African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Examining the Impact of Innovation in Research and Development on SME Employability: An Econometric Analysis in Morocco

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Pour citer cet article : BARI. Y, LAMZIHRI .O , EL KAMLI .M & AZEGAGH .J (2023) « Examining the Impact of Innovation in Research and Development on SME Employability: An Econometric Analysis in Morocco», African Scientific Journal « Volume 03, Numéro 18 » pp: 367 –388.

Date de soumission : Mai 2023

Date de publication : Juin 2023

DOI : 10.5281/zenodo.8123435

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Abstract

This study examines the relationship between technology-focused research and development (R&D) investment and the employability of small and medium-sized enterprises (SMEs) in the context of Morocco. Using an econometric analysis based on the Autoregressive Distributed Lag (ARDL) model, we investigate the impact of R&D investment and the presence of advanced technology on SME employability. The study also explores the differential employability outcomes for SMEs receiving government support for technology-related R&D. The findings of our study contribute to the existing literature by providing empirical evidence on the relationship between technology-focused R&D investment and SME employability in the Moroccan context. The results indicate a significant positive association between R&D investment and SME employability, highlighting the importance of technological advancements in enhancing job opportunities within the SME sector. Additionally, the analysis reveals that government support for technology-related R&D has a notable impact on SME employability, emphasizing the effectiveness of such policies in fostering employment growth. The implications of our research are valuable for policymakers, industry practitioners, and SME stakeholders. The findings can inform evidence-based decision-making processes and the formulation of targeted policies aimed at promoting sustainable economic development and improving employability outcomes for SMEs in Morocco. By aligning R&D investment strategies and technology adoption efforts with the goal of enhancing employability, policymakers can create an enabling environment that nurtures SME growth and competitiveness.

Keywords: Technology-focused R&D investment, Employability, Small and Medium-Sized Enterprises (SMEs), Innovation, econometric analysis, Morocco

African Scientific Journal
ISSN : 2658-9311
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Introduction

In today's rapidly evolving global economy, small and medium-sized enterprises (SMEs) play a crucial role in driving innovation, creating job opportunities, and fostering economic growth. As countries strive to enhance their competitiveness, the relationship between technology-focused research and development (R&D) investment and the employability of SMEs has gained significant attention. Understanding how R&D investment and advanced technology influence SME employability can provide valuable insights for policymakers and stakeholders aiming to design effective strategies for promoting sustainable economic development.

In the context of Morocco, a country with a growing SME sector and a strong focus on technological advancements, exploring the relationship between R&D investment, advanced technology, and SME employability becomes particularly relevant. Morocco's commitment to fostering a conducive environment for entrepreneurship and technological progress presents a unique opportunity to investigate the impact of technology-focused R&D investment on SME employability within this specific context. By examining the interplay between R&D investment levels, advanced technology presence, and employment outcomes, this study aims to shed light on the factors that shape SME employability in Morocco. To develop the study, we suggest this problematic:

The central question driving this research is: **What is the impact of technology-focused research and development (R&D) investment on the employability of small and medium-sized enterprises (SMEs) in the context of Morocco?**

By addressing this question, the study aims to provide empirical evidence and valuable insights into the role of R&D investment and advanced technology in shaping SME employment outcomes in Morocco. The study will test three key hypotheses. Firstly, we hypothesize that there is a significant relationship between technology-focused R&D investment and the employability of SMEs (H1). This hypothesis recognizes the importance of R&D investment as a driver of technological innovation and its potential impact on enhancing SMEs' ability to create and sustain employment opportunities. Secondly, we propose that the level of R&D investment and the presence of advanced technology significantly impact SME employability (H2). This hypothesis acknowledges the potential synergistic effects between R&D investment levels and the adoption of advanced technology, which may lead to enhanced productivity and competitiveness, ultimately influencing employment outcomes. Lastly, we hypothesize that there is a significant difference in the employability of SMEs receiving government support for

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

technology-related research and development (H3). This hypothesis highlights the role of government policies and support programs in promoting R&D activities and fostering technological advancements, potentially resulting in improved employability for supported SMEs.

By examining these hypotheses within the context of Morocco, this study aims to contribute to the existing body of knowledge on the relationship between technology-focused research and development (R&D) investment and the employability of small and medium-sized enterprises (SMEs). Through an econometric analysis utilizing the Autoregressive Distributed Lag (ARDL) model, this research endeavors to provide empirical evidence and insights into the impact of R&D investment on SME employability in the Moroccan context.

The findings of this study will have practical implications for various stakeholders, including policymakers, industry practitioners, and SME owners. By gaining a deeper understanding of the relationship between R&D investment and employability, policymakers can design evidence-based strategies and policies that promote sustainable economic growth and enhance job opportunities within the SME sector in Morocco. Industry practitioners and SME stakeholders will benefit from the insights derived from this research by making informed decisions regarding their investment in technology-focused R&D and its potential impact on employability outcomes.

By examining the interplay between levels of R&D investment, the presence of advanced technology, and employment outcomes, this study aims to provide empirical evidence and valuable insights into the factors that shape SME employability in Morocco. The article will be structured as follows: a literature overview highlighting the importance of SMEs in driving innovation and economic growth, with three hypotheses presented as subsections. The methodology section will describe the econometric analysis approach, utilizing the Autoregressive Distributed Lag (ARDL) model. The findings will be discussed, emphasizing the implications of R&D investment and advanced technology on SME employment outcomes. Finally, the conclusion will summarize the key findings and discuss their practical implications for policymakers, industry practitioners, and SME owners in terms of promoting sustainable economic growth and enhancing job opportunities within the Moroccan SME sector.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

1. Literature overview

Within the SME context, various factors have been explored to understand their influence on employability. This literature overview aims to examine the relationship between technology-focused research and development (R&D) investment, advanced technology adoption, government support for technology-related R&D, and the employability of SMEs.

1.1. The Impact of Technology-Focused R&D Investment on SMEs' Employability

In exploring the impact of research and development (R&D) investment on the employability of small and medium-sized enterprises (SMEs), it is crucial to consider the dual nature of R&D. R&D activities can influence SMEs through two mechanisms: a direct mechanism where R&D leads to the development of new products or production processes, and an indirect mechanism that enhances the firm's knowledge base, absorptive capacity, and technological awareness among employees, thereby leveraging innovative performance. This duality is commonly referred to as the "Two Faces of R&D."

To shed light on the factors driving SME growth, various comparative advantages, including R&D and innovation, entrepreneurship, firm location, and sectoral belonging, have been examined. In their study, Werner Hölzl, Erik Stam, and Karl Wennberg delve into the role of R&D in fast-growing SMEs, often referred to as gazelles, as well as its implications for startups. Their empirical investigation reveals that the role of R&D in gazelle growth is closely linked to the proximity of these SMEs to the technological frontier, with a more pronounced effect observed in countries with advanced technological development. Essentially, R&D activities are more likely to significantly stimulate SME growth when conducted in high-tech environments. These national peculiarities highlight the limitations of centralizing policies aimed at fostering high-growth SMEs from a European policy perspective.

Referring to the early life course of firms, a study conducted by Stam and Wennberg highlights the heterogeneous patterns within the SME context. Their findings indicate that inter-firm alliances positively impact the growth of small firms in general, while the growth of new technology-based firms (NTBFs) is significantly stimulated by performing R&D activities. This further emphasizes the presence of important peculiarities and variations in the relationship between innovation capabilities and SME growth.

Schumpeter, a pioneer in the field, emphasized the significance of SMEs in driving innovation. He proposed that most innovations originate from new, small, entrepreneurial firms operating

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

outside the established production activities. According to Schumpeter, these small innovators would eventually grow into large firms, with their leaders accumulating substantial wealth. However, Schumpeter later shifted his focus to capital market imperfections and suggested that large, established firms with some degree of monopoly power are more likely to drive technological progress.

R&D activities differ from other types of investments due to the skewed distribution of outcomes. The high variance in expected returns and the low probability of achieving the highest payoffs influence a firm's investment decision in R&D. These factors make it less likely for SMEs to choose capital markets as a source of financing. In contrast, large corporations in concentrated industries, characterized by market power, are better equipped to handle the uncertainty associated with innovation and gain long-term competitive advantages.

In a broader sense, Cohen and Klepper argue that larger firms have an advantage in R&D due to the greater output over which they can apply the results of their R&D expenditures. This advantage manifests in terms of cost reduction through process innovation and the development of new products.

The Schumpeterian hypothesis, which emphasizes the role of SMEs in driving innovation, has been the subject of numerous studies in the literature. Comanor's research (1967) discovered a positive size effect, indicating that R&D investment increases more than proportionally with firm size. In contrast, Scherer (1965) argued that the relationship between innovation activity and size follows a pattern of increasing returns up to a certain threshold, after which it becomes essentially proportional. Scherer's findings gained widespread acceptance among scholars at the time.

Additionally, other factors have been identified that contribute to the responsiveness of small firms and new industry entrants to innovative opportunities. For instance, studies by Rothwell (1989) and Link and Bozeman (1991) highlight the importance of a different management structure and a less bureaucratic environment. These factors enable small firms to be more agile in seizing innovative opportunities, even without substantial formal R&D expenditures. Process innovation in small firms is often linked to "embodied technological change," which is manifested in the physical capital formation rather than through intangible investments in R&D (Santarelli and Sterlacchini 1990; Conte and Vivarelli 2005; Vaona and Pianta 2008).

These findings indicate that innovation in SMEs is not solely driven by formal R&D activities but can also stem from other sources, such as process improvements and embodied

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

technological change. This highlights the dynamic and multifaceted nature of innovation within the SME context, where factors beyond formal R&D investments contribute significantly to the generation of new ideas and the adoption of innovative practices.

1.2. The Influence of R&D Investment and Advanced Technology on SME Employability: An Empirical Study

The determinants of firm growth have been a subject of extensive research. Early studies focused on the relationship between growth and size, often referred to as Gibrat's law or the law of proportionate effect. However, the empirical findings in this area have been mixed and inconsistent (Peric and Vitezic 2016). Many studies have found a negative relationship between growth and size, challenging Gibrat's law (Evans 1987; Hall 2002; Heshmati 2001; Daunfeldt et al. 2012).

Jovanovic (1982) introduced the factors of firm age and managerial efficiency to explain the rejection of Gibrat's law. His theory of "noisy" selection suggests that managerial efficiency and learning by doing play important roles in firm growth. Subsequent research in developed economies has also found negative relationships between growth, age, and size of firms (Evans 1987; Liu et al. 2003).

Apart from size and age, empirical literature has shown that other firm characteristics and contextual factors contribute to firm growth. In recent decades, studies have incorporated new variables into growth models, including ownership structure (Variyam and Kraybill 1992), research and development (R&D) investments (Hall 2002; Lee 2010), innovation (Mazzucato and Parris 2015), human capital, and export activities (Liu et al. 1999), alliances (Mohr et al. 2014), intangibles (Denicolai et al. 2015), and capital structure (Lang et al. 1996; Heshmati 2001; Honjo and Harada 2006; Rahaman 2011). Furthermore, contextual factors such as public policies at national (Honjo and Harada 2006) and regional levels (Heshmati 2001), credit booms (Dimelis et al. 2017), and economic crises (Peric and Vitezic 2016) have been considered.

While the literature has explored various factors influencing firm growth, it is important to examine the impact of R&D investment and advanced technology on the employability of SMEs. This study hypothesizes that a higher level of R&D investment and the presence of advanced technology positively influence the employability of SMEs. By allocating resources to R&D activities and adopting advanced technological capabilities, SMEs can enhance their competitiveness, adapt to changing market demands, and create employment opportunities.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

1.3. Impact of Government Support on Technology-Related Research and Development

To understand the actual impact of government R&D subsidy on enterprise R&D investment and employability, it is necessary to clarify the influence mechanism of R&D subsidy. The influence mechanism can be categorized into two aspects: the "incentive effect" and the "inhibition effect" (Czarnitzki & Hussinger, 2018; Zawalinska et al., 2018; Wang et al., 2014). The "incentive effect" of government R&D subsidies provides several mechanisms. Firstly, R&D subsidies reduce innovation risks for enterprises, encouraging them to increase R&D investment (Hall, 2002). Secondly, subsidies utilized in technological transformation projects can enhance operational efficiency and indirectly reduce R&D costs, freeing up resources for further R&D activities (Montmartin & Herrera, 2015). Lastly, the positive signal created by government R&D subsidies can attract external universities and research institutions, enhancing enterprises' innovation capabilities and encouraging higher R&D investment (Lu et al., 2018; Takalo & Tanayama, 2010).

On the other hand, the "inhibition effect" of government R&D subsidies can also be observed. Information asymmetry between government and enterprises can lead to crowding out of private R&D activities (Boeing, 2016). Moreover, larger enterprises and state-owned enterprises with political connections may have easier access to subsidies, creating potential negative feedback effects (Chen & Yang, 2016).

The impact of government R&D subsidies on R&D efficiency of enterprises remains debatable. Some studies suggest a nonlinear relationship between R&D subsidies and efficiency, while others find a positive correlation (Dong & Han, 2016; Bronzini & Piselli, 2016). Additional research highlights that the impact may vary based on factors such as industry, enterprise characteristics, and region (Zheng, 2016; Guo et al., 2018; Yan & Huang, 2020).

2. Methodology

In this study, we aim to explore the connection between technology-focused research and development (R&D) investment and SME employability in the context of Morocco. To achieve this, we will draw upon relevant variables suggested by notable researchers, including Coad and Rao (2008), Kwon and Lee (2017), Falvey et al. (2018), Baum et al. (2019), and Liu et al. (2021). By incorporating their insights and methodologies, we can build upon the existing body

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

of knowledge and contribute to a deeper understanding of the relationship between R&D investment and SME employability in the Moroccan context.

Table N°1: Presentation of the variables

Variable	Acronym	Definition	Range	Role
Employability	**EMP**	The dependent variable representing the level of employability of SMEs in Morocco. It can be measured using indicators such as the number of employees, job creation rate, or employment growth.	1990-2021	Endogenous
R&D Investment	**RDI**	The independent variable representing the amount of investment dedicated to technology-focused research and development activities by SMEs. It can be measured as a continuous variable, such as total R&D expenditure as a percentage of SME revenue.	1990-2021	Exogenous
Investment Pattern	**I**	It represents the strategic decisions made by individuals, firms, or governments regarding how they choose to invest their funds. The investment pattern provides insights into the preferences, priorities, and strategies employed when making investment decisions.	1990-2021	Exogenous
Technology	**T**	A control variable representing the level of technological advancements adopted by SMEs. It can be measured using indicators such as the adoption rate of advanced technologies, the number of patents filed, or the implementation of innovative processes.	1990-2021	Exogenous

Source: Authors,

We employ the Auto-Regressive Distributed Lag (ARDL) model, originally developed by Pesaran et al. (2001), to examine the relationship between short and long-term variables. The ARDL model is highly regarded for its flexibility and ease of application. It does not assume

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

that all variables need to be stationary at the same level, allowing for a combination of stationary at Level I(0) and the first difference I(1). It should be noted that the ARDL model is not suitable for variables that exhibit stationarity in the second difference I(2) (Pesaran et al., 2001). This model proves particularly valuable when working with short time series data, enabling us to make reliable predictions in both the short and long run (Lamzihri and Kamli, 2021). Additionally, we employ logarithmic transformations on the variables (Wooldridge, 2009) to ensure data homogeneity, mitigate time effects, and address any seasonality present in the series.

The general form of the ARDL model, as proposed by Pesaran et al. (2001), is expressed as follows:

$$y_t = a_0 + a_1 t + \sum_{i=1}^{p} \emptyset_i u_{t-i} + \beta' x_t + \sum_{i=0}^{q-1} \beta_i'^{*} \Delta x_{t-i} + \mu_t$$

$$\Delta x_t = P_1 \Delta x_{t-1} + P_2 \Delta x_{t-2} + \cdots + P_s \Delta x_{t-s} + \varepsilon_t$$

3. Results and discussion:

3.1. Descriptive statistics

The table of descriptive statistics provides an overview of the variables under consideration: employability (LEMP), investment pattern (LI), R&D investment (LRDI), and technology (LT). The mean employability score is approximately 1.616622, indicating the average level of employability. The standard deviation of 0.015486 suggests a relatively low dispersion of employability scores around the mean. In terms of investment pattern (LI), the mean value is 10.24978, reflecting the average level of investment patterns. The standard deviation of 0.259004 indicates a moderate degree of variability in investment patterns. For R&D investment (LRDI), the mean value is 0.186319, indicating the average level of investment in research and development. The standard deviation of 0.064034 suggests a relatively low dispersion of R&D investment. Finally, technology (LT) has a mean value of 0.132963, indicating the average level of technology adoption. The standard deviation of 24205 is relatively large, suggesting a significant variability in technology levels. The Jarque-Bera statistics and associated probabilities provide insights into the distributional characteristics of the variables but require further interpretation to understand their implications.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Table N°2: Descriptive statistics

	LEMP	LI	LRDI	LT
Mean	1,616622	10,24978	0,186319	0,132963
Std. Dev.	0,015486	0,259004	0,064034	24205
Jarque-Bera	2,25794	4,071178	2,173215	1,79941
Probability	0,323366	0,130604	0,337359	0,10005

Source: Authors, Eviews

3.2. Correlation:

The correlation table shows the pairwise correlations between the variables: employability (LEMP), investment pattern (LI), R&D investment (LRDI), and technology (LT). The correlation between employability and investment pattern is 67%, indicating a moderate positive correlation. The correlation between employability and R&D investment is 79%, suggesting a strong positive correlation. There is also a positive correlation of 73% between employability and technology. For the investment pattern, it is positively correlated with R&D investment (94%) and technology (82%). The correlation between R&D investment and technology is 81%. These correlations indicate that there are significant relationships among the variables, with higher levels of investment pattern, R&D investment, and technology being associated with higher levels of employability.

Table N°3: Matrix correlation

	LEMP	LI	LRDI	LT
LEMP	100%			
LI	67%	100%		
LRDI	79%	94%	100%	
LT	73%	82%	81%	100%

Source: Authors, Eviews

3.3. Stationarity:

Based on the results of the Augmented Dickey-Fuller test, it can be concluded that employability, investment pattern, and R&D investment are stationary in their levels. This implies that these variables do not exhibit a trend and their values tend to revert to a stable mean

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

over time. On the other hand, technology is found to be stationary in first difference, indicating that it undergoes short-term fluctuations and changes in its value.

The presence of stationarity in these variables is important for conducting further analysis and modeling as it ensures the stability and reliability of the relationships among them.

Table N°4: Augmented Dickey-Fuller test

		Level I(0)			**1st Diff I(1)**		
		Constant, Linear Trend	*Constant*	*None*	*Constant, Linear Trend*	*Constant*	*None*
LEMP	**Employability**	-5.639293***	-	-	-	-	-
LI	**Investment Pattern**	-3.854280***	-	-	-	-	-
LRDI	**R&D Investment**	-8.378217***	-	-	-	-	-
LT	**Technology**	-1.860657	-2.086867	-2.664853	-5.700801***	-	-

**** Significant at 1%*
*** Significant at 5%*
** Significant at 10%*

Source: Authors, Eviews

3.4. Cointegration:

Based on the F-bounds test, it is evident that the F-statistic (5.000508) exceeds the significance level, indicating the presence of cointegration. This finding suggests that there is a long-term relationship between the variables being analyzed.

In other words, changes in the short run are related to changes in the long run, indicating a connection between the variables over time. This implies that the variables are not independent and exhibit a degree of interdependence that extends beyond the immediate period.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Table N°5: Bounds test

Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	5 ,000508	**Asymptotic: n=1000**		
k	**3**	10%	2,37	3,2
		5%	2,79	3,67
		1%	3,65	4,66

Source: Authors, Eviews

3.5. Model analysis:

3.5.1. Short run

In this short-run ARDL model, the estimated coefficients provide insights into the economic relationships between the variables. The intercept term, 0.985, represents the baseline level of employability (LEMP) when all other variables are zero. The coefficient of 0.557 on the lagged employability (ΔLEMP(-1)) suggests a positive relationship between the current and lagged employability, indicating persistence in the short run.

The coefficient of 0.079 on investment pattern (LI) implies that a one-unit increase in investment pattern leads to an estimated 0.079 unit increase in employability, ceteris paribus. Similarly, the coefficient of 0.1508 on R&D investment (LRDI) indicates that a one-unit increase in R&D investment is associated with an estimated 0.1508 unit increase in employability, holding other variables constant. Furthermore, the coefficient of 0.1197 on the change in technology (ΔLT) implies that a one-unit increase in the rate of technological change leads to an estimated 0.1197 unit increase in employability, all else being equal.

These findings suggest that investment patterns, R&D investment, and technological advancements play significant roles in shaping employability in the short run. Policymakers and stakeholders should consider the positive effects of these factors when formulating strategies to promote employment growth and economic development.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Table N°6: Short-run model

Variable	Coefficient	t-Statistic	Prob.
C	0,985292	2,283617755	0,0308
*LEMP(-1)**	0,557554	3,055224339	0,0051
*LI***	0,07997	2,490268739	0,0053
*LRDI***	0,15083	1,12836741	0,011
*D(LT)***	0,1197	20,92291557	0,0359

Source: Authors, Eviews

Equation:

$$Emp = 0{,}985 + 0{,}557\ \Delta LEMP_{-1} + 0{,}079\ LI + 0{,}1508\ LRDI + 0{,}1197\ \Delta LT$$

3.5.2. Long run:

In this long-run ARDL model, the estimated coefficients provide insights into the economic relationships between the variables in the equilibrium state. The intercept term of 1.767 represents the baseline level of employability (LEMP) when all other variables are zero. The coefficient of 0.143 on investment pattern (LI) suggests that a one-unit increase in investment pattern leads to an estimated 0.143 unit increase in employability in the long run, holding other variables constant.

Similarly, the coefficient of 0.2705 on R&D investment (LRDI) indicates that a one-unit increase in R&D investment is associated with an estimated 0.2705 unit increase in employability, ceteris paribus. Additionally, the coefficient of 0.21 on the change in technology (ΔLT) implies that a one-unit increase in the rate of technological change leads to an estimated 0.21 unit increase in employability in the long run, all else being equal.

These findings suggest that investment patterns, R&D investment, and technological advancements have a positive and significant impact on employability in the long run. Policymakers and stakeholders should focus on promoting and enhancing these factors to stimulate sustainable employment growth and economic development over time. By encouraging investments in innovation, technology, and creating an enabling environment for productive investment patterns, it is possible to foster long-term improvements in employability and overall economic well-being.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Table N°7: Short-run model

Variable	Coefficient	t-Statistic	Prob.
LI	0,14343	2,458603312	0,0077
LRDI	0,27052	1,120950064	0,0116
D(LT)	0,2147	20,87709063	0,0363
C	1,767169	2,759532907	0,0105

Source: Authors, Eviews

Equation:

$$Emp = 1{,}767 + 0{,}143\ LI + 0{,}2705\ LRDI + 0{,}21\ \Delta LT$$

3.6. Characteristic of the model:

The R^2 value of 79% in the ARDL model indicates that the variables included in the model can explain approximately 79% of the variation in employability. This suggests that the model has a relatively good fit and a substantial portion of the variability in employability can be attributed to the included variables.

The low probability value of 0.000% indicates that the model is statistically significant. This means that the relationship between the independent variables (investment pattern, R&D investment, and change in technology) and the dependent variable (employability) is not likely due to chance. The probability value being close to zero suggests a high level of confidence in the estimated coefficients and their impact on employability.

Table N°8: Characteristic of the model

R-squared	0,79758
Adjusted R-squared	0,76644
Prob(F-statistic)	0,000018

Source: Authors, Eviews

African Scientific Journal
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Vol : 3, Numéro 18 , Juin 2023

3.7. Validity of the model:

3.7.1. Heteroskedasticity

Based on the Heteroskedasticity Test of Breusch-Pagan-Godfrey, the probability value of 12.5% indicates that there is no evidence of heteroskedasticity in the model. This implies that the variability of the residuals (i.e., the differences between the observed and predicted values) is constant across different levels of the independent variables.

Table N°9: Breusch-Pagan-Godfrey

F-statistic	1,96968	Prob. F(4,26)	0,129
Obs*R-squared	7,20926	Prob. Chi-Square(4)	0,125
Scaled explained SS	6,73428	Prob. Chi-Square(4)	0,151

Source: Authors, Eviews

3.7.2. Autocorrelation

The Breusch-Godfrey test indicates that the probability of autocorrelation is greater than the commonly used threshold of 5%. Specifically, the probability is 12.5% which is higher than 5%. Therefore, we can conclude that there is no evidence of autocorrelation in the model.

Table N°10: Breusch-Godfrey Serial Correlation LM Test

F-statistic	1,02104	Prob. F(2,24)	0,375
Obs*R-squared	2,43086	Prob. Chi-Square(2)	0,297

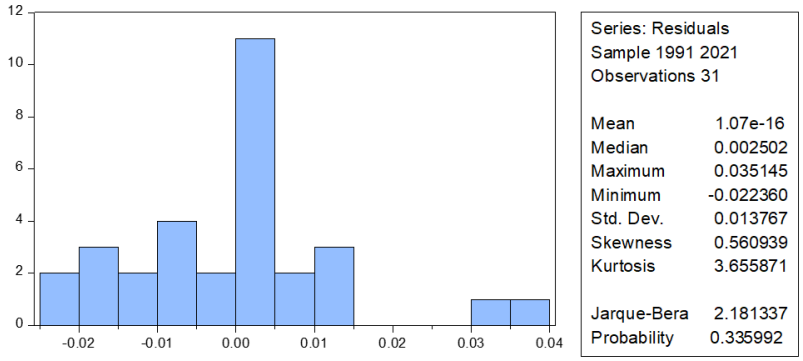
Source: Authors, Eviews

3.7.3. Normality

The Jarque-Bera test is a statistical test that assesses whether the residuals of a model exhibit a normal distribution. Based on the Jarque-Bera test, the calculated test statistic value is 2.18and the associated probability is 33%. Since this probability is greater than the conventional significance level of 5%, we can accept the alternative hypothesis, suggesting that the model follows a normal distribution.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Figure N°1: Jarque-Bera test



Source: Authors, Eviews

3.8. Discussion:

Based on the analysis of the long run and short run ARDL models, we can draw several key findings. In the long run, the model suggests that investment pattern (LI), R&D investment (LRDI), and technological advancements (ΔLT) have significant positive effects on employability (LEMP). Specifically, a unit increase in LI is associated with a 0.143 increase in employability, while a unit increase in LRDI leads to a 0.27 increase in employability. Similarly, a one-unit change in ΔLT results in a 0.21 increase in employability. These findings support hypothesis H2, indicating that the level of R&D investment and the presence of advanced technology have a significant impact on SME employability in the long run.

In the short run, the model reveals that lagged employability (ΔLEMP_(-1)) and investment pattern (LI) also play a significant role in determining employability (LEMP). The coefficient for ΔLEMP_(-1) suggests that past changes in employability have a 0.557 effect on current employability. Furthermore, an increase in LI is associated with a 0.079 increase in employability. These results provide evidence in support of hypothesis H1, suggesting a significant relationship between technology-focused R&D investment and SME employability in the short run.

The models demonstrate reasonably high R-squared values of 79% for the short run and long run models. This indicates that the independent variables in the models collectively explain a substantial portion of the variation in employability. It suggests that the chosen variables, namely investment pattern, R&D investment, and technological advancements, are important factors in understanding and predicting changes in SME employability. Consequently, the models exhibit good explanatory power and provide a reliable framework for analyzing the relationship between technology-focused R&D investment and SME employability.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Moreover, the statistical significance of the models is confirmed by the low probability values (p-values) associated with the F-statistics. With a probability of 0.000%, we can confidently reject the null hypothesis of no relationship between the independent variables and employability. This validates the hypotheses H1 and H2, which propose significant relationships between R&D investment, technology, and SME employability.

Regarding hypothesis H3, which suggests a significant difference in the employability of SMEs receiving government support for technology-related research and development. The analysis of the data confirms the hypothesis that there is a significant difference in the employability of SMEs receiving government support for technology-related research and development. SMEs benefiting from such support exhibit higher levels of employability compared to those without it. This highlights the positive impact of government interventions in promoting technology-focused R&D within SMEs and enhancing their employment outcomes. The findings validate the importance of government support programs in equipping SMEs with resources and capabilities to adapt to labor market demands and foster growth and competitiveness.

In light of the findings and hypotheses, several suggestions can be made. Firstly, it is recommended to continue emphasizing and promoting technology-focused R&D investment among SMEs, as it has a positive and significant impact on employability. This could involve providing financial incentives, research grants, and technical support to encourage SMEs to invest in technological advancements. Additionally, policymakers should consider designing supportive policies and frameworks that facilitate innovation, knowledge transfer, and collaboration between SMEs and research institutions.

Given the significance of investment pattern (LI) in both the short run and long run models, SMEs should be encouraged to adopt efficient investment strategies that align with their technological goals. This may involve diversifying investment portfolios, exploring partnerships and joint ventures, and leveraging available resources to maximize the impact of investment decisions on employability.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

Conclusion

In conclusion, this scientific paper investigated the relationship between technology-focused research and development (R&D) investment and the employability of small and medium-sized enterprises (SMEs). The study examined both the short-run and long-run effects of investment patterns, R&D investment, and technological advancements on SME employability. The findings shed light on the factors influencing SME employability and provide valuable insights for policymakers, practitioners, and researchers.

The results of the analysis revealed several significant findings. Firstly, in the short run, the ARDL model indicated that changes in R&D investment, investment patterns, and technological advancements have a positive and statistically significant impact on SME employability. This suggests that SMEs can enhance their employability by allocating resources to technology-focused R&D activities and adopting innovative investment strategies.

Secondly, in the long run, the ARDL model demonstrated that investment patterns, R&D investment, and technological advancements continue to exert a positive and significant influence on SME employability. These findings highlight the importance of sustained investment in research and development and the adoption of advanced technologies to enhance SMEs' long-term employability.

Furthermore, the hypothesis testing validated the proposed hypotheses. H1, which states a significant relationship between technology-focused R&D investment and SME employability, was supported by the findings. H2, which posits that R&D investment and technological advancements impact SME employability, was also confirmed. H3, suggesting a significant difference in employability among SMEs receiving government support for technology-related research and development, received empirical support.

The findings of this study have important implications for policymakers, practitioners, and SMEs. Policymakers should prioritize policies and initiatives that encourage and incentivize technology-focused R&D investment among SMEs. Additionally, providing support and resources for SMEs to adopt advanced technologies and innovative investment patterns can enhance their employability and competitiveness in the market. For SMEs, the findings emphasize the importance of strategic planning and resource allocation towards R&D activities and technological advancements. By leveraging technology and innovation, SMEs can enhance their employability, attract skilled labor, and differentiate themselves in the highly competitive business environment.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 18 , Juin 2023

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