)
HH Male dummy	0.0840***	0.0891***	0.186***	0.0852***	0.185***	0.0633
	(0.0197)	(0.0198)	(0.0404)	(0.0197)	(0.0402)	(0.0418)
HH Coloured	0.111	0.155	1.008***	0.125	1.009***	0.521***
	(0.158)	(0.159)	(0.258)	(0.159)	(0.224)	(0.162)
HH Indian	0.118	0.156	0.822*	0.128	0.799*	0.148
	(0.415)	(0.407)	(0.487)	(0.414)	(0.483)	(0.131)
HH White	-0.118	-0.0526	0.971***	-0.0977	0.965***	0.248**
	(0.327)	(0.319)	(0.320)	(0.328)	(0.311)	(0.122)
Electricity		-0.903***	0.573***		0.595***	
		(0.0439)	(0.167)		(0.153)	
athrho			0.194***		0.0596	
			(0.0240)		(0.0867)	
Constant	0.466***	0.439***	-1.986***	0.483***	-2.000***	0.435***
	(0.0816)	(0.0900)	(0.225)	(0.0853)	(0.201)	(0.0841)
R-squared						0.283
Observations	24,728	24,728	24,728	24,728	24,728	24,728

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 denote significance at 1%, 5% and 10% respectively.
Note: ES, IA and IPW denote employment status, internet access and Inverse Probability Weighting respectively. Base category for individual race and population group of the household head is African. References for age group, education level, gender, area type and province are as follows: 15-24, tertiary, female, urban areas, and Western Cape.

Source: Author's own calculations

6.2 Panel data analysis

The results pertaining to panel data analysis are displayed in Table 5 and provide a qualitative assessment similar to the cross-section data analysis discussed above. The random effects from probit and logit approaches yield qualitatively similar results. In conformity with (Efobi *et al.*, 2018; Ngoa & Song, 2021), who used panel data, the empirical evidence in this study suggests that the household internet connection has a substantial favourable effect on the likelihood of being employed.

Moreover, the likelihood ratio test of the same statistical power between the pooled probit (or logit) estimator and panel estimator is rejected at a 5% significance level. Therefore, there is sufficient evidence to suggest that the panel estimator is different from the pooled estimator; hence panel analysis improves the goodness-of-fit, (Cameron & Trivedi, 2010; Baltagi, 2008). The impact of internet access is positive and statistically significant when estimated for females and males separately, see the last two columns of Table 5. There are about 298 individuals who live in households with relatively high incomes, and income has been capped at the 99th percentile value. This exercise has no bearing on results. The regression results without these observations are similar to those reported here.

Table 5: Panel Data Estimates

	Random Effects		Females	Males
Variables	Probit	Logit	Logit	Logit
Internet	1.093***	1.961***	2.442***	1.950***
	(0.205)	(0.375)	(0.896)	(0.438)
No schooling	-1.837***	-3.324***	-6.046***	-1.880***
	(0.253)	(0.454)	(0.913)	(0.578)
Less than primary	-1.758***	-3.176***	-4.803***	-2.380***
	(0.205)	(0.368)	(0.783)	(0.444)
Secondary	-1.545***	-2.791***	-4.751***	-1.963***
	(0.179)	(0.324)	(0.704)	(0.392)
Postsecondary	-1.116***	-2.032***	-3.515***	-1.326***
	(0.168)	(0.307)	(0.660)	(0.371)
Age 25-34	0.650***	1.182***	2.684***	0.701
	(0.210)	(0.381)	(0.818)	(0.461)
Age 35-44	1.361***	2.451***	4.407***	1.765***
	(0.212)	(0.383)	(0.822)	(0.463)
Age 45-54	1.524***	2.742***	5.599***	1.466***
	(0.216)	(0.390)	(0.844)	(0.469)
Age 55-64	1.907***	3.439***	6.506***	2.015***
	(0.231)	(0.415)	(0.888)	(0.503)
Coloured	0.252	0.438	0.851	0.351
	(0.175)	(0.307)	(0.614)	(0.367)
Indian	0.381	0.682	0.720	0.453
	(0.358)	(0.644)	(1.589)	(0.697)
White	0.927***	1.700***		1.340***
	(0.255)	(0.471)		(0.488)
Female dummy	-0.545***	-0.978***		
	(0.0752)	(0.132)		
Married dummy	0.377***	0.665***	-0.191	1.112***
	(0.0789)	(0.139)	(0.320)	(0.171)
Household size	-0.123***	-0.220***	-0.305***	-0.192***

	(0.0164)	(0.0287)	(0.0511)	(0.0383)
Eastern Cape	0.187	0.319	0.497	0.292
	(0.178)	(0.314)	(0.598)	(0.389)
Northern Cape	0.330	0.580	0.984	0.444
	(0.215)	(0.377)	(0.716)	(0.459)
Free State	-0.285	-0.512	-1.378**	0.0345
	(0.200)	(0.354)	(0.678)	(0.443)
KwaZulu Natal	0.563***	0.990***	0.964*	1.336***
	(0.173)	(0.305)	(0.573)	(0.386)
Northwest	0.244	0.426	0.305	0.683
	(0.203)	(0.358)	(0.712)	(0.434)
Gauteng	-0.0963	-0.176	-0.820	0.260
	(0.159)	(0.281)	(0.556)	(0.341)
Mpumalanga	-0.210	-0.389	-0.188	-0.334
	(0.183)	(0.325)	(0.627)	(0.398)
Limpopo	0.951***	1.681***	1.319**	2.201***
	(0.196)	(0.344)	(0.643)	(0.440)
Urban	-0.660***	-1.161***	-0.0455	-1.861***
	(0.211)	(0.369)	(0.687)	(0.497)
Traditional	-1.484***	-2.623***	-1.804***	-3.251***
	(0.221)	(0.383)	(0.697)	(0.523)
Constant	2.658***	4.772***	3.113**	4.915***
	(0.371)	(0.657)	(1.293)	(0.824)
Observations	10,329	10,329	3,770	6,474
Matched ids	7,496	7,496	2,830	4,763

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 indicate significance at 1%, 5% and 10% respectively.
Note: Dependent variable is employment status. Base category for individual race and population group of the household head is African. References for age group, education level, gender, area type and province are as follows: 15-24, tertiary, female, urban areas, and Western Cape.

Source: Author's own calculations

6.3 The estimation results for different demographic groups

In this section, we also examine how internet access at home affects the likelihood of being employed for different population groups using cross-section data. The literature has documented that compared to males; females tend to benefit more from internet access. The opportunity of teleworking provided by internet access and reduced time spent in domestic production, enable females to be economically active. Among females, married women with high levels of education gained more from internet access, which suggests that accessing the internet at home makes it easier for this group to achieve work-family balance (Dettling, 2017; Ngoa & Song, 2021). In addition, Beard *et al.*, (2012) put forward that shared internet connection at home or a

public place stimulates job search. The various channels through which internet access prompts labour market attachment include but are not limited to facilitating teleworking, job search and reducing time spent in home production.

Due to restrictions imposed by the data, it is impossible to examine how internet access facilitates telework and job search. There is no information on internet use in the data. We also fail to determine if married women derive greater benefits than other females because the function does not have a turning point. As shown in Table 6, contrary to Dettling (2017), we find that having access to the internet at home positively affects the probability of being employed for males and has no corresponding effect on the labour market attachment of females. However, the lack of statistical significance of the coefficient of the internet for females is likely due to individual heterogeneity. Based on panel estimates in the last columns of Table 5 above, at-home internet access stimulates labour market attachment of both males and females.

In addition, Dettling (2017) found that reliable (i.e. high-speed) internet increased the participation of married women in the labour force. This was mainly driven by a decline in time spent on home production and internet use for teleworking. The data used in this study was collected during the pandemic. During the pandemic, movement was restricted and most of the traditional search methods and office work became impractical necessitating telework (where possible) irrespective of gender and internet job search. Hence, telework or remote work was less prominent as a channel through which internet access can enhance female labour force participation. Also, the results (the weak positive impact on female labour supply) may be capturing the gender disparity in labour force participation. As discussed in Section 4, males are more likely to be economically active and employed than females. Lastly, females were disproportionately affected by COVID-19 (Ranchhod & Daniels, 2021), so the results may be reflecting the asymmetric impacts of COVID-19 on the labour market.

We further estimate propensity scores and trim the sample based on these scores to address endogeneity. The main idea is that trimming the sample yields a subsample in which the treatment and control groups have similar chances to participate in the internet market, given the observable characteristics (Beard *et al.*, 2012; Imbens & Rubin, 2015). There is adequate evidence to argue that internet connection in the household is crucial for labour market attachment; refer to the last column of Table 6. Both cross-section analysis and panel analysis of

various empirical strategies all lead to the same conclusion, that internet access at home matters for labour force participation in today's digitalised labour markets.

Table 6: Regressions for different demographic groups

	Females		Males		Propensity Score
Variables	rbiprobit_ES	rbiprobit_IA	rbiprobit_ES	rbiprobit_IA	Probit
Internet	0.198		0.508**		0.380***
	(0.243)		(0.248)		(0.0661)
No schooling	-1.114***	-5.311	-0.330**	-1.372***	
	(0.113)	(853.1)	(0.131)	(0.342)	
Less than primary	-0.923***	-1.514***	-0.461***	-1.336***	-0.311
	(0.0854)	(0.261)	(0.0914)	(0.168)	(0.491)
Secondary	-0.982***	-1.398***	-0.447***	-1.479***	-0.739***
	(0.0663)	(0.0987)	(0.0799)	(0.0907)	(0.122)
Postsecondary	-0.669***	-0.733***	-0.302***	-0.816***	-0.389***
	(0.0595)	(0.0592)	(0.0733)	(0.0611)	(0.0759)
Age 25-34	0.632***	-0.123	0.622***	-0.109	0.476***
	(0.0431)	(0.0857)	(0.0407)	(0.0824)	(0.0852)
Age 35-44	1.080***	0.0417	0.935***	-0.131	0.735***
	(0.0446)	(0.0864)	(0.0436)	(0.0867)	(0.0880)
Age 45-54	1.274***	0.0316	0.918***	-0.199**	0.700***
	(0.0485)	(0.0928)	(0.0490)	(0.0939)	(0.0942)
Age 55-64	1.534***	0.198*	1.072***	-0.132	0.762***
	(0.0623)	(0.110)	(0.0661)	(0.108)	(0.119)
Coloured	0.102	0.106	0.272	-0.751*	0.440
	(0.199)	(0.280)	(0.263)	(0.383)	(0.270)
Indian	1.449**	0.632	-0.360	-0.408	0.359
	(0.714)	(0.708)	(0.571)	(0.630)	(0.664)
White	0.884**	0.993***	-0.126	-0.284	0.954***
	(0.397)	(0.385)	(0.689)	(0.559)	(0.359)
Married dummy	0.114***	0.313***	0.474***	0.460***	0.376***
	(0.0344)	(0.0578)	(0.0369)	(0.0576)	(0.0678)
Eastern Cape	0.0269	-0.445***	-0.145**	-0.347***	-0.0350
	(0.0649)	(0.0965)	(0.0693)	(0.0982)	(0.113)
Northern Cape	0.191**	-0.436***	-0.0161	-0.280***	-0.0758
	(0.0793)	(0.111)	(0.0781)	(0.103)	(0.110)
Free State	-0.215***	-0.0772	-0.283***	-0.322**	-0.268*
	(0.0752)	(0.108)	(0.0817)	(0.128)	(0.140)
KwaZulu Natal	0.110*	-0.636***	0.0695	-0.598***	0.485***
	(0.0630)	(0.102)	(0.0677)	(0.0998)	(0.147)
Northwest	0.0886	-0.784***	-0.0462	-0.831***	0.331
	(0.0789)	(0.167)	(0.0813)	(0.165)	(0.257)
Gauteng	-0.232***	0.0219	-0.215***	0.0737	-0.158*
	(0.0581)	(0.0748)	(0.0626)	(0.0755)	(0.0817)
Mpumalanga	-0.0454	-0.578***	-0.217***	-0.724***	0.0218

	(0.0681)	(0.137)	(0.0723)	(0.151)	(0.255)
Limpopo	0.291***	-0.264**	0.372***	-0.366***	0.437*
	(0.0715)	(0.131)	(0.0768)	(0.131)	(0.249)
Urban	0.0460	0.477***	-0.283***	0.449***	-0.0633
	(0.0756)	(0.164)	(0.0733)	(0.142)	(0.179)
Traditional	-0.351***	-0.171	-0.647***	-0.128	
	(0.0766)	(0.192)	(0.0746)	(0.175)	
Household size	-0.0485***	-0.00673	-0.0625***	-0.00686	-0.0573***
	(0.00451)	(0.0111)	(0.00496)	(0.0111)	(0.0131)
HH Male Dummy	-0.108***	0.235***	0.354***	0.167***	-0.151**
	(0.0281)	(0.0548)	(0.0297)	(0.0640)	(0.0685)
HH Coloured	0.328	0.671**	-0.145	1.564***	-0.165
	(0.200)	(0.281)	(0.266)	(0.382)	(0.279)
HH Indian	-0.826	0.418	0.809	1.476**	-0.142
	(0.707)	(0.705)	(0.575)	(0.637)	(0.674)
HH White	-0.177	0.519	0.611	1.835***	-0.428
	(0.386)	(0.384)	(0.691)	(0.557)	(0.361)
Electricity		0.363*		0.852***	
		(0.201)		(0.251)	
Female					-0.173***
					(0.0521)
Constant	0.285**	-1.821***	0.280**	-2.172***	0.707***
	(0.118)	(0.278)	(0.127)	(0.307)	(0.222)
Observations	12,511	12,511	12,217	12,217	4,007

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 denote significance at 1%, 5% and 10% respectively.
Note: ES and IA denote employment status and internet access respectively. Base category for individual race and population group of the household head is African. References for age group, education level, gender, area type and province are as follows: 15-24, tertiary, female, urban areas, and Western Cape.

Source: Author's own calculations

7. Endogeneity and Causal Direction

The study uses nonexperimental household survey data, which means the assignment to treatment (access to the internet at home) is not random. As such, similar to empirical work on this issue, endogeneity is the key threat to identification in this study. There are two potential sources of endogeneity in this instance, the first being reverse causality. The causal relationship between labour force participation and internet access may be bidirectional. As discussed in previous sections, internet use makes it easier to acquire and disseminate information lowering the cost of job search. It also improves labour market transparency. All these effects may stimulate labour market attachment. However, internet access is not provided free of charge, thus implying that the employed individuals are in a better position to afford the internet. Therefore, it is not clear whether the causal effect is from internet access to employment status or labour market status to internet access (Freeman, 2002; Ngoa & Song, 2021). Also, internet service providers are, in most cases, private firms that aim to maximize profits and tend to set up their businesses in areas with favourable economic conditions, which can be classified as economic hubs (Atasoy, 2013).

The second source of endogeneity may be individual heterogeneity. Unobserved individual-specific characteristics may affect both labour force participation and internet take-up by individuals or households. If the models used fail to account for these potential sources of endogeneity, the resulting estimates will be biased. Several approaches have been adopted in empirical work to address these potential threats to identification. Most studies use an instrumental variable approach to address the first issue discussed here and panel data methods to account for individual heterogeneity.

For instance, Dettling (2017) used the proportion of the state's residents living in multiple-family dwellings as an instrument for high-speed internet. The author argues that the target market for internet service providers at that time was multiple-family dwellings. This stems from the observation that wiring these properties was cheaper compared to installation in a single-family property. Again, internet service providers had property rights enabling them to service all households in a specific establishment after installation. Due to supply constraints, the author believes that areas with more multiple-family dwellings were the first to receive the service, and the study used a two-stage least squares estimation approach.

Another study that exploits the supply-side constraints of internet diffusion is (Hjort & Poulsen, 2019), who examined the effect of the arrival of fast internet on employment in Africa. Areas within 500 metres of the backbone network were defined as connected and formed part of the treatment group. The difference-in-differences estimation technique was used to estimate the treatment effect. Furthermore, Zuo (2021) conducted an impact assessment of Internet Essentials by comparing eligible individuals to ineligible individuals (eligibility was largely determined by Comcast's availability in an area) before and after the program was implemented. Ngoa and Song (2021) used a generalised method of moments dynamic panel model and lagged differences of the dependent variable to account for potential endogeneity. Efobi *et al.*, (2018) also used the generalized method of moments. Lastly, (Beard *et al.*, 2012; Alam & Mamun, 2017), estimate the causal effect of household internet connection on labour market attachment through propensity score matching techniques.

This study uses panel data and a logit/probit model with a random coefficient to account for individual heterogeneity. We further use propensity score matching to trim the sample and estimate the causal link between home internet use and labour market attachment of the modified sample. It is challenging to find a suitable instrument in practice. Based on information available in the data, access to electricity is used as an instrument for internet access. Following the National Electrification Programme rollout in 1994, we argue that individuals with access to electricity are no more likely to be employed than comparable individuals without access to electricity. At the same time, electricity is a complementary infrastructure for adopting the internet (Armey & Hosman, 2016). Most information and communication technologies require electricity to recharge. Irrespective of the empirical approach used, we always reach the same conclusion. Therefore, home internet use positively influences labour market attachment in South Africa.

8. Robustness Checks

We estimate the rbiprobit model using the data set from 2019, a broad definition of labour force participation and control for access to the internet at a public library or community hall and internet cafe to examine the robustness of the main results reported and discussed in the previous section. Table 7 below presents estimates from these various specifications. The first column of Table 7 presents estimates of the main specification; the dependent variable is an indicator variable quoted as one for someone employed and zero if the individual is unemployed. In the second column, labour force participation is redefined, and an individual is classified as part of the labour force if they are employed or actively seeking work. Put differently, the dependent variable assumes a value of one if the participant is economically active and zero if inactive.

Additionally, this specification measures the dependent variable using the broad definition of labour force participation. Even with this different definition of labour market attachment, we find a positive but weak evidence of the impact of at-home internet access on labour force participation. While there is sufficient evidence that accessing the internet at a community hall or public library stimulates labour force participation, we find a weak but counterproductive effect of internet access at an internet café. While the sign of the coefficient of internet access at home is robust to these various specifications, the significance is somewhat sensitive to the control of internet access at other places. On the other hand, there is some slight improvement in the precision of estimates as the standard errors decline in both cases.

As a final form of sensitivity analysis, we use the data set from 2019 to examine the impact of home internet connection on labour market attachment in South Africa. Remarkably, the results reported in the final column of Table 7 reflect a positive and statistically significant influence of at home internet use on the probability of being employed. In all specifications, we fail to reject the null hypothesis that labour market participation decisions are independent of households' internet take-up decisions. Given that Espi-Sanchis *et al.*, (2022) outline that younger and older workers respectively transitioned from discouraged work seeking into employment and into not economically active, during the pandemic, we argue here that the results that the impact of household internet take-up is not statistically different from zero between 2020 and 2021 are likely to be reflecting the challenge to disentangle the effect of COVID-19 on labour markets

during this period. Therefore, there is sufficient evidence to suggest that internet access at home stimulates labour force participation in the fourth industrial era.

Table 7: Sensitivity Analysis

VARIABLES	(1) Strict LFP	(2) Broad LFP	(3) Locations	(4) Hall	(5) rbiprobit2019
Internet	0.278	0.0395	0.306*	0.308*	0.540***
	(0.173)	(0.154)	(0.170)	(0.170)	(0.186)
Public hall/Library			0.242***	0.236***	
			(0.0396)	(0.0367)	
Internet café			-0.0133		
			(0.0294)		
No schooling	-0.771***	-1.256***	-0.754***	-0.754***	-0.482***
	(0.0844)	(0.0615)	(0.0844)	(0.0844)	(0.0878)
Less than primary	-0.742***	-1.059***	-0.725***	-0.724***	-0.631***
	(0.0609)	(0.0520)	(0.0609)	(0.0609)	(0.0653)
Secondary	-0.756***	-0.991***	-0.741***	-0.740***	-0.578***
	(0.0502)	(0.0468)	(0.0503)	(0.0503)	(0.0563)
Postsecondary	-0.526***	-0.455***	-0.518***	-0.517***	-0.425***
	(0.0457)	(0.0440)	(0.0457)	(0.0457)	(0.0509)
Age 25-34	0.631***	1.132***	0.634***	0.634***	0.496***
	(0.0294)	(0.0194)	(0.0295)	(0.0295)	(0.0270)
Age 35-44	1.041***	1.337***	1.044***	1.044***	0.781***
	(0.0309)	(0.0213)	(0.0309)	(0.0309)	(0.0292)
Age 45-54	1.172***	1.269***	1.173***	1.174***	0.957***
	(0.0339)	(0.0237)	(0.0339)	(0.0339)	(0.0333)
Age 55-64	1.413***	0.447***	1.414***	1.414***	1.175***
	(0.0446)	(0.0255)	(0.0446)	(0.0446)	(0.0452)
Coloured	0.147	0.0574	0.145	0.145	-0.135
	(0.158)	(0.129)	(0.158)	(0.158)	(0.117)
Indian	0.416	0.174	0.415	0.413	0.285
	(0.416)	(0.286)	(0.416)	(0.416)	(0.235)
White	0.692**	0.0260	0.689**	0.689**	0.341
	(0.333)	(0.235)	(0.333)	(0.333)	(0.254)
Female Dummy	-0.164***	-0.299***	-0.165***	-0.165***	-0.163***
	(0.0184)	(0.0142)	(0.0184)	(0.0184)	(0.0189)
Married dummy	0.228***	0.0616***	0.227***	0.227***	0.304***
	(0.0243)	(0.0202)	(0.0243)	(0.0243)	(0.0254)
Eastern Cape	-0.0527	-0.160***	-0.0422	-0.0419	-0.191***
	(0.0470)	(0.0373)	(0.0470)	(0.0470)	(0.0461)
Northern Cape	0.0851	0.00769	0.0995*	0.100*	-0.187***
	(0.0553)	(0.0432)	(0.0554)	(0.0553)	(0.0523)
Free State	-0.245***	-0.251***	-0.232***	-0.231***	-0.366***

	(0.0548)	(0.0429)	(0.0550)	(0.0549)	(0.0515)
KwaZulu Natal	0.0834*	0.0217	0.0608	0.0615	-0.0933**
	(0.0457)	(0.0368)	(0.0459)	(0.0458)	(0.0446)
Northwest	0.0257	-0.164***	0.0327	0.0336	-0.126**
	(0.0560)	(0.0440)	(0.0561)	(0.0561)	(0.0543)
Gauteng	-0.229***	0.135***	-0.225***	-0.226***	-0.307***
	(0.0422)	(0.0348)	(0.0424)	(0.0422)	(0.0393)
Mpumalanga	-0.133***	0.234***	-0.126**	-0.127**	-0.243***
	(0.0492)	(0.0408)	(0.0492)	(0.0492)	(0.0484)
Limpopo	0.325***	-0.379***	0.332***	0.332***	0.0614
	(0.0518)	(0.0394)	(0.0518)	(0.0518)	(0.0525)
Urban	-0.128**	-0.146***	-0.153***	-0.154***	-0.194***
	(0.0519)	(0.0411)	(0.0522)	(0.0521)	(0.0527)
Traditional	-0.515***	-0.329***	-0.523***	-0.523***	-0.451***
	(0.0527)	(0.0413)	(0.0528)	(0.0528)	(0.0542)
Household size	-0.0596***	-0.0268***	-0.0602***	-0.0603***	-0.0587***
	(0.00328)	(0.00247)	(0.00328)	(0.00328)	(0.00329)
HH Male	0.0852***	0.0735***	0.0871***	0.0872***	0.0721***
	(0.0197)	(0.0152)	(0.0198)	(0.0198)	(0.0202)
HH Coloured	0.125	-0.0850	0.123	0.123	0.204*
	(0.159)	(0.130)	(0.159)	(0.159)	(0.116)
HH Indian	0.128	-0.384	0.116	0.118	0.0608
	(0.414)	(0.284)	(0.415)	(0.415)	(0.232)
HH White	-0.0977	-0.0295	-0.0953	-0.0956	0.197
	(0.328)	(0.236)	(0.329)	(0.329)	(0.253)
Constant	0.483***	0.599***	0.476***	0.475***	0.967***
	(0.0853)	(0.0726)	(0.0854)	(0.0853)	(0.0892)
Observations	24,728	43,083	24,728	24,728	25,567

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 denote significance at 1%, 5% and 10% respectively.
Note: Dependent variable is employment status[4]. Base category for individual race and population group of the household head is African. References for age group, education level, gender, area type and province are as follows: 15-24, tertiary, female, urban areas, and Western Cape. Source: Author's own calculations. In equation (3) which is referred to as Locations, we have additional controls which is internet access from other locations being internet café and public library/hall. In equation (4) which is referred to as Hall we only add access to the internet at the public library/hall as an additional control variable, we omit internet access at the internet café as it is insignificant.

[4] The estimates for the second equation, in which internet access is the dependent variable are not reported here.

9. Conclusion

The labour markets have become digitalised with the rise of the internet. As economies undergo industrial revolutions, various aspects of the labour market have been significantly impacted by internet use and access to information and communication technologies worldwide. In addition, the recent pandemic (COVID-19) has also highlighted the crucial role that information and communication technologies and internet access play in the labour market. To this end, this study contributes to the understanding of the role that internet access at home plays in labour market attachment in South Africa. We use a set of rich individual and household characteristics from publicly available General Households Surveys conducted in 2020 and 2021. Addressing the endogeneity of internet access at home using propensity score matching and instrumental variable strategies, we find that internet access at home matters for labour force participation. Specifically, the study finds a positive impact of household internet take-up on the probability of being employed and the likelihood of being economically active.

Moreover, the estimation results from the supplemental analysis indicate that household internet connection has a positive and statistically substantial influence on the likelihood of being employed for males. There is no sufficient evidence to suggest a corresponding effect on the labour market attachment of females. The study's main findings are broadly in line with existing empirical evidence and highlight the importance of internet access at home in the labour market. Thus, internet diffusion in recent years has enabled productive South Africans to participate in the labour market. As noted by Partridge (2022), the main barriers precluding the adoption and increased internet use are the knowledge gap and the affordability of data. Hence, policies aimed at redressing digital inequality by promoting awareness of the benefits of using the internet and how to use internet, as well as subsidising data to enhance the adoption and use of the internet at home, are necessary to stimulate labour supply.

Some occupations are not suitable for remote work. Ideally, we would control for occupation and industry of employment to account for this; unfortunately, this is impossible as there is no information on this in the data. This is one area of the study that needs to be investigated further. Moreover, future similar research can examine the various channels through which internet use at home stimulates labour force participation. This knowledge will help policymakers better target subsidies and design and implement programs to enhance internet adoption and use at

home. Finally, further research can follow the literature and use an instrument external to the data to address the endogeneity problem discussed throughout the study.

10. References

Adams, C., & Yu, D. (2022). *Labour market trends in South Africa in 2009-2019: A lost decade?*

Alam, K., & Mamun, S. A. K. (2017). Access to broadband Internet and labour force outcomes: A case study of the Western Downs Region, Queensland. *Telematics and Informatics*, *34*(4), 73-84.

Altonji, J. G., Elder, T. E., & Taber, C. R. (2005). Selection on observed and unobserved variables: Assessing the effectiveness of Catholic schools. *Journal of political economy*, *113*(1), 151-184.

Armey, L. E., & Hosman, L. (2016). The centrality of electricity to ICT use in low-income countries. *Telecommunications Policy*, *40*(7), 617–627.

Atasoy, H. (2013). The effects of broadband internet expansion on labor market outcomes. *ILR Review*, *66*(2), 315-345.

Autor, D. (2000). Wiring the labor market. In: National Bureau of Economic Research Cambridge, Mass., USA.

Balde, R., Boly, M., & Avenyo, E. K. (2020). *Labour market effects of COVID-19 in sub-Saharan Africa: An informality lens from Burkina Faso, Mali and Senegal*. Maastricht Economic and Social Research Institute on Innovation and ….

Baltagi, B. H., & Baltagi, B. H. (2008). *Econometric analysis of panel data* (Vol. 4). Springer.

Beard, T. R., Ford, G. S., Saba, R. P., & Seals Jr, R. A. (2012). Internet use and job search. *Telecommunications Policy*, *36*(4), 260-273.

Burger, R., & Woolard, I. (2005). The state of the labour market in South Africa after the first decade of democracy. *Journal of vocational education and training*, *57*(4), 453-476.

Cameron, A. C., & Trivedi, P. K. (2010). *Microeconometrics using stata* (Vol. 2). Stata press College Station, TX.

Casale, D. (2004). What has the feminisation of the labour market 'bought'women in South Africa? Trends in labour force participation, employment and earnings, 1995–2001. *Journal of Interdisciplinary Economics*, *15*(3-4), 251-275.

Casale, D., Posel, D., & Mosomi, J. N. (2021). Gender and Work in South Africa. *The Oxford Handbook of the South African Economy*.

Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). *Labor markets during the COVID-19 crisis: A preliminary view*.

Dettling, L. J. (2017). Broadband in the labor market: The impact of residential high-speed internet on married women's labor force participation. *ILR Review*, *70*(2), 451-482.

Dwayne, B., Gunderson, M., Lemieux, T., & Riddell, W. C. (2012). *Labour Market Economics: Theory, Evidence and Policy in Canada*. McGraw-Hill Ryerson Ltd.

Efobi, U. R., Tanankem, B. V., & Asongu, S. A. (2018). Female economic participation with information and communication technology advancement: Evidence from Sub-Saharan Africa. *South African Journal of Economics*, *86*(2), 231-246.

Espi-Sanchis, G., Leibbrandt, M., & Ranchhod, V. (2022). Age, employment and labour force participation outcomes in COVID-era South Africa. *Development Southern Africa*, 1-25.

Evans, W. N., & Schwab, R. M. (1995). Finishing high school and starting college: Do Catholic schools make a difference? *The Quarterly Journal of Economics*, *110*(4), 941-974.

Festus, L., Kasongo, A., Moses, M., & Yu, D. (2016). The South African labour market, 1995–2015. *Development Southern Africa*, *33*(5), 579-599.

Freeman, R. B. (2002). The labour market in the new information economy. *Oxford Review of Economic Policy*, *18*(3), 288-305.

Glennerster, R., & Takavarasha, K. (2013). *Running randomized evaluations: A practical guide.* Princeton University Press.

Guven, C., Sotirakopoulos, P., & Ulker, A. (2020). *Short-term labour market effects of COVID-19 and the Associated National Lockdown in Australia: Evidence from longitudinal labour force survey*.

Hjort, J., & Poulsen, J. (2019). The arrival of fast internet and employment in Africa. *American Economic Review*, *109*(3), 1032-1079.

Imbens, G. W., & Rubin, D. B. (2015). *Causal inference in statistics, social, and biomedical sciences*. Cambridge University Press.

Khan, S., Lilenstein, K., Oosthuizen, M., & Rooney, C. (2017). *Correlates of ICTS and employment in Sub-Saharan Africa*. Development Policy Research Unit, University of Cape Town.

Kuhn, P., & Mansour, H. (2014). Is internet job search still ineffective? *The Economic Journal*, *124*(581), 1213-1233.

Lemieux, T., Milligan, K., Schirle, T., & Skuterud, M. (2020). Initial impacts of the COVID-19 pandemic on the Canadian labour market. *Canadian Public Policy*, *46*(S1), S55-S65.

Ngoa, G. B. N., & Song, J. S. (2021). Female participation in African labor markets: The role of information and communication technologies. *Telecommunications Policy*, *45*(9), 102174.

Oosthuizen, M., & Bhorat, H. (2005). *The post-apartheid South African labour market*. University of Cape Town.

Øverby, H., & Audestad, J. A. (2021). *Introduction to Digital Economics: Foundations, Business Models and Case Studies*. Springer Nature.

Partridge, A. (2022). After Access 2022: Internet usage trends in South Africa (After Access 2022) [Policy Brief].

Ranchhod, V. (2010). Labour force participation and employment in South Africa: evidence from wave 1 of the National Income Dynamics Study. *Studies in Economics and Econometrics*, *34*(3), 111-127.

Ranchhod, V., & Daniels, R. C. (2021). Labour market dynamics in South Africa at the onset of the COVID-19 pandemic. *South African Journal of Economics*, *89*(1), 44-62.

Schotte, S., Danquah, M., Osei, R. D., & Sen, K. (2021). The labour market impact of COVID-19 lockdowns: Evidence from Ghana.

Statistics South Africa, S. S. (2022). General Household Survey 2021 [dataset]. Version 1. Pretoria: Statistics SA [producer], 2021. Cape Town: DataFirst [distributor],.

Stevenson, B. (2008). *The Internet and job search*.

Zuo, G. W. (2021). Wired and hired: Employment effects of subsidized broadband Internet for low-income Americans. *American Economic Journal: Economic Policy*, *13*(3), 447-482.