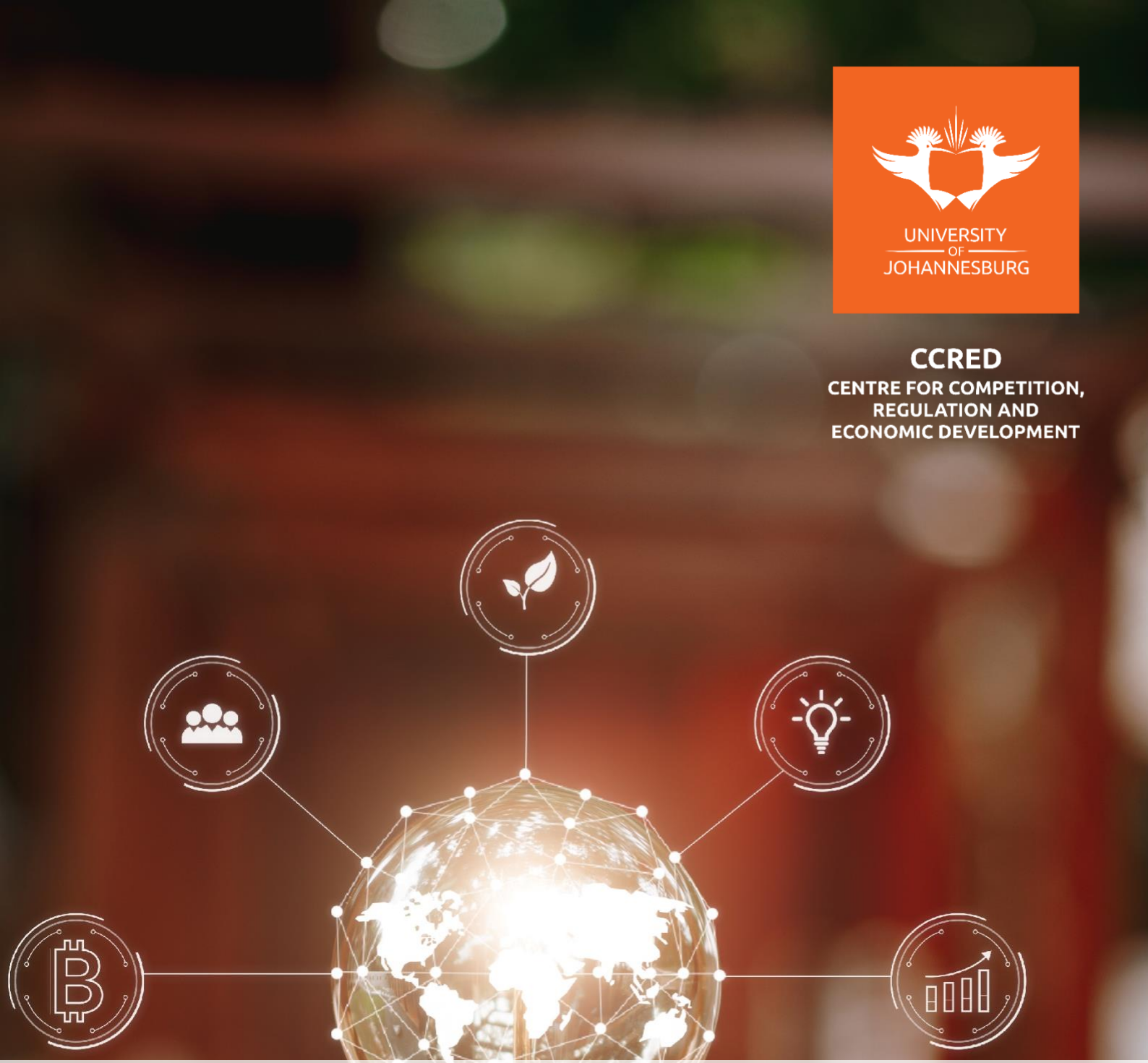

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Financing digital industrialisation in South Africa: Emerging issues

Julius Nyamwena and Elvis K. Avenyo

CCRED-IDTT Policy Brief 2023/5

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1. Introduction

The importance of finance to support firm growth and performance is well documented in the finance-growth nexus literature.[1] This is based on the evidence that access to finance helps in the expansion of business operations and production facilities, investment in innovation activities, training and hiring of skilled employees.[2] The entrepreneurship and innovation literature is replete with evidence that access to finance is a major obstacle to firm growth.[3] The literature highlights that finance does not merely sustain entrepreneurs' ventures but also acts as a vital cog in financing firms' innovative strategies such as the adoption of digital technologies. As such finance is critical in shaping a firm's innovative strategies and evolution.[4] The availability of financial resources enables a firm to invest in efficient and new cost-effective ways of doing things such as the benefits attributed to the adoption of new digital technologies.[5]

Access to finance has a direct impact on a firm's technology adoption decisions and determines the kinds of technologies that are adopted across an industry.[6] Lack of financial resources is detrimental to firms' growth and performance trajectory.[7] This is even more so in late industrialising countries.

The 21st century has witnessed rapid technological advancements that are disrupting traditional business models. The emergence of digital transformation and its associated advanced digital technologies offer potential benefits of scaling up productivity levels, improving product quality and competitiveness, reducing overhead costs and entry barriers in developing countries.[8] As a result, the adoption and adaptation of digital technologies has become an unavoidable requirement in all sectors of the economy, requiring financial resources of the scale and form required to fund investments in advanced digital technologies such as robots, machine learning and artificial intelligence, a reliable infrastructure and digital skills.[9]

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[1] Ayyagari, M., Demirguç-Kunt, A. & Maksimovic, V. 2011. Firm innovation in emerging markets: the role of finance, governance, and competition. *Journal of Financial and Quantitative Analysis*. 46(6), pp.1545-1580.
[2] OECD. 2006b. Financing SMEs and Entrepreneurs, OECD Policy Brief.
[3] Beck, T. & Demirguc-Kunt, A. 2006 Small and Medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking and Finance*. 30(11), pp. 2931-2943.
[4] Fumagalli, A. & Lucarelli, S. 2008. The Role of Financing in the Process of Evolution. *Money and Technological Change*. 21(1), pp. 151-163.
[5] Witell, L., Heiko, G., Jaakkola, E., Hammedi, W., Patricio, L. & Perks, H. 2017. A Bricolage Perspective on Service Innovation. *Journal of Business Research*. 79(1), pp. 290–298. doi:https://doi.org/10.1016/j.jbusres.2017.03.021. [Crossref], [Web of Science ®], [Google Scholar]
[6] Midrigan, V. & Xu, D.X. 2014. Finance and Misallocation: Evidence from Plant-Level Data. *American Economic Review*. 104 (2), pp. 422-458.
[7] Ayyagari, M., Demirguç-Kunt, A. & Maksimovic, V. 2011. Firm innovation in emerging markets: the role of finance, governance, and competition. *Journal of Financial and Quantitative Analysis*. 46(6), pp.1545-1580.
[8] Andreoni, A., Mondliwa, P., Roberts, S. & Tregenna, F. 2021. Structural Transformation in South Africa: The challenges of inclusive Industrial development in a middle-income country. Oxford University Press.
[9] Khin, S. & Ho, T. C. F. 2019, Digital technology, digital capability, and organisational performance: A mediating role of digital innovation, *International Journal of Innovation Science*. 11(2), pp. 177–195. Doi: 10.1108/IJIS-08-2018-0083.

The transition from traditional production processes to new digital-driven production modes therefore poses new and unique financial challenges to firms due to the radical investments it requires.[10]

Based on unique questions collected in the South African digital skills survey conducted in March 2021,[11] this policy brief explores the finance and digital industrialisation nexus, taking into consideration the size and export activities of firms. We explore the emerging relationship between finance and digital industrialisation in the South African manufacturing sector, albeit descriptively. We conclude by setting out implications for the role of policy in unlocking successful in digital industrialisation in South Africa, including through the provision of finance.

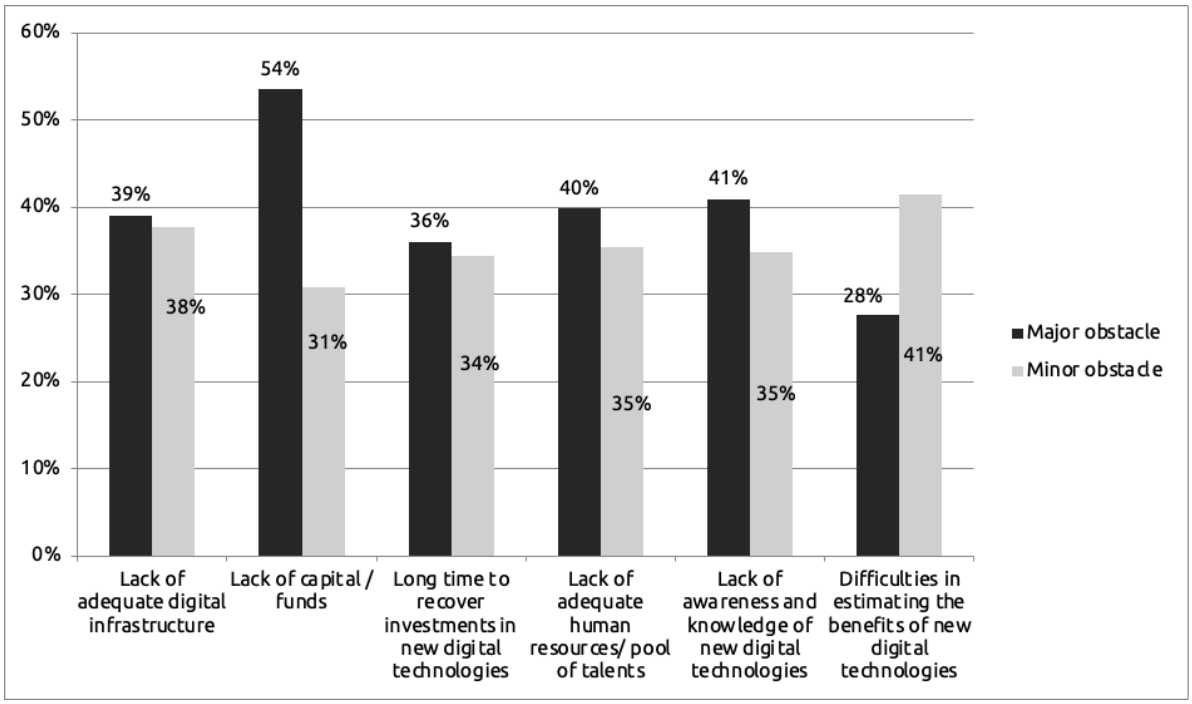
2. Emerging firm-level evidence from South Africa

The emerging firm-level evidence shows that South Africa's digital industrialisation has been slow, with uneven diffusion and uptake of advanced digital technologies across industries.[12] To better understanding this phenomenon, the digital skills survey asked sampled manufacturing firms to indicate the major obstacles affecting their adoption of advanced digital technologies.

The descriptive evidence based on our sample highlights the importance of finance in the adoption of digital technologies. Figure 1 shows that, while other factors such as lack of knowledge on advanced digital technologies, lack of human resources, and lack of infrastructure are key obstacles to firms' adoption of advanced digital technologies, lack of capital poses a major obstacle to most of our sampled firms. *That is, about 54% of manufacturing firms sampled highlight that access to finance is a key barrier to their uptake of advanced digital technologies, followed by the lack of skills and awareness, and knowledge of digital technologies*. This corroborates the technology adoption and upgrading literature and suggests that access to finance could be an important factor to fuel and shape the speed with which manufacturing firms adopt new advanced technologies.

[10] Baldwin, J. & Lin, Z. 2002. Impediments to advanced technology adoption for Canadian manufacturers. *Research policy*. 31(1), pp. 1-18.
[11] The digital skills survey is an ongoing Industrial Development Think Tank (IDTT) joint project for the Department of Trade, Industry, and Competition between the Centre for Competition, Regulation, and Economic Development (CCRED) and the South African Research Chair in Industrial Development (SARChI-ID) at the University of Johannesburg and in collaboration with the Sector Education and Training Authorities (SETAs) that govern skills training in manufacturing and engineering services (MerSETA), chemicals (CHIETA), and textiles and fibre processing (FP&M SETA).
[12] Andreoni, A. & Avenyo. E.K.2021: December 2). South Africa is failing to ride the digital revolution wave. What it needs to do. The Conversion. Link: https://theconversation.com/south-africa-is-failing-to-ride-the-digital-revolution-wave-what-it-needs-to-do-171515

Figure 1: Obstacles to Firm's adoption of digital technologies

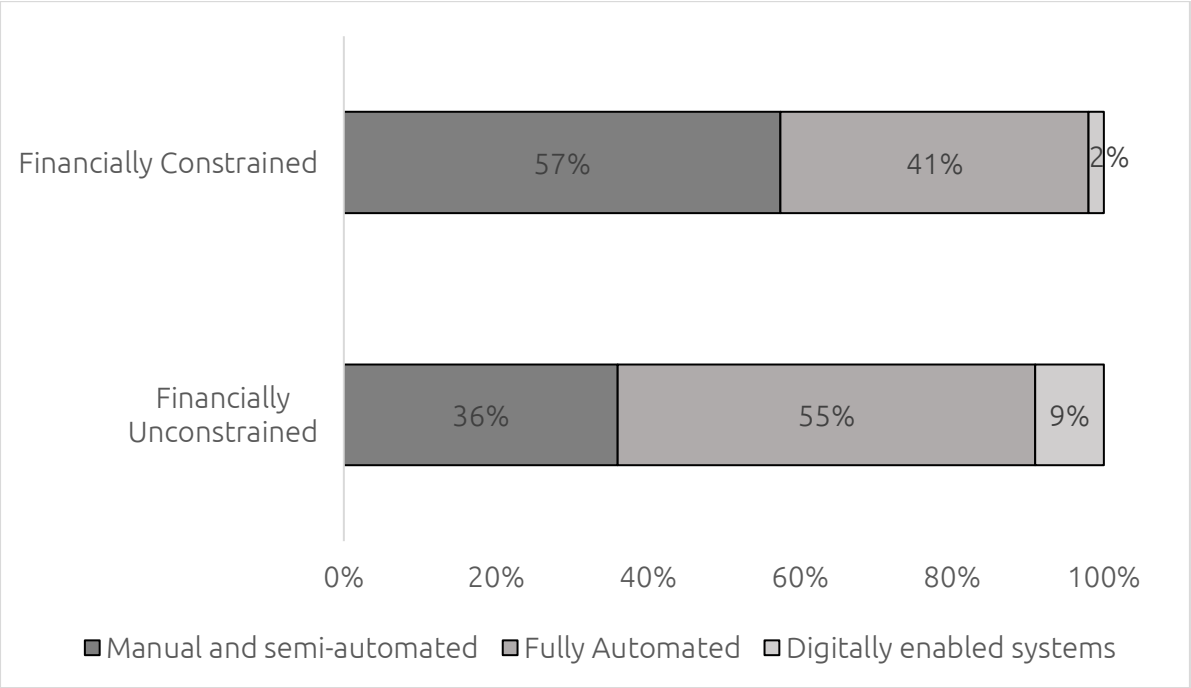


Source: Authors' elaboration based on data from the IDTT's digital skills survey of 516 manufacturing firms.

The financial requirements of firms differ not only between sectors, and between phases in a firm and industry's life cycle, but also in terms of exposure to and application of new technologies.[13] The method of production in South African manufacturing firms is still dominated by manual and semi-automated processes.[14] Financial constraints explain the unstable character of advanced technological adoption patterns across South African manufacturing firms (Figure 2). Comparing the technology adoption patterns of financially constrained firms and firms that were financially unconstrained, we find that both categories of firms exhibit similar patterns with manual and semi-automated, and fully automated technologies largely dominating the production systems. The expectation is that financially unconstrained firms would fare better in terms of technology adoption as the costs associated with radical technologies require significant financial investment. The evidence from the survey corroborates this expectation, and highlights that a higher proportion of financially constrained firms still use manual and semi-automated technologies, followed by fully automated technologies. We observed that only 2% of firms that are financially constrained adopt and use digitally enabled systems in their production processes. On the contrary, we observe that financially unconstrained firms in our sample use more fully automated technologies and a larger proportion (9%) of them have integrated digitally enabled systems in their production process compared with constrained firms.

[13] Arellano, C., Bai, Y. & Zhang, J. 2009. Firm Dynamics and Financial Development. Research Department Staff Report 392.
[14] Avenyo, E. K, Bell, J. F & Nyamwena, J. 2022. Determinants of digital technologies' adoption in South African manufacturing: Evidence from a firm-level survey. CCRED Working Paper 2022/3.

Figure 2: Digital technological adoption and finance

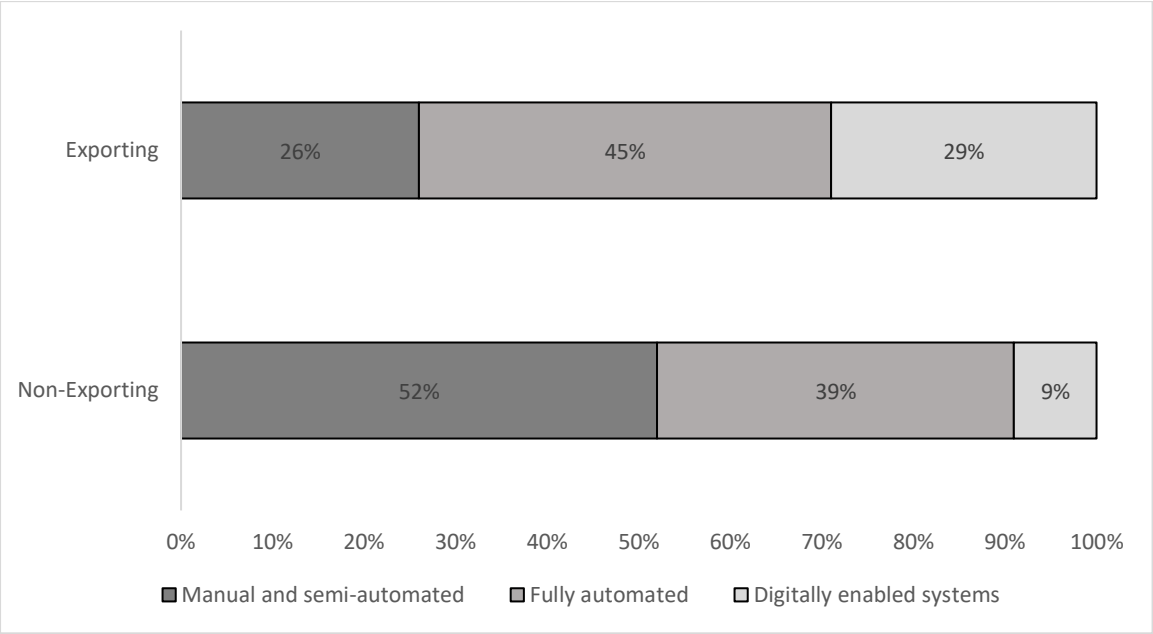


Source: Authors' elaboration based on data from the IDTT's digital skills survey of 516 firms: financially constrained =286; financially unconstrained =230.

The exporting activities of a firm influence the adoption of new digital technologies.[15] Firms that export tend to be more receptive to innovation and technological upgrading.[16] Their exposure to global value chains (GVCs) and standards specified by foreign markets can increase adoption. This is also the case in South Africa. We find that although financial constraints affect both exporting and non-exporting firms, there is a higher proportion of exporting firms that use more advanced digital technologies compared with non-exporting firms (Figure 4). Specifically, a higher proportion of financially constrained exporting firms currently use digitally enabled systems (29%) when compared with non-exporting firms (9%). This may be because exporting firms are exposed to global value chains that make use of the latest technologies to increase competitiveness. In addition, exporting firms generate extra foreign exchange from exporting which allows them to afford the latest digital production technologies. That is, we observe that even though South African manufacturing firms are exhibit comparatively limited technology adoption and are trapped in low value-added segments of digital GVCs,[17] a significant difference exist between the technological diffusion patterns of financially constrained exporting and non-exporting firms.

[15] Meyer, K.E., Estrin, S., Bhaumik, S.K., & Peng, Mike W. 2008. Institutions, resources, and entry strategies in emerging economies. *Strategic Management Journal*. 24(1), pp. 527-534
[16] Wang, K., Wang, J. & Xiong, S. 2020. How Does Technology Import and Export Affect the Innovative Performance of Firms? From the Perspective of Emerging Markets Firms. *Journal of Complexity*. 2 (10), pp. 251-263
[17] Andreoni, A, Barnes, J., Black, A. & Sturgeon, T. 2021. Digitalization, Industrialisation, and Skills Development: Opportunities and challenges for Middle-Income Countries. In Structural Transformation: The Challenges of Inclusive Industrial Development in a Middle-Income Country, pp.261-285. Oxford University Press.

Figure 3: Lack of finance, export activities and digital technology adoption



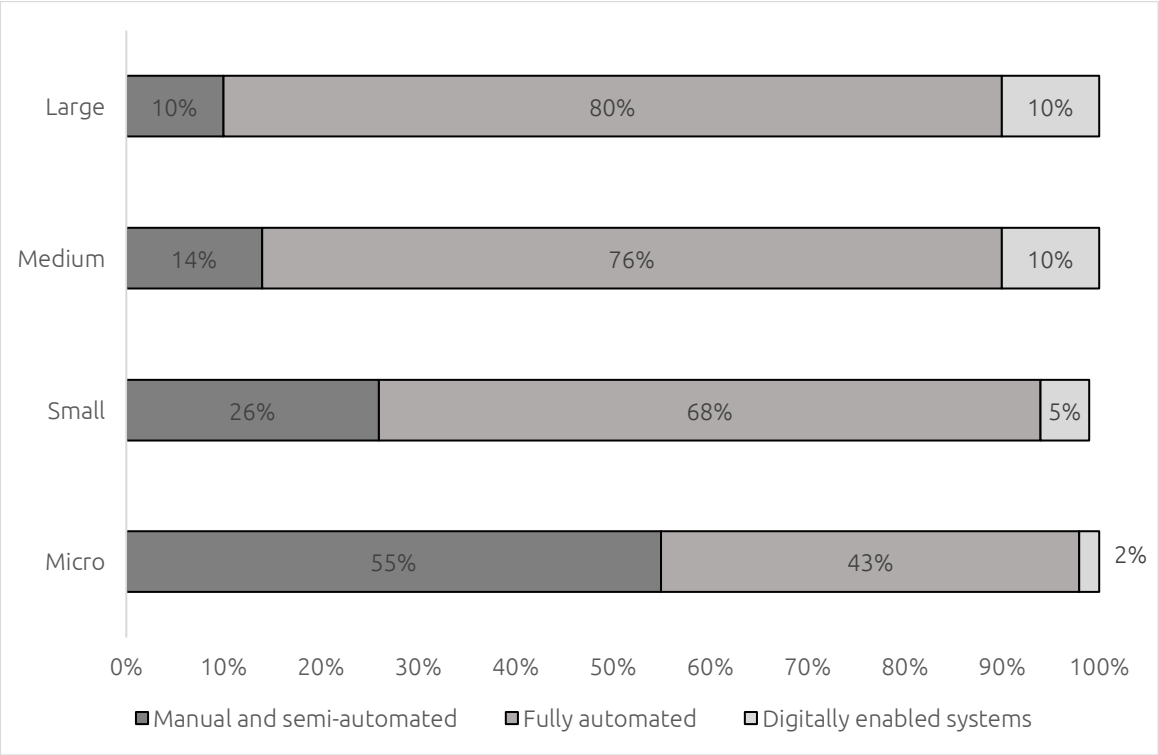
Source: Authors illustration; exporting =59; non-exporting =94.

Technology adoption patterns across firms can also be shaped by firm size, and our data reveals significant heterogeneity (Figure 4).[18] Firms that indicated that they are financially constrained were mainly micro and small-sized businesses. Micro firms are still dependent on manual and semi-automated production processes with limited adoption of advanced digital technologies while small, medium and large firms are more likely to employ fully automated systems.

In addition, medium and large firms in our sample had a greater affinity towards the adoption of sophisticated digital technologies (digitally enabled systems) while micro and small firms are still mastering technologies from the previous industrial revolution (manual, semi-automated and fully automated systems). These findings are contrary to the evidence in the literature that suggest small firms are more likely to be innovative and better at adapting to new technologies changes in the market.[19] Our results may be explained by the evidence that smaller firms often tend to experience greater financial constraints. The foregoing highlights that firm size (and the relationship with financial resources) has a significant bearing on the technological diffusion patterns of firms.

[18] Avenyo, E. K., Bell, J. F. & Nyamwena, J. 2022. Drivers of digital technologies adoption in South African. CCRED Policy Brief 2022/3.
[19] Khan, A. M. 1989. Innovative and Non-Innovative Small Firms. *Management Science.*35(5), pp. 597-624

Figure 4: Lack of finance, firm size, and digital technology adoption



Source: Authors

Notes: Micro (n=44) - sales valued at below R10 million in the 2019/20 financial year; Small (n=57) - sales valued at between R11 million and R50 million in the 2019/20 financial year; Medium (n=42) - sales valued between R51 million and R250 million in the 2019/20 financial year; and, Large (n=10) - sales valued at more than R250 million in the 2019/20 financial year.

3. Reflections and policy implications

This policy brief examined the relationship between lack of finance and advanced digital technology adoption, and the possible heterogeneities that exist across size and export activities of firms. The common thread emerging from the preliminary analysis is that lack of finance has hindered most firms' efforts to adopt new and advanced technologies. The analysis also showed the relationship between financial constraints, technological adoption, and size and export activity. The findings reveal that small and non-exporting firms are most constrained in terms of financial resources and thus have poorer advanced technology adoption patterns.

These initial findings are important in deepening understanding of digital technology adoption patterns in manufacturing firms in South Africa and shows how finance is instrumental in enabling the firms in the adoption of the new digital technologies. However, the provision of financial support alone is not the only panacea for increasing the adoption of advanced digital technologies. A host of other key factors, including digital capabilities, are critical for the adoption of new technologies and the success of digital transformation. The attributes in the form of digital capabilities, for instance, is complementary and allows

the transition to digital transformation.[20] The articulation and propagation of technological diffusion also require a set of attributes in a firm to allow the transition to digital transformation.

These preliminary insights can inform government policies that are aimed at shaping the opportunities and incentives provided at the firm level for digital industrialisation. The insights provided here are expected to serve as a platform for further discussions and analyses regarding the design and implementation of more targeted financial interventions to help firms to innovate. However, financial interventions may need to take into account the heterogeneity across firms and industries. For instance, the findings revealed that exporting firms exhibited a greater affinity towards new digital technologies when compared to their non-exporting firms. In sum, these early reflections suggest that a mix of innovative financial policies are needed to spur digital industrialisation across different categories of firms.

[20] Kindermann, B., Beutel, S., Garcia de Lomana, G., Strese, S., Bendig, D. & Brettel, M. Digital orientation: Conceptualization and operationalization of a new strategic orientation. 2020. *European Management Journal*. 39(1), pp. 645–657.