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Automation and Cost Structures in SMEs: Are Small Firms Disadvantaged vs. Multinationals?

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Abstract

This paper examines how automation reshapes the cost structures of small and medium-sized enterprises (SMEs) compared to multinational corporations (MNCs). Using the dual lenses of economies of scale and the resource-based view, the study analyzes financial, human capital, and informational constraints that disadvantage SMEs in adopting capital-intensive technologies such as artificial intelligence, robotics, and enterprise platforms. Comparative case studies from Germany, Japan, India, Sub-Saharan Africa, the United States, and the European Union highlight persistent adoption gaps shaped by institutional context. Findings suggest that while automation-as-a-service and supply-chain integration offer partial relief, structural disadvantages risk widening productivity inequalities worldwide.

Keywords

Finance, Automation, MNCs, SMEs, Artificial Intelligence, RBV, Economies of Scale, Technology

1. Introduction

Automation technologies, primarily artificial intelligence (AI), robotics, and various digital services, are rapidly reshaping the cost structures of firms globally. These capital-intensive technologies can raise fixed costs for firms through investment and skilled labor, even if they eventually lower marginal costs. For example, recent data published by Eurostat highlight a significant digital divide by firm size: in the European Union (EU) only 38% of small firms use enterprise resource planning (ERP) systems versus 86% of large firms, and only about 12% of small firms in member states of the Organisation for Economic Co-operation and Development (OECD) use AI, compared to 39% of large firms (Eurostat, 2024; Kergroach

& Héritier, 2025). Such gaps emulate broader findings that SMEs fall behind larger corporations in the integration of technology, with the gap only widening for more sophisticated tools (Kergroach, 2021).

This imbalance raises an important question: does automation increase cost disparities between SMEs and MNCs? In other words, does the new wave of digital automation further reinforce the structural advantage of large firms? This paper investigates whether capital-intensive automation creates a very skewed dynamic that boosts productivity for larger early adopters and sidelines smaller players. The question is urgent, as if SMEs cannot keep pace technologically, this may affect their survival and global market concentration. Since SMEs typically account for the vast majority of firms and jobs—for example, OECD data note SMEs are 99% of businesses and generate roughly 50% - 60% of value in OECD economies—any technology-driven disadvantage has broad social implications (Long, 2025).

The significance of this inquiry spans industrial and labor policy. If automation primarily benefits large MNCs, developing economies might see increased market concentration and reduced opportunities for SME-led growth. Labor markets could polarize further if small employers cut jobs rather than invest in productivity. Conversely, if suitable policies or market mechanisms, such as cloud services, help SMEs bridge the gap, the digital era could bring widespread productivity gains. Consequently, we ask if automation amplifies cost asymmetries between SMEs and MNCs. In exploring this, we synthesize global survey data and industry analyses, from sources including the World Bank Enterprise Surveys, Eurostat, the OECD, Deloitte, and the International Labour Organization (ILO). The data from these sources features the core problem that automation's high fixed costs may be easier for big firms to bear. Furthermore, our analysis examines how emerging models and integration in global value chains can create spillovers, but also how scalability and winner-take-all effects might widen the SME-MNC divide. Ultimately, the findings have direct relevance for competitive balance, SME survival, labor productivity, and industrial policy worldwide.

2. Literature Review

The question of how automation influences firm cost structures has long origins in economic theory and has been addressed by recent studies on digital adoption. Classic microeconomics emphasizes the difference between fixed and variable costs, and how economies of scale reduce average costs for larger firms. When automation requires high fixed investments in hardware, software, and training, larger enterprises are better positioned to spread these costs across greater volumes of output, while SMEs face much higher per unit costs (OECD, 2023). This uneven trend is consistent with learning curve models, which formalizes how cumulative experience reduces costs and reinforces the advantage of early adopters (Arrow, 1962).

Other schools of organizational economics provide alternative explanations on

why this uneven trend persists. For instance, transaction cost economics explains how firms decide between outsourcing and internalizing activities. Internet platforms and digital services reduce search, communication, and transaction costs for businesses, making it easier for companies, even smaller ones, to access suppliers and manage automated tools. However, SMEs still face comparatively higher transaction costs when negotiating directly with vendors, as they lack the bargaining power and established relationships of MNCs (Long, 2025). Beyond these costs, other theories also influence these disadvantages. The resource-based view suggests that unique firm resources, such as skilled employees, intellectual property, and organizational routines, drive competitive advantage. Since SMEs often lack specialized human capital and data management systems, their ability to capture value from automation is limited (Barney, 1991). This limitation exemplifies how resource constraints are an obstacle for smaller firms in achieving meaningful automation gains similar to larger firms. However, to add nuance, Handley & Mollow (2022) suggest that SMEs may offset some of these disadvantages through organizational flexibility and informal network ties. Regardless, structural divides remain.

Technology adoption patterns further highlight these disparities. In developing countries, World Bank Enterprise Survey data show dramatically lower technology adoption in small firms than in large firms (Comin et al., 2022). While large firms commonly implement advanced systems such as industrial robotics, AI, and big data analytics—SMEs tend to rely on more accessible tools like cloud computing, Customer Relationship Management (CRM) software, or accounting apps (Massini et al., 2025; Long, 2025). A UK national study shows cloud computing is widely used, potentially by up to 80% of firms, while AI and robotics remain far less common and more specialized. Cloud services help reduce upfront costs and improve operational flexibility, but they do not match the scale efficiencies of integrated automation platforms (Massini et al., 2025). Furthermore, cutting-edge solutions such as AI-driven optimization or robotic automation require significant investments in data infrastructure and cybersecurity, areas where SMEs are often underfunded (Benjamin et al., 2024). As a result, SMEs tend to pursue gradual digital upgrades rather than full automation, strengthening long-term productivity gaps compared to larger firms.

Finally, many empirical studies confirm that one of the most prominent barriers affecting smaller firms is financing. Financing is an important obstacle due to SMEs often lacking retained earnings, facing difficulties obtaining long-term loans, and paying higher costs of credit relative to MNCs (Jiménez-Rico et al., 2023). Even when funding is available, the shortage of qualified personnel remains another pressing issue for most SMEs. Deploying artificial intelligence or robotic systems requires engineers, data analysts, or information technology (IT) specialists that SMEs often cannot afford to hire (OECD, 2023). Information gaps deepen the problem, since smaller firms are less connected to vendor networks or industry associations that could guide them through automation uptake choices

(UNCTAD, 2021). This mix of financial and informational disadvantages creates these gaps in digital transformation between larger firms and SMEs.

Despite this, recent research highlights emerging opportunities for SMEs to bridge the current gaps. Cloud computing, subscription-based digital services, and automation-as-a-service model lower upfront costs and could help SMEs bypass traditional barriers (UNCTAD, 2021). Some OECD case studies note that SMEs integrated into multinational supply chains adopt digital tools more quickly, partly because larger partners mandate digital compatibility (OECD, 2023). This suggests that automation adoption is not entirely determined by firm size, but also by network position and access to shared platforms. However, the gap in transformative adoption remains large: the OECD's 2025 digital SME survey found that only about 8 percent of SMEs had reached advanced integration of digital tools, compared to much higher rates among large corporations (Bianchini & Sancho, 2025). Even when SMEs adopt digital technologies, they often do so in an unsystematic way, using them for basic tasks rather than full process automation.

Overall, the literature shows that automation interacts with firm size in ways that consistently put SMEs at a disadvantage. Existing theoretical frameworks emphasize how cost structures (economies of scale, transaction costs) or resources shape uneven outcomes, but few attempts have been made to integrate multiple lenses into a nuanced framework. Moreover, they must be supported by the outlined technology adoption studies, which reveal that smaller firms often rely on basic digital tools rather than advanced automation systems. Empirical evidence shows barriers such as limited financing, shortages of skilled personnel, and information gaps, all of which slow down SME automation uptake. At the same time, emerging opportunities such as cloud computing and supply chain integration suggest that these gaps are not fixed but depend on firm networks and access to affordable digital services. Taken together, current research makes clear that SMEs face structural obstacles that hinder productivity gains from automation, while also pointing to new pathways for reducing these divides. Future research therefore needs to move beyond observational accounts and examine how firm size and organizational resources interact to shape automation outcomes, highlighting the need for a framework that integrates multiple frameworks.

3. Theoretical Framing

As explored, a shortcoming of the existing literature is that we know which firms tend to adopt automation, and relatively less about the structural mechanisms that make adoption consistently easier for MNCs, as opposed to SMEs. Again, this paper goes further by building a framework that combines economies of scale and the resource-based view of firms, then using that framework to interpret why similar technologies produce systematically different outcomes across firm sizes.

Economies of scale provide the first pillar of this theoretical framework. In standard microeconomics, as alluded to previously, average costs fall when fixed costs are spread over larger output, which means that capital-intensive projects

become more affordable and feasible to implement as their volume rises (Eckert et al., 2022). As observed, automation typically requires large fixed expenses in equipment, data infrastructure, other software, and even workforce training, with literature from the Federal Reserve System drawing initial links between economies of scale and automation adoption (Firooz et al., 2022).

While the logic is standard (or foundational), its implications for firms must be made clear: capital-intensive technologies are more likely to embed scale advantages within cost structures, creating a structural advantage for MNCs. The aforementioned idea of learning curves only further corroborates our framing, where Anzanello & Fogliatto (2011) demonstrate that as firms accumulate experience in production, their unit costs see a persistent decline, giving early adopters with larger scale and capital flows a lasting advantage. Both of these factors offer a clear and unified explanation for why MNCs are initially able to adopt automation.

The second pillar is the resource-based view (RBV), which holds that durable advantage arises from resources and capabilities that are valuable, rare, imperfectly imitable, and non-substitutable (Oria et al., 2021). MNCs typically have significantly better access to such resources because they hire at a global scale, operate integrated information systems, and maintain a close relationship with other firms and vendors (Peng, 2001). Meanwhile, as will be investigated further, SMEs tend to rent these inputs and don't have the capacity to conduct complementary investments at the same time as the core technology purchase.

Thus, foundational RBV theory explains why differences in complementary assets matter as much as the technology itself for fully realizing performance gains, and why imitation is slow when certain capabilities are dependent on networks (i.e. for data and hiring) and culture, rather than tools that can be purchased off the shelf. Moreover, subsequent advances in dynamic capabilities for firms exacerbate this point, as firms need the ability to quickly sense shifts in industry and reconfigure assets, which raises the bar for SMEs that cannot absorb experimentation costs (Teece, 2007).

Crucially, these two lenses interact. Scale lowers the effective price of a large fixed investment and increases the expected payoff by allowing for broader technology deployment. Meanwhile, RBC determines how well a firm converts the initial investment into real gains through complementary assets and intangible factors. When these elements align, the returns are amplified. Firms that can coordinate these investments capture disproportionately higher benefits, while those that adopt automation in a fragmented or partial way often realize only modest improvements.

With these pillars, the contribution of this paper can be made precise. The existing empirics document adoption gaps across firm sizes, yet it rarely offers a compact and nuances theoretical explanation of why such gaps persist even when financing programs or discounts are available. The framework explains persistence by locating the cause in two structural features that are slow to equalize. First, capital-intensive automation embeds economies of scale through fixed cost

spreading and learning accumulation. Second, automation is a capability-absorbing technology whose benefits scale with the complementary resources and with the ability to reconfigure them. The interaction of these forces predicts that, without targeted mechanisms that lower the cost burden and provide complementary resources, automation will continue to diffuse primarily among companies that already possess scale and diverse capabilities (i.e. MNCs).

This shifts the central question from asking why SMEs do not adopt new technologies to examining how cost structures and supporting capabilities can be adjusted so that adoption becomes feasible and productivity gains are more evenly shared. Ultimately, by combining these perspectives and applying them across different institutional settings, this paper contributes a more comprehensive understanding of how automation shapes inequalities between SMEs and multinationals.

4. Methodology

This analytical study adopts a solely comparative approach to examine how the automation of business processes impacts the cost structures of SMEs relative to larger MNCs. This approach is taken with the intent to study how variations in circumstances such as infrastructure, economic conditions, and institutional support influence the ability to adopt automation across different tiers of businesses.

For consistency across datasets, this study adopts the operational definitions of firm size categories used by its primary data sources. According to the OECD and Eurostat, small and medium-sized enterprises (SMEs) are defined as firms with fewer than 250 employees, with small firms generally employing fewer than 50 and medium firms between 50 and 249 employees, often accompanied by thresholds on annual turnover or balance sheet totals (≤€50 million for medium firms) (Eurostat, 2022). In contrast, multinational corporations (MNCs) in this study are considered large firms exceeding these thresholds, typically operating across multiple national jurisdictions and reporting consolidated revenues well above the SME limits (Eurostat, 2025). Applying these standardized definitions ensures comparability across cases and data sources while clarifying the scope of the firms under analysis.

For the purpose of this study, automation is defined based on a prior study by MIT Economics that identifies a range of technologies with varying cost structures and accessibility. Previous studies conceptualize automation to include 1) Artificial Intelligence applications, 2) Robotics, including industrial machinery and automated production, 3) Cloud-computing platforms that provide scalable and flexible access, and 4) Enterprise Resource Planning (ERP) systems and other integrated digital platforms that streamline business processes (Acemoglu et al., 2022). This literature-based definition reflects both capital-intensive technologies requiring substantial upfront investment and service-based models that lower entry barriers for SMEs, capturing the diversity of automation adoption observed in practice.

Thematic review sections A and B examine both the structural and operational

factors that affect automation uptake in SMEs relative to larger firms. A myriad of literature and industry-specific reports were analyzed to identify key themes, which include cost structures, financial constraints, human capital limitations, informational disadvantages, and regulatory burdens (Delgado et al., 2019). Comparative insights were drawn across firm size, industry sector, and geographic context to highlight systematic differences in automation uptake, which all influence selection of the aforementioned case studies. The findings from these sections provide the analytical foundation for understanding why SMEs face persistent barriers compared to MNCs and inform subsequent discussion on policy interventions and strategic recommendations. This review aims to synthesize quantitative data with qualitative insights to clarify how structural and institutional factors shape automation outcomes to support the scope of the paper.

Thematic C focuses on analyses of global case studies. Six distinct geographical contexts were selected: Germany, Japan, India, Sub-Saharan Africa, the United States, and the European Union (EU). These cases often reflect deliberate contrasts between advanced industrial economies and more emerging or yet-to-develop regions. Germany and Japan were chosen as high-income and more industrialized economies where SMEs benefit from more well-integrated industrial and economic ecosystems. German SMEs, often referred to as the Mittelstand, and Japanese SMEs embedded in Keiretsu networks are existing and clear examples of how collaborative industrial systems can mitigate cost barriers to automation for smaller businesses (Hiebl & Pielsticker, 2022; Dhungana, 2023). In contrast, India and Sub-Saharan Africa were chosen to discuss the challenges to advancement that SMEs face in environments that are often characterized by weaker infrastructure, limited capital availability, and more fragmented regulatory frameworks (Ricci et al., 2025; Joy & Nambirajan, 2017). Both the EU and US were chosen as role models in promoting SME digital adoption and automation. Both regions have established policy frameworks, financial incentives, and technology support programs that actively encourage integration. These cases provide a benchmark against which to compare SMEs in emerging nations.

Thematic review section D draws on various review papers to examine how technology spillovers influence automation adoption among SMEs. Studies were analyzed to identify mechanisms such as cloud-based and Automation-as-a-Service (AaaS) platforms, integration into global supply chains, and knowledge transfer from lead firms, highlighting both cost-reducing effects and potential inequalities. Comparative insights were extracted from case studies, cross-country analyses, and firm-level surveys to assess how spillovers operate in different economic and geographic contexts (Sánchez et al., 2025).

Overall, the empirical analysis relies primarily on three main data sources: Eurostat, the OECD, and the World Bank Enterprise Surveys. Eurostat provides detailed firm-level adoption data for EU member states, offering insight into any adoption gaps between SMEs and large firms. OECD reports complement this with cross-national evidence on digital adoption, financing conditions, and policy

interventions relevant to SMEs. The World Bank Enterprise Surveys provide firm-level data from developing and emerging economies, including India and Sub-Saharan Africa, with particular emphasis on access to finance, infrastructure, and digital readiness. These datasets were selected for their reliability, comparability across countries, and breadth of coverage, enabling both quantitative and qualitative insights into automation adoption.

5. Thematic Review

5.1. Cost Structures of SMEs vs. MNCs

As explored through our economies of scale framing, MNCs and SMEs face completely different realities when it comes to automation. Large firms typically work on economies of scale and consequently have significantly more capital, whereas SMEs can't rely on large economic networks for financial backing and support (Bertanzetti et al., 2024). It has been mentioned that fixed overhead costs such as machinery tend to impact smaller businesses' profits more as they are naturally already operating on tighter margins than large, international corporations (Mccorquodale, 2023). This results in a higher per-unit production cost. Corporate automation technologies require an immense amount of up-front capital investments along with significant operational restructuring (IFR, 2025). Again, for MNCs, their sheer scaled economies allow such costs to be distributed across global supply chains, making investment more feasible. Moreover, MNCs will always have access to more competitive financing, internal research and development capacity, and strategic partnerships with automation providers (Qiang et al., 2021). SMEs, on the other hand, struggle with liquidity constraints, limited collateral for loans, and an overall higher perceived risk from lenders when investing in automation technologies. This financing gap is reflected in adoption outcomes. As shown in **Figure 1**, SMEs in the EU are far less likely than large firms to adopt AI technologies, with the disparity widening between 2023 and 2024 (Eurostat, n.d.). This aligns with the theoretical framing: economies of scale allow MNCs to spread fixed automation costs over larger outputs, while SMEs face structurally higher per-unit costs due to limited scale.

For an MNC, a single automation project may represent a fraction of their annual investment portfolio; for an SME, it can be business-critical. Research suggests that SMEs essentially allocate disproportionate shares of budgets to survival activities, such as wages, rent, and regulatory compliance, leaving little room for technological experimentation (Cristofaro et al., 2025). This cost gap is further broadened by subsidies and other government-issued incentives. Large corporations tend to capture a disproportionate share of available grants and tax breaks due to established reputations and brand awareness (Lincicome et al., 2024). SMEs will often lack the administrative bandwidth to be eligible for such programs. Taken together, these disparities mean that automation adoption is not merely a matter of firm willingness, but is tied to structural cost asymmetries between SMEs and MNCs.

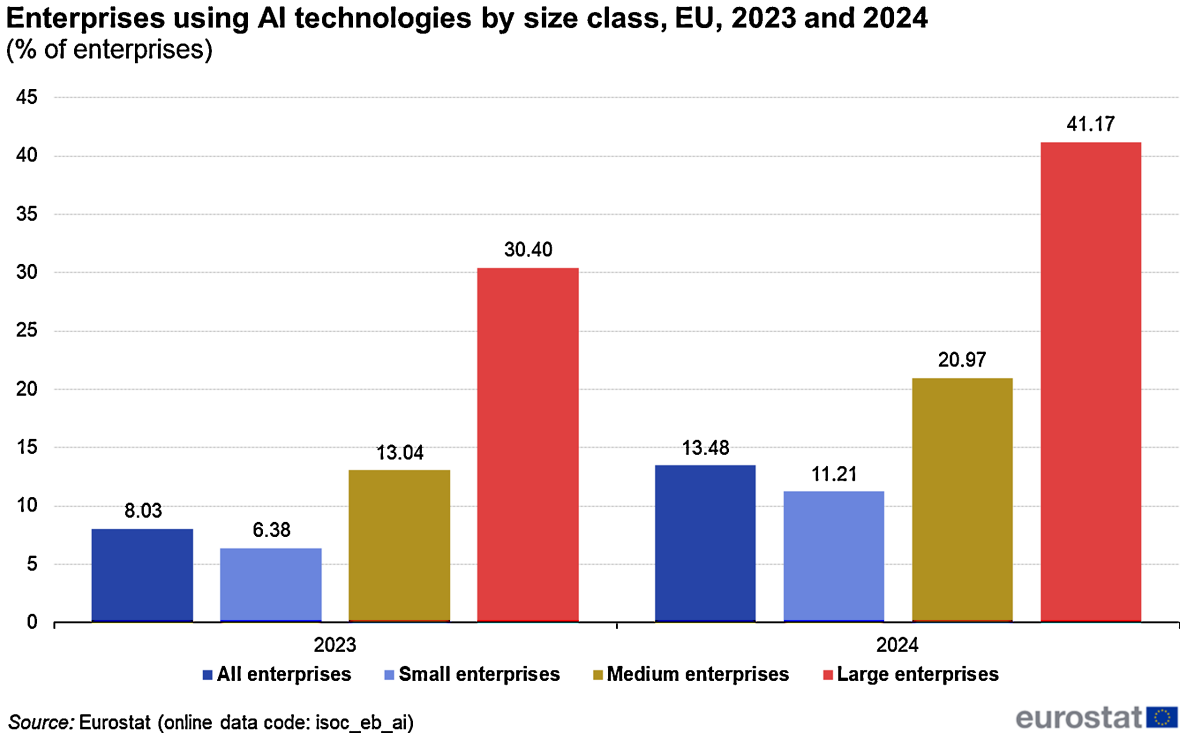


Figure 1. Enterprises using AI technologies by size class, EU, 2023 and 2024 (% of enterprises).

Another major factor regarding cost structures would be external factors that influence monetary patterns. The difference in automation adoption lies in their exposure to shocks such as tariffs, for example. MNCs typically hedge against these risks through diversified international operations, vertical integration, and strategic supplier networks (Zahoor et al., 2022). A U.S. International Trade Commission (USITC) report published in 2010 has reflected on how SMEs face disproportionately higher burdens than larger firms when confronted with such obstacles. **Figure 2** highlights a related divide in the adoption of enterprise resource planning (ERP) systems, where only about a third of small firms use ERP compared to over four-fifths of large firms in the EU (Eurostat, 2024).

Moreover, SMEs report high tariffs, difficulty in processing payments, and challenges finding foreign partners as particularly burdensome impediments in the manufacturing sector (Okun et al., 2010). In niche sectors such as knit-goods and meat, SMEs face average applied tariffs exceeding 20%, while the average across all products faced by SMEs is about 3.4% (Okun et al., 2010). These higher rates on key SME-exported goods also mean that even minor increases can inflate automation costs by raising the price of imported machinery and technology components from overseas. In contrast, multinationals leverage global resource allocation, treasury management, and sophisticated supply-chain networks to buffer against such trade barriers. They can redirect sourcing, exploit preferential trade agreements, or shift capital investments across divisions in response to cost shocks, while using more powerful and widespread ERM systems, options largely unavailable to SMEs.

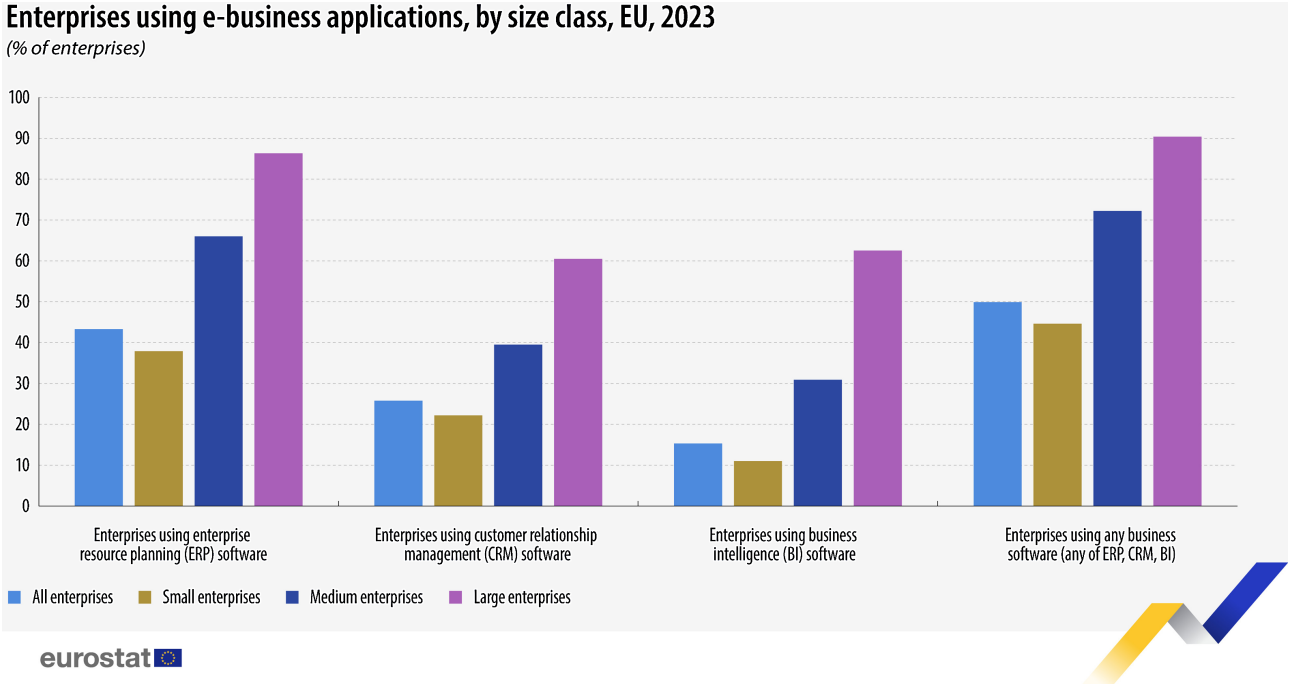


Figure 2. Enterprises using e-business applications, by size class, EU, 2023 (% of enterprises).

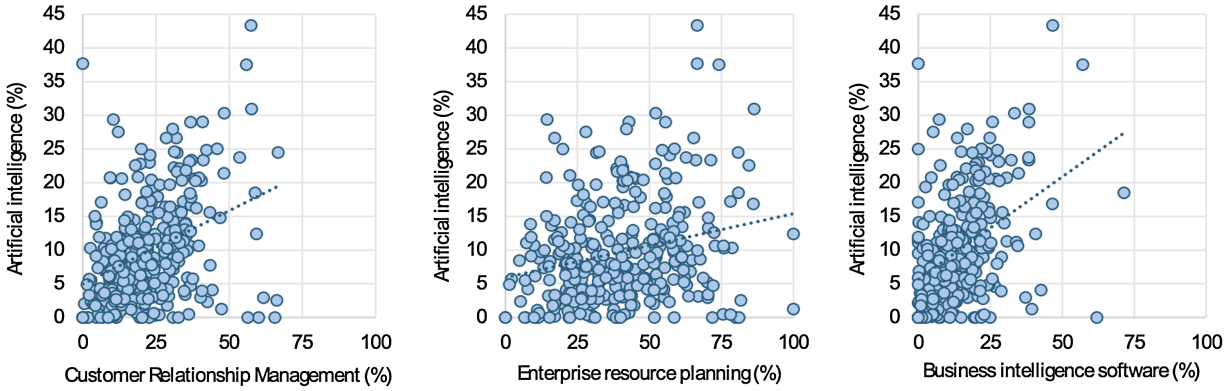
5.2. Barriers to Automation in SMEs

Cost structures themselves describe much of the automation gap, however, SMEs also face more complex barriers that simply prevent them from deploying advanced technologies at the same pace as multinationals.

The largest barrier to entry for SMEs remains the financial one. A white paper published by the International Trade Centre reveals that 44% of businesses report difficulties securing financing and capital, and this includes 57% of micro-businesses and 43% of SMEs worldwide. This is compared to an overall less-than 25% of larger firms and enterprises (International Trade Centre, 2025). Unlike multinationals, which rely on retained earnings or favorable credit lines, SMEs often depend on short-term loans with higher interest rates and stricter collateral requirements. This financing structure leaves little flexibility for long-horizon investments in automation technologies that require years before producing returns (World Bank, 2025). Liquidity pressures also discourage SMEs from experimenting with risky or unfamiliar automation tools, making survival expenditures such as payroll and utilities the higher priority.

SMEs also tend to lack the specialized human capital resources needed to safely and efficiently integrate automation into their daily operational time periods. Large corporations can draw on in-house engineers, IT specialists, and data scientists, but SMEs frequently operate with generally-trained administrative staff who lack specific-enough training in emerging technologies. According to Eurostat's Digital Intensity Index, only 11.21% of SMEs reported using AI in 2024, compared to 41.17% of large firms, a number reportedly reflecting on internal expertise (Eurostat, 2025). This pattern is reflected across the OECD, as shown in

Figure 3. Large firms consistently adopt both AI and business process integration tools at several times the rate of SMEs, confirming that resource barriers translate into systemic adoption gaps (Kergroach & Héritier, 2025). According to the theoretical RBV framework, SMEs' limited access to complementary resources, coupled with scale disadvantages, constrains their ability to fully realize performance gains even when financial support is available, explaining why adoption lags despite subsidies or incentives.



Note : Firms with 10 employees or more, by NACE sector and NUTS2 regions for which data are available. 2024 or latest year available.
Source : (Héritier and Kergroach, 2025 forthcoming[60]). Based on (Eurostat, 2025[61]) Integration of internal processes by NACE Rev. 2 activity and NUTS 2 region [isoc_r_eb_iipn2] and (Eurostat, 2024[49]) Artificial intelligence by NACE Rev. 2 activity and NUTS 2 region [isoc_r_eb_ain2]. Data retrieved on 08 April 2025.

Figure 3. Adoption rate of AI and business process integration software (%) by EU27 region and sector, 2024.

Moreover, hiring newer technical talent is also disproportionately expensive for smaller firms, as they cannot match the compensation and career development packages offered by MNCs (Thompson, 2023). Meanwhile, this is compounded by the fact that SMEs face informational disadvantages in navigating the automation landscape. Enterprise surveys show that many SMEs are unaware of existing automation vendors or lack the networks needed to evaluate competing technologies (OECD, 2021). MNCs, by contrast, maintain long-standing partnerships with global suppliers and often co-develop new technologies with equipment providers, so they're consistently exposed to cutting-edge (or advanced) technology (Sun et al., 2024). As a result, SMEs become dependent on third-party consultants or trade associations to bridge these knowledge divides.

Finally, SMEs are disproportionately strained by compliance obligations. Fixed regulatory costs, such as mandatory reporting and safety certifications standards, constitute a larger share of revenue for SMEs than for MNCs. A European Investment Bank survey report notes that smaller firms spend an average of up to 4% of annual turnover on these costs, whereas larger corporations spend only about 1% of their yearly revenue on turnover fees (European Investment Bank, 2025). In addition, SMEs often struggle to navigate overlapping national and EU-level regulations, while MNCs benefit from dedicated legal departments and compliance teams that diffuse these costs across a global scale.

5.3. Case Studies across Countries

Germany and Japan both represent economies where SMEs form the backbone of production (Madgavkar et al., 2024). Yet, their integration into industrial ecosystems provides insulation from some automation hurdles. In Germany, the Mittelstand, comprising over 99% of firms, benefits from dense industrial clusters, access to training pipelines, and various Research and Development (R&D) partnerships that help SMEs access new technologies (Paust, 2014). These networks not only lower the cost of accessing technology but also create spillovers in skills, knowledge, and supplier linkages. The results show this greatly. According to the ILO's Digitalization Report (2024), nearly 40% of German SMEs report using some form of robotics or cloud computing, well above the EU average (IfM Bonn, 2025). Similarly, Japanese SMEs embedded in Keiretsu, a system where several companies invest in each other, supply chains gain indirect exposure to automation through partnerships with larger manufacturers. This arrangement allows Japanese SMEs to adopt automation indirectly by aligning their processes with field-leading firms that provide both technological guidance and stable demand. (Klim, 2021) Such examples illustrate how informal networks and governance traditions within firms amplify the benefits of scale by diffusing knowledge and reducing the risks of costly investments, corroborating OECD (2021).

In contrast, SMEs in India and across Sub-Saharan Africa face persistent challenges despite their central role in generating employment. SMEs account for more than 80% of jobs in Africa and nearly 62% in India, yet digital adoption rates remain minimal (Runde et al., 2021; McKinsey Global Institute, 2017). It has been found that fewer than 10% of Indian SMEs reported using advanced digital tools, with most investment concentrated in a handful of export-oriented sectors (World Bank, 2020). This unevenness reflects structural divides. While globally competitive firms in metropolitan hubs integrate automation to meet international standards, the vast majority of domestic-oriented SMEs remain reliant on traditional, labor-intensive methods. African SMEs face additional hurdles. Most notably, this includes unreliable infrastructure, limited credit markets, and fragmented regulatory frameworks. The risks of automation failure in such environments outweigh potential productivity gains, discouraging investment. These cases highlight that employment dominance does not necessarily translate into technological upgrading without complementary institutional and infrastructural support.

In advanced economies like the U.S. and EU, subsidy frameworks have been introduced to narrow the automation gap, especially in critical industries. The EU's Digital Europe Programme allocates €7.5 billion (2021-2027) for SME digital adoption, while the U.S. Small Business Administration (SBA) has expanded technology-focused lending programs in areas such as defense manufacturing and healthcare digitalization (European Commission, 2022; Albon, 2023). Yet despite this policy push, uptake remains uneven. Again, Eurostat data reports that while 78% of large firms in the EU use cloud services, only 44% of SMEs do so (Eurostat,

2025). U.S. surveys indicate that American SMEs remain cautious, citing high upfront costs, cybersecurity risks, and uncertainty over returns on investment as key deterrents. (Peretz-Andersson et al., 2024). These findings suggest that while subsidies from economically larger nations can mitigate barriers, they are insufficient on their own to close the digital divide.

5.4. Spillovers

New delivery models of automation, especially cloud-based and "Automation-as-a-Service" (AaaS) platforms, can lower the upfront cost barriers that typically hinder small firms. By outsourcing expensive hardware and software to cloud providers, SMEs can acquire advanced capabilities on a pay-as-you-go basis. From the theoretical perspective, spillovers can partially mitigate scale and capability disadvantages by providing SMEs with access to knowledge, technology, or standards they could not independently develop. Studies find that cloud adoption delivers significant cost savings for smaller companies. For example, a study from the Information Technology and Innovation Foundation reports that 82% of studies find SMEs that adopt cloud computing experience significant cost savings, and industry surveys note that providing cloud credits and SME-oriented AI toolkits has historically lowered experimentation costs with automation for small firms (Long, 2025). By offloading investment into infrastructure and new technologies, cloud services effectively turn fixed costs into variable costs, effectively enabling an SME to test and scale automation (including AI, data analytics, and robotics software) with a lower immediate need for capital.

From a theoretical standpoint, AaaS changes how economies of scale and the resource-based view apply to automation adoption. Traditional models embed scale advantages through large fixed investments, whereas AaaS uses pay-as-you-go and measured-service characteristics that convert fixed to variable costs and lower entry thresholds for SMEs (Lu et al., 2024). However, this shift does not fully neutralize scale benefits. Large buyers can still obtain commitment-based discounts and preferential terms that drive lower unit costs at higher volumes, and they also benefit from data and platform network effects that increase returns to scale (Varga et al., 2023). Overall, scale is less about owning physical capital and more about bargaining power, committed usage, data aggregation, and scale of integration.

Through the resource-based view, AaaS shifts which capabilities matter. Outsourcing infrastructure allows SMEs to reallocate scarce resources toward higher-value activities, but access alone rarely yields durable advantage unless firms build complementary routines such as process redesign, employee reskilling, and data governance that appropriate value from the service (Uddin et al., 2023). Empirical work on cloud assimilation and dynamic capabilities shows that performance gains depend on developing these complementary, hard-to-imitate capabilities rather than simply subscribing to the technology (Khayer et al., 2023).

Moreover, integration into global supply chains and tech-driven economic sec-

tors offers another catch-up channel. SMEs that are suppliers or service providers to MNCs often receive technology spillovers. Lead firms in a value chain may transfer or demand certain digital standards and tools from their SME suppliers. The UNCTAD Technology and Innovation Report (2023) explains how digital tools can help SMEs in developing nations join global value chains. Internet of Things (IoT) and AI applications enable tracking of shipments and inventories, reducing trade frictions and costs for small suppliers (UNCTAD, 2023). An example of such a strategy in action comes from CloudFactory, a U.S. data-processing firm that divides its workflow. High-tech AI development remains in the U.S., while data annotation and quality control are done in Nepal and Kenya (Pant & Siddiqui, 2023). This "smarter offshoring" uses digital connectivity and cloud technologies to offshore work, creating new SME opportunities without requiring initial full capital investment. Overall, UNCTAD predicts that such technologies could decentralize advanced activities across networks, allowing SMEs in emerging markets to handle engineering, design, or software tasks regionally (UNCTAD, 2023).

However, there is a notable risk of "winner-takes-all" dynamics. Fast adopters, which are typically large, well-resourced firms, can capture the early advantages regarding emerging technologies. OECD analysis of AI diffusion finds that in 2024 large firms were three times more likely to use AI than small firms (Kergroach & Héritier, 2025). Such concentrated adoption matters because the gains from new technology are often obtained disproportionately by early adopters. The main benefits of automation, such as improved productivity and new capabilities, therefore cluster with innovators and early-majority firms, while late adopters see diminishing returns. Similarly, McKinsey's modeling warns that as automation progresses, the majority of performance gains will go to those who invest first (McKinsey Global Institute, 2017). In other words, without deliberate spillover mechanisms, established corporations could further outcompete smaller rivals, which has the potential to widen inequality.

Overall, the situation is nuanced. Cloud-based and AaaS models both offer a promising route for SMEs to overcome cost barriers, and supply-chain linkages can serve as channels for technology transfer. But the leading-firm capture of automation gains is a real concern. Policy and industry efforts must therefore focus on reducing entry costs for SMEs, such as subsidizing cloud credits, promoting shared AI platforms and ensuring that integration into value chains comes with learning spillovers. Incorporating the global data suggests that spillovers can lift broad productivity, yet also that SMEs could lag in the digital race without supportive action.

6. Discussion

The evidence throughout suggests that automation creates more than just a temporary technology gap between large firms and SMEs. Instead, it imposes a structural burden, since automation requires a lot of spending on robotics, artificial

intelligence, data infrastructure, and enterprise platforms. These fixed costs are a bigger burden on smaller firms than on multinationals. Larger corporations are able to spread costs across global supply chains and larger production volumes, while also drawing on deeper financial reserves to manage risks. By applying the two theoretical lenses of economies of scale and the resource-based view (RBV), and connecting them with the thematic review of cost structures, barriers, case studies, and spillovers, a clearer picture emerges of how automation interacts with firm size.

From the perspective of economies of scale, automation intensifies cost divides. As described in the thematic review, the high fixed investments needed for advanced technologies are sustainable for MNCs because they are distributed across vast outputs and locations. For an SME, however, a single automation project can represent a decisive share of its annual budget, raising per-unit costs and making returns more uncertain. These financial constraints are also influenced by reliance on short-term loans and higher interest credit, which increases the risks of long-term technology investment. Theoretical models of learning curves further explain why large firms strengthen their lead. By adopting early and at large scale, MNCs accumulate experience, refine processes, and lower costs further, while SMEs adopt late and gain fewer efficiency benefits. This creates a cycle in which economies of scale amplify the structural disadvantages of smaller firms.

The RBV framing highlights an equally important disadvantage. Automation is not a technology that can be instantly implemented but one that depends on complementary resources such as skilled engineers, strong IT infrastructure, proprietary data, and organizational routines. MNCs usually have these resources in-house, supported by global recruitment pipelines, R&D departments, and vendor networks. SMEs, in contrast, often have limited IT staff, fragmented systems, and smaller budgets for training, which reduces their ability to fully capture the benefits of automation. Human capital shortages are especially pressing; Engineers, AI specialists, and data analysts command salaries that small firms cannot match, and the absence of specialized staff means automation projects are harder to implement. While multinationals are embedded in global supply chains and maintain long-standing vendor partnerships, SMEs often lack such connections, leading to weaker information flows and higher risks of misinformed investment. This combination of resource shortages helps explain why SMEs not only adopt more slowly, but also achieve smaller productivity gains when they do.

Despite these structural disadvantages, SMEs are not entirely helpless. They do have unique resources that can serve as advantages in certain contexts. Their small size often makes them more flexible, allowing them to adapt quickly to shifting customer preferences, customize products, and build closer client relationships. Many SMEs begin digital adoption not with advanced robotics or AI but with lighter, cheaper tools such as cloud computing, customer relationship management systems, or accounting apps. These technologies may not deliver the same scale efficiencies as fully integrated platforms, but they allow SMEs to lower costs,

improve efficiency, and strengthen customer service. In RBV terms, this agility and client focus can be seen as valuable and sometimes rare capabilities that give SMEs competitive space even in industries dominated by large corporations. Some studies also suggest that automation is not equally beneficial across all areas, leaving niches where human labor, creativity, and personal service outperform machines. In such areas, SMEs can retain an edge by leveraging their unique strengths rather than competing head-on with multinational scale.

Our case studies across countries illustrate how these disadvantages vary depending on institutional context. In Germany, the Mittelstand benefits from industrial clusters, training pipelines, and university partnerships that provide access to R&D and shared resources. These networks lower cost barriers and help SMEs access the complementary assets required for effective automation. In Japan, Keiretsu supply chains provide similar benefits, giving SMEs indirect exposure to automation through close ties with larger firms. In contrast, SMEs in India and Sub-Saharan Africa face weak infrastructure, limited financing options, and fragmented markets, which amplify the disadvantages of both scale and resources. Even in advanced economies like the U.S. and EU, where subsidies and digital adoption programs exist, uptake remains uneven, as larger firms often capture a disproportionate share of support due to stronger administrative capacity. These examples confirm that structural disadvantages are shaped not only by firm size, but also by the ecosystems in which firms are embedded.

Policy implications therefore become critical. Financial barriers remain the most consistent obstacle for SMEs, with many relying on high-interest short-term loans that make automation investments too risky. Vouchers, grants, and subsidized loans, as seen in the EU and U.S., can help reduce upfront costs, but they must be designed to be accessible to smaller firms with limited administrative staff. Beyond finance, policies that provide institutional support, such as training, R&D partnerships, and networking opportunities, address resource shortages identified by RBV. The German and Japanese cases show that policies combining financial relief with institutional integration can reduce adoption gaps more effectively than isolated measures. Without such targeted support, many SMEs risk being excluded from supply chains where automation is rapidly becoming a requirement rather than an option.

Emerging technology delivery models offer another promising way forward. Cloud computing, subscription-based AI platforms, and automation-as-a-service convert heavy fixed investments into variable operating costs. This directly addresses the economies of scale barrier by lowering the entry cost and spreading payments over time. It also reduces RBV disadvantages, since external providers manage updates and maintenance, reducing the need for in-house specialists. Integration into global value chains offers further opportunities, as SMEs often adopt automation more quickly when larger partners demand compatibility and provide technical support. Despite these opportunities, there remain risks that large firms will capture most of the gains from automation. Early adopters, typi-

cally MNCs, combine economies of scale with strong complementary resources, enabling them to learn faster, refine processes, and secure competitive advantages long before SMEs catch up. This creates a "winner-takes-all" dynamic where productivity gains cluster with large firms and late adopters see diminishing returns. From the perspective of economies of scale, costs keep falling for large firms as adoption expands, while RBV explains why the skills, data, and organizational capabilities needed to use automation effectively become harder to replicate over time. Unless deliberate spillovers, shared platforms, and SME-focused policies are created, automation risks amplifying rather than reducing inequalities across firm sizes.

Taken together, this discussion suggests a mixed but cautiously optimistic outlook. On the one hand, automation clearly disadvantages SMEs by raising costs, limiting financing, and slowing productivity growth compared to multinationals. On the other hand, selective strategies, new service-based delivery models, and supportive institutional frameworks can create opportunities for SMEs to adapt and compete. The combined insights of economies of scale and RBV make it clear that disadvantages are structural, but also that they can be reduced through policy and ecosystem design. The key challenge for the future is ensuring that automation becomes a force for inclusive productivity growth rather than a driver of long-term inequality.

Policy Recommendations

The analysis of automation disparities underscores the need for integrated policy measures to prevent a widening productivity gap between SMEs and larger firms. The priority should be addressing the Economies of Scale barrier by shifting the cost structure for technology acquisition. Policymakers must actively promote and subsidize flexible, service-based digital models such as cloud computing, subscription-based AI platforms, and automation-as-a-service (AaaS), as these directly convert heavy fixed investments into variable operating costs. This not only allows this technology to become scalable, but also helps mitigate RBV disadvantages for SMEs, since external providers manage updates and maintenance, reducing the need for in-house specialists that smaller firms often cannot afford to hire.

Effective intervention requires moving past isolated financial measures toward institutional integration. Evidence shows that policy relief with institutional integration can reduce adoption gaps more effectively than isolated measures. This coordinated approach is essential because without such targeted support, many SMEs risk being excluded from supply chains where automation is rapidly becoming a requirement rather than an option. Furthermore, governments should capitalize on market forces by incentivizing large firms; integration into global value chains offers further opportunities, as SMEs often adopt automation more quickly when larger partners demand compatibility and provide technical support. Therefore, policy should reward MNCs for providing technical assistance and knowledge

transfer to their established SME business partners.

Finally, long-term technological inclusion requires promoting strong, collaborative ecosystem networks that supply complementary resources. As demonstrated by global models, case studies from Germany and Japan stress that institutional networks and governance traditions can provide the required means that individual SMEs lack. These frameworks can facilitate access to shared infrastructure, specialized human capital, and simplified regulatory compliance. Such foundational efforts must also address the uneven access to infrastructure and policy support, particularly in developing regions, to create a stable environment where all firm sizes can sustainably adopt and benefit from digital automation.

Ultimately, successful policy will hinge on recognizing that the competitive environment has shifted from one of technology availability to one of structural accessibility. By focusing on these systemic solutions rather than short-term subsidies, governments can build durable competitive resilience across the entire business landscape. The window for proactive intervention is narrowing, and decisive, multi-faceted action is now required to secure inclusive economic growth.

7. Conclusion

Automation is and will undoubtedly continue to fundamentally change the competitive scope of production, but its benefits are distributed unevenly across firm sizes in the short term. From the perspective of economies of scale, MNCs can absorb high fixed costs, leverage global supply chains and networks, and access better financing to deploy advanced technologies. By contrast, SMEs operate under tighter margins and more constrained financing conditions, leaving them at a structural disadvantage in implementing automation. Resource-based constraints—such as limited human capital, data infrastructure, and organizational routines—exacerbate this imbalance. These uneven cost structures and capability gaps risk creating longer-term inequalities in productivity, market access, and overall operational resilience.

At the same time, emerging digital service-based models, such as cloud automation and AaaS, offer more flexible entry points. These approaches have significant potential to mitigate the disadvantages identified by scale and RBV perspectives, reducing upfront investment for SMEs and helping them access complementary resources externally. If widely adopted, these options could help rebalance opportunities between SMEs and larger corporations, though uneven access to infrastructure and policy support remains a concern.

Looking ahead, the key challenge is not simply whether SMEs adopt automation, but how they can do so in ways that align with their existing resource bundles and organizational flexibility. Case studies from Germany and Japan stress that institutional networks and governance traditions can provide the complementary capabilities that RBV highlights as essential, softening the disadvantages of smaller scale. Firms in India and Africa, by contrast, reveal how weak infrastructure and fragmented markets exacerbate both scale disadvantages and resource deficits. In

advanced economies, subsidies and lending programs have narrowed but not closed the adoption gap that arises from these structural dynamics. Overall, these patterns show that automation is not a neutral technology, but one that reinforces and exacerbates preexisting divides. Whether digital service models and ecosystem partnerships can provide SMEs with the scale economies and resource complements they currently lack will determine if automation becomes a source of inclusive growth or long-term inequality.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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