The High 5

'Catch Me if You Can' On Drivers of Venture Capital Investment in Africa

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Industrialise Africa

Working Paper Series
n° 364
June 2022
African Development Bank Group

AFRICAN DEVELOPMENT BANK GROUP

Working Paper No. 364

Abstract

This paper investigates the determinants of venture capital investments across 25 African countries over the period 2014-2019. In particular, it considers the significance of innovation and digitalization in Africa's venture capital activity. The results show that digital infrastructure, high-technology exports, internet coverage, market size, minority investor protection, and government effectiveness are the main drivers of venture capital deals in Africa over the period examined. More generally, these findings highlight that digital infrastructure and connectivity, innovation and institutional frameworks all play an important role in shaping a favorable environment to attract venture capital funding.

This paper is the product of the Vice-Presidency for Economic Governance and Knowledge Management. It is part of a larger effort by the African Development Bank to promote knowledge and learning, share ideas, provide open access to its research, and make a contribution to development policy. The papers featured in the Working Paper Series (WPS) are considered to have a bearing on the mission of AfDB, its strategic objectives of Inclusive and Green Growth, and its High-5 priority areas: Power Africa, Feed Africa, Industrialize Africa, Integrate Africa, and Improve Living Conditions of Africans. The authors may be contacted at workingpaper@afdb.org.

Citation: Jaoui, F., O. Amoussou, and H.F. Kemeze (2022), 'Catch Me if You Can': On Drivers of Venture Capital Investment in Africa, Working Paper Series N° 364, African Development Bank, Abidjan, Côte d'Ivoire.

‘Catch Me if You Can’
On Drivers of Venture Capital Investment in Africa

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JEL Classification: G18 ; G24 ; O33

Key words: Venture capital; Digitalization; Innovation; Africa

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We would like to thank Racheal Mubeezi for her excellent research assistance in drafting the paper and for her many helpful comments and suggestions. The paper benefited from feedback from the Africa Development Bank (AfDB)’s research seminar series, and comments from Eugene Bempong, Chief Research Economist at AfDB. We also would like to thank the African Private Equity and Venture Capital Association (AVCA) for giving us access to their database. The views expressed herein are those of the authors and not necessarily of the AfDB. All errors remain our own.

1. Introduction

Attracting private funding, in particular of the kind that finances risky yet innovative endeavors, is essential to ensure that Africa reaches its development objectives while concurrently futureproofing its economies. Indeed, one of the fundamental challenges to achieve development goals in Africa remains the ability to mobilize significant resources to finance them. Sub-Saharan Africa alone needs about USD 574 billion per year until 2030 to finance the Sustainable Development Goals (SDGs). The COVID-19 pandemic has further exacerbated government financing needs, increasing debt levels from 60% in 2019 to an estimated 75% by end of 2021. In fact, based on estimates from the African Development Bank, African governments require additional gross financing of about USD 485 billion between 2021 and 2023 to adequately respond to the crisis and support the recovery. Given the already limited fiscal space, private sector investments must play a significant role, and alternative financing instruments beyond debt such as equity investments must be explored. Furthermore, the achievement of the continent's development goals can be judiciously accelerated by channeling some of the public and private investments to boost the digital economy, including the underlying digital infrastructure to bridge the connectivity gap in Africa (around USD 100 billion or close to USD 9 billion a year of funding is needed (Gallegos et al., 2020)). This would have broad-based ramifications with the potential to add USD 712 billion to the continent's economy or 8.5% of GDP by 2050 (Google et al., 2020).

Venture capital, an alternative type of financing, with multiplier effects, can be key in accomplishing Africa's 'digital moonshot'. It represents an important source of risk capital to fuel innovative companies, scale up the digital economy, thereby creating the jobs of the future and boosting economic growth (Calderon et.al., 2019)[2]. While we observe an exponential trend of VC funding in Africa recently as this paper will show, it is far from sufficient, only representing 0.4% of global VC funding flows as of 2020 (or 0.05% of GDP in Africa). This explains in part why despite a few successful tech startup stories in the continent that managed to reach 'unicorn' status, these are still isolated cases, concentrated in only a few countries, as Africa's entrepreneurial tech ecosystem is still in its infancy. Thus, to ensure that the African tech companies of tomorrow—

[2] The World Bank estimates an impact of digitization on the continent's growth per capita of 1.5 percentage points per year and a reduction of the poverty headcount ratio by 0.7 percentage point per year (the potential growth and poverty reduction effects are even larger for Sub-Saharan Africa; a growth impact of 1.95 percentage points per year and poverty reduction by 0.96 percentage point per year).

which will form the basis of the African digital economy by generating innovative technological solutions—are adequately funded today, we need to understand what factors attract VC financing.

So, how can we 'catch' and attract more VC funding in Africa? There has been little analytically rigorous research so far on the determinants of venture capital funding in Africa, especially with a focus on digitization. This study seeks to fill this gap through an empirical analysis of VC drivers using a dataset of African economies over the more recent 2014-2019 period. Empirical evidence will show that digital infrastructure and the state of innovation play a significant role in shaping a favorable environment to attract venture capital funding, in addition to regulatory frameworks, institutional factors, market size, and corporate governance.

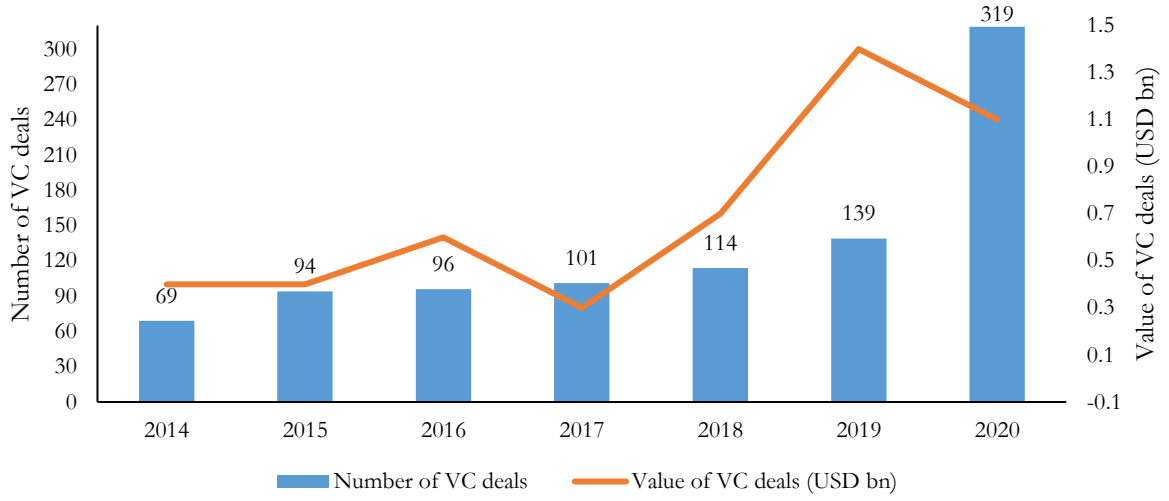
The paper is organized as follows: Section 2 examines the recent trends in VC funding in Africa, Section 3 reviews the related literature, Section 4 describes the methodology and data while Section 5 presents the analytical results, Section 6 provides robustness checks, and Section 7 draws policy implications and concludes.

2. Venture capital dynamics and profile in Africa

African startups have been on an upward fundraising trend in the past few years. The average annual growth rate in the value of venture capital (VC) deals was over 100% between 2017 and 2019 (African Venture Capital Association [AVCA], 2020). The value of VC deals reached an all-time high in 2019 with USD 1.4 billion invested (see Figure 1) with 98% of the 139 identified deals being tech deals (AVCA, 2020).[3] Furthermore, approximately 319 deals and USD 1.1 billion worth of publicly disclosed and non-disclosed funding deals were recorded in 2020, suggesting steady and resilient VC funding despite the COVID-19 pandemic (AVCA, 2021).

[3] AVCA's "technology sector" is defined as the category of companies relating to the research, development and/or distribution of technology-based goods and services. It also includes businesses that use existing tools, platforms, libraries, and frameworks to either make a company and/or a solution they provide more efficient or to provide a new service.

Figure 1: Number and value of venture capital deals over time



Source: AVCA data

The amount of venture capital channeled into African businesses in 2019 was practically double the amount raised in 2018. Over 90 African companies were recorded to have raised more than a million dollars each in 2019 (Briter Bridges, 2020). The increased VC activity in 2019 saw the emergence of new unicorns, such as the Nigerian digital payments firm, Interswitch that reached unicorn status following the acquisition of a 20% stake by Visa for USD 200 million, valuing the startup at USD 1 billion. The second largest disclosed deal in 2019 was also in the fintech space with a USD 120 million Chinese-backed investment in OPay, a Lagos-based financial payments startup founded by the consumer internet company Opera. Other deals of note in 2019 included a USD 100 million investment in Andela, a Nigerian company that trains software developers and connects them with technology companies around the world; a USD 30 million investment in Lori Systems, a mobile, on-demand trucking logistics startup founded in Kenya; and a USD 29.8 million deal led by the investment bank Goldman Sachs in Twiga Foods, a Kenya-based food logistics startup.

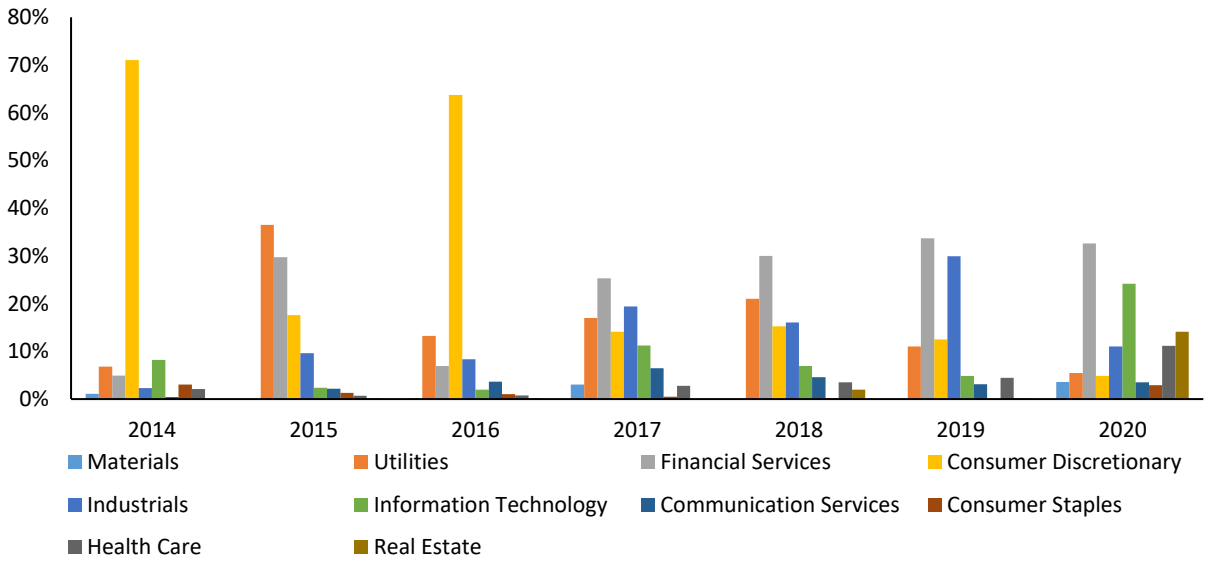
The first quarter of 2020 recorded over USD 300 million in investments, beating Q1 2019 numbers by almost USD 100 million (WeeTracker, 2021). The Q1 2020 deals included a USD 55 million investment in South African fintech Jumo with Goldman Sachs in the pool of investors; a USD 40 million Series D funding in Vezeeta, an Egyptian e-health venture; a USD 35 million Series B round in Flutterwave, a Nigerian-founded fintech startup; and a USD 20 million

investment in Kenyan logistics startup Sendy. The global COVID-19 pandemic and resulting economic contraction was reflected in the 57% decline in Q2 2020's investment value relative to the same period in 2019, though the VC funding pace in Africa picked up again in the third and fourth quarters of 2020 to levels comparable to those in 2019 (WeeTracker, 2021).

2.1 Sectoral distribution

The financial services, utilities and consumer discretionary sectors have remained the most attractive to VC investors on the continent (see Figure 2). Between 2014 and 2020, over 80% of funding deals in terms of value were concentrated in 5 sectors: Financials, Consumer discretionary, Industrials, Utilities, and IT. Africa Internet Group (Jumia) essentially drove the consumer discretionary spike observed in 2016 with USD 326 million in funding from investors including Goldman Sachs and telecom company MTN to become Africa's first startup unicorn at a USD 1.08 billion valuation (Bright, 2016). Investors' confidence in the value proposition of e-commerce appears to have waned following Jumia's underwhelming financial performance and declining market capitalization. Jumia's stock traded at $3.3 per share in 2020, having plunged from the $43 per share level a year prior.[4]

Figure 2: Share of value of VC deals by sector and year



Source: AVCA data

[4] https://seekingalpha.com/article/4339136-jumia-long-game

In 2020, the VC funding landscape continued to be heavily skewed towards financial technology companies who retained 31% of total funding followed by clean technologies (e.g. solar energy) at 22% (Briter Bridges, 2020). Fintech investments are expected to continue dominating the African VC space given that approximately 66% of Africa's population remained unbanked as of 2017[5] and fintech services represent a viable alternative to traditional banking in both urban and rural areas. Indeed, the 2017 Global Findex report by the World Bank notes that the power of financial technology to expand access to and use of accounts has been demonstrated most persuasively in Sub-Saharan Africa (Global Findex Database, 2017 & World Bank, 2017). The report highlights that 21% of adults in the region had a mobile money account in 2017, which was nearly twice the share of mobile money accounts in 2014. As African firms (particularly SMEs) continue to struggle to access finance from the formal banking sector, VCs will increasingly be seen as an alternative source of funding that supports the development of innovative products by local startups.

Furthermore, VC investments in Africa could help in the transition to formality for many workers and businesses in the informal sector. In addition to the fintech startups, ventures that connect customers with workers for manual labor such as Lynk in Kenya and Sweepsouth in South Africa[6] as well as mobility companies like GoZem in Togo and Max.ng in Nigeria provide formal employment to workers previously in the informal sector. The United Nations Economic Commission for Africa estimates that the informal economy in sub-Saharan Africa makes up about 80% of employment and 55% of GDP (United Nations Economic Commission for Africa, 2015). There is therefore significant room for more VC funding in this space to further unlock the potential of African economies by gradually supporting the transition toward a more formalized economy.

2.2 Geographical distribution

The destination of VC funding on the African continent has been concentrated in four countries over the past years. Nigeria, Kenya, South Africa, and Egypt accounted for approximately 80% of

[5] https://www.itnewsafrica.com/2018/12/66-percent-of-sub-saharan-africans-are-listed-as-unbanked-world-bank/
[6] https://vc4a.com/blog/2020/02/10/african-venture-trends-to-watch-in-2020/

funded ventures between 2014 and 2019[7] and 77.3% of the funded ventures in 2020.[8] To put this in context, the four countries combined make up about 50% of total African GDP,[9] signaling a disproportionate share of VC funding destined to these countries. Similar trends are observed in terms of deal volume. South Africa attracted the most venture capital deals through the 2014-2020 period at 21% of total VC deals in Africa, followed by Kenya at 16%, Nigeria at 15% and Egypt at 12%.

Nevertheless, some of the other African countries are looking to increase their attractiveness to VC investors either by improving their enabling environments for VC financing or by providing incentives to investors directly, or a combination of both. Rwanda, for example, enacted the Investment Promotion Law in 2015 to promote and facilitate investments with an eye to attracting alternative financing for early-stage ventures. In addition, incentives such as a capital gains tax exemption for angel investors investing a maximum of USD 500,000 in primary equity issuances of startups were put in place by the Rwandan government. Consequently, Rwanda has seen a boost in VC funding as the country's startups raised an estimated USD 4 million in 2020, a 248% increase from the USD 1.15 million raised in 2019. [10]

Venture capital allocated to transition states remains negligible

Transition states tend to attract relatively less Foreign Direct Investment (FDI) compared to other African economies.[11] It is reported that only 6% of overall FDI to development countries goes to fragile countries, with 72% of that concentrated in resource-rich countries. [12] Indeed, the cost of setting up a business in fragile African countries is 3 times higher than in non-fragile African countries.[13] In terms of VC specifically, funding to transition states is also negligible ranging between 1%-2% of the total African value of VC deals annually during the period 2014-2019[14], in

[7] Source: African Private Equity and Venture Capital Association (AVCA). Data excludes the share of funding directed to startups with headquarters outside of Africa.
[8] Rwandan Tech Start-Ups Raised Over U.S.$4 Million in Financing in 2020 - allAfrica.com
[9] Source: World Development Indicators. The period considered was from 2014-2019 with constant share of GDP at approximately 50% each year.
[10] Rwandan Tech Start-Ups Raised Over U.S.$4 Million in Financing in 2020 - allAfrica.com
[11] Fragile States include the following 21 countries: Burundi, Central African Rep., Chad, Comoros, DRC, Eritrea, Gambia, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mozambique, Niger, Sierra Leone, Somalia, Sudan, South Sudan, Togo, Zimbabwe and Djibouti.
[12] https://ec.europa.eu/info/sites/info/files/external-investment-plan-factsheet_en.pdf
[13] https://ec.europa.eu/info/sites/info/files/external-investment-plan-factsheet_en.pdf
[14] AVCA database.

line with their share of GDP in Africa, estimated at 1% (International Monetary Fund, 2014). In fact, over the period, there were only four recipient countries in fragile context, namely DRC, Mozambique, Sierra Leone, and Zimbabwe.

There are several reasons for less funding in transition states, not least due to weaker institutions, political uncertainty, and tight ties between political and economic systems which tend to be unfavorable to investments. British International Investment (formerly the Commonwealth Development Corporation Group or the CDC) notes that investments in fragile and conflict-affected states tend to have more complex environmental, social, and business integrity issues than those in more stable or developed jurisdictions (CDC Investment Works, 2019). Furthermore, finding credible opportunities for investment even with local partnerships can be extremely difficult and in the event that investments are made, the difficulty of exiting often diminishes the appetite of investment funds/venture capitalists. As such, investing in transition states takes more time and engagement than in non-transition states with no clear evidence of it being more profitable.

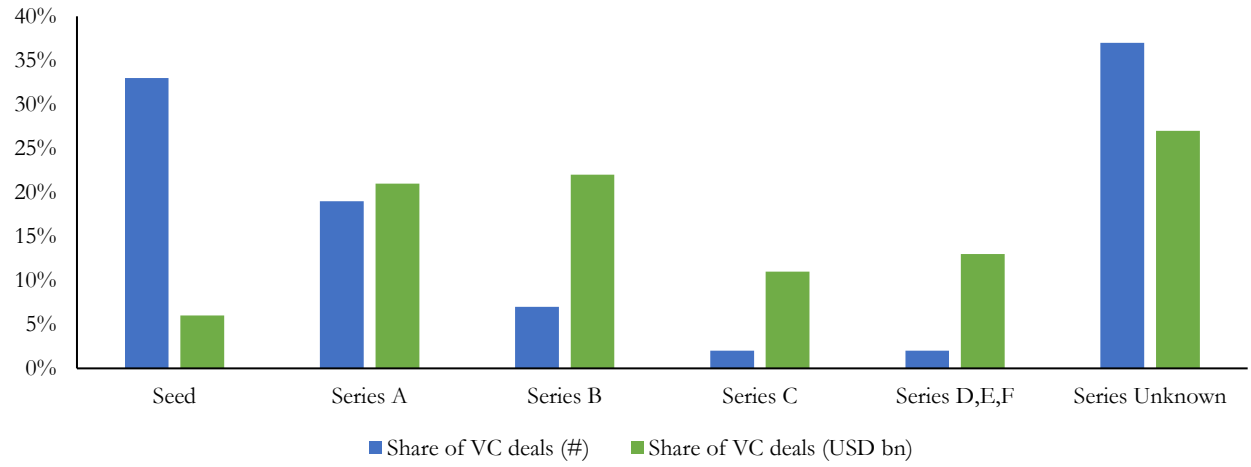
The outcomes of limited VC funding to transition states are not inconsequential. Failure to channel risk capital to fragile economies will ultimately mean that their entrepreneurial ecosystems will remain under-developed and consequently they will be left behind in the digitization race, unable to generate the jobs of the future necessary to absorb the youth bulge that enters the labor market every year. It is estimated that approximately 10 to 12 million youth enter the workforce each year in Africa (Mukasa & Salami, 2021). Intervention from catalysts, such as Development Finance Institutions, is particularly important in this context to move these countries from lower funding equilibrium to higher equilibrium ("pump priming" role) that could help boost local entrepreneurship

2.3 Funding stage distribution

For deals with known funding stages, VC financing appears to have occurred predominantly at the early stages (seed and series A) between 2014 and 2020 when the number of deals is considered versus in later stages for value of deals (Figure 3). The evolution of investments raised over time in the AVCA data suggests that investors are increasingly willing to take early bets in Africa. The share of seed and Series A rounds in terms of value increased on average by 20% from 2018 to

2019. The Briter Bridges report notes that ecosystem organizations such as syndicates, venture builders, and technology hubs that provide early-stage support by deploying financial and in-kind resources into companies across the continent are also contributing to the increased focus on early-stage ventures.

Figure 3: Share of VC funding by stage (2014-2020)



Source: AVCA data

It is noted that in 2020, however, the value of seed round deals fell by half relative to 2019 given the many uncertainties in the investor playfield (WeeTracker, 2021) while the number of seed round deals did not decline as steeply, suggesting that smaller value deals were the focus for investors as they adjusted to the ongoing effects of the COVID-19 pandemic in 2020. This is supported by the fact that the amount invested in growth stage deals (i.e., Series C and above) in 2020 was also slashed by two-thirds relative to 2019 (Partech, 2020). Large fundraising rounds seem to have been postponed in anticipation of better market conditions after the adverse effects of the COVID-19 crisis have subsided.

3. Literature Review

There is no shortage of empirical research on the determinants of venture capital activity. Previous studies have tested the impact of macroeconomic factors, depth of financial markets, the institutional environment, innovation, and entrepreneurship on venture capital investments. However, most of the work has been focused on Europe, North America, Asia, and Australia. This study aims at filling the gap for Africa using more recent data covering more countries on the

continent and focusing on digitalization. This section will summarize key findings from published papers for the groupings of determinants highlighted above. It will also provide an overview of the literature covering determinants of VC activity in emerging markets as well as in Africa more specifically.

3.1 Macroeconomic factors

Overall, the effects of key macroeconomic factors such as GDP growth, interest rate, and unemployment rate on venture capital investments in the literature are inconclusive, particularly with respect to GDP growth. Widely cited studies (Cherif & Gadzar, 2011; Félix et al., 2013; Gompers & Lerner, 1998) that looked at the effects of real GDP growth on venture capital found a positive and statistically significant relationship. The reason being that economic growth engenders a stimulus for entrepreneurship, business establishment and expansion, thereby creating demand for venture capital investments and favorable conditions for exit. Cherif and Gadzar (2011) study the determinants of venture capital investments across 21 European countries annually over 1997-2006 using fixed and random effects panel data estimation techniques. With respect to macroeconomic factors, they find that real GDP growth rate, market capitalization and long-term real interest rates have a positive impact on venture capital investment while the unemployment rate has a negative impact on early-stage investments with no impact on total funds raised. Similarly, Félix et al.'s (2013) paper, which examines the determinants of VC activity in 23 European countries annually for the period 1998-2003 using fixed and panel effects methods, conclude that real GDP growth and the level of real long-term interest rate are significantly and positively associated with venture capital whereas there is a negative relationship between venture capital supply and unemployment.

There are studies, however, that have found the relation between GDP growth and venture capital investment either negative or not statistically significant (Jeng & Wells, 2000; Wang, 2019). Jeng and Wells (2000) use annual data covering the period between 1986 and 1995 in a sample of 21 countries across North America, Europe, Asia, and Australia with a Pooled OLS approach to examine the determinants of venture capital (measured as the amount funded annually divided by average GDP). They find no significant impact of GDP growth on venture capital investing. Wang (2019) finds a negative and statistically significant effect of GDP growth in early-stage VC investments and total VC funded but no significant correlation with VC investments in

the late stage. He examines the determinants of VC investments after the 2008 global financial crisis in a set of 17 OECD countries over the years 2007-2017 using both fixed and random effects estimation techniques. The dependent variables in his reduced form regression model are total venture capital, early-stage venture capital and late-stage venture capital, which are normalized by the respective GDP value (for each year and each country). Wang (2019) credits the GDP growth results to the fact that recessions may bring about more opportunities for innovative investments.

3.2 Depth of financial markets

The size and depth of financial markets impact the venture capital process, thus affecting VC activity. Deeper financial markets (i.e., more liquid markets characterized by high trade volumes, which has been found to be a major determinant of stock market development in Africa (Andrianaivom & Yartey, 2010)) should attract more venture capitalists due to greater exit opportunities while providing other funding options for entrepreneurs. Similar to the case of GDP growth described above, the literature also provides mixed results with respect to the effect of the depth of financial markets on venture capital investments. A study by Schertler (2003) that uses a panel data set of 14 European countries with a GMM estimation approach to analyze the incentives of VC finds that the liquidity of stock markets (proxied by the stock market capitalization) has a significant positive impact on early-stage investments. On the other hand, Jeng and Wells (2000) find no statistically significant relationship between the value of early-stage investments and stock market liquidity (proxied by the market value of initial public offerings) but rather find that IPOs are a significant determinant of later stage venture capital investing across countries. Félix et al.'s (2013) paper shows that IPOs and M&As have a positive impact on venture capital while Cherif and Gadzar (2011) conclude that divestments by IPO, trade sale and write-offs have no significant effect on European venture capital investments.

3.3 Institutional quality

The impact of institutional factors such as legal systems, taxation, corruption, and other regulations on VC activity has been widely studied in the literature, although research on this dimension has been limited for the African region. Overall, most studies are consistent about the negative effect of taxes and corruption on venture capital investments (Bonini & Alkan, 2011; Gompers & Lerner, 1998; Johan & Najar, 2012; Porteba, 1989; Wang, 2019) and the positive relationship between

strong legal/institutional frameworks and VC funding (Allen & Song, 2002; Bottazzi et al., 2009; Herrera-Echeverri, 2017; Tykvová, 2018).

Jeng and Wells' (2000) study assesses the legal environment using the rule of law, anti-director rights, and one-share-one-vote variables as instruments to control for potential endogeneity issues between IPOs and venture capital activity. While none of the legal environment variables had a significant effect on venture capital investments, when a legal origin dummy that captures civil law versus common law countries is included, they find that German and Scandinavian countries' civil law systems are negatively associated with the amount of venture capital invested compared to common law systems. Similarly, Allen and Song (2002) investigate the relationship between venture capital and corporate governance (measured by creditor rights and the rule of law) in 16 Asian countries, 16 European countries and the US during the 1993 to 2000 period. They find that creditor rights are a positively significant determinant of the level of venture capital across countries while, surprisingly, the rule of law is negatively related to venture capital investments. They attribute this result to the fact that relationships may be more important than contracts in many countries. Tykvová (2018) explores the relationship between the success of 8,270 venture capital investments (as defined by those that exited) and legal frameworks in 41 investment countries across the world. Using a legal and regulatory framework index provided annually by the IMD World Competitiveness Yearbook—that captures a broad variety of different aspects of a country's legal framework—she finds a significant and positive relationship between legal framework quality and a successful exit with fixed effects as the main methodology and OLS as a robustness check. This finding is more pronounced for domestic deals than for international deals (i.e., deals where there is at least one international VC financing the investment). Her results also suggest that legal framework quality seems to be more important for success in syndicated than in standalone deals.

Bottazzi et al. (2009) use a principal-agent framework to model the bargaining relationship between an investor and a venture capital entrepreneur in a static setting where the principal has all the bargaining power. The theory recognizes that the success of a portfolio company is dependent on the investor and the entrepreneur and moral hazard may be an issue for both parties. Their study covers the period from 1998 to 2001 across 17 European countries and augments the double moral hazard, principal-agent model with a legal system component to determine the

influence of the legal environment on VC. They find that a better legal environment (i.e., better rule of law and common law systems) are positively related to more VC activity. Cumming et al. (2010) also find similar results using data from 1971 to 2003 across 39 countries in North America, Europe and Latin America with a fixed effects estimation method.

The relationship between taxes paid by companies and venture capital activity was investigated earlier on in the US by Gompers and Lerner (1998). Covering the period from 1969 through 1994 using Heckman two-stage models, they find that capital gains tax, defined as a tax on profit realized on the sale of non-inventory assets (such as real estate, property, bonds) affects VC negatively which is consistent with Porteba's (1989) paper. Porteba sought to explain the links between capital gains taxation and the amount of venture capital activity in the US in the 1980s. He argues that individual capital gains tax mostly impacts the incentives of entrepreneurs who forgo wage and salary income to accept compensation through corporate stock and related gain-producing instruments. Wang (2019) asserts that the corporate profit tax, which includes taxes of both income and capital gains, negatively influences total VC investments as well as late-stage investments but are not significant in early-stage VC investments. He attributes this to the fact that VC-backed firms in the early stages are not yet generating profits making the influence of corporate profit taxes unimportant while in the later-stages profits are generated and lower taxes could present more of an incentive for VC activity.

3.4 Innovation and entrepreneurship

Innovation and entrepreneurship in the VC literature are typically described as being deeply rooted in the quality and level of education acquired. The VC literature tends to capture innovation using variables such as total factor productivity, patent counts, and growth in R&D expenditure while entrepreneurship is typically captured by the levels/stock of entrepreneurs and tertiary education variables in specified sectors. Furthermore, the availability of mentors, technological opportunities, and favorable institutional frameworks are seen to positively impact VC activity.

Earlier research by Timmons and Bygrave (1986) indicates the importance of innovation to the flow of VC (defined as whether there was VC investment activity in a firm) but places higher emphasis on the explanatory variables of mentorship, strategic guidance, markets, and networks provided by venture capitalists. Often budding entrepreneurs possess promising ideas which need

further strategic development. Another study of 16 OECD countries that assesses the economic impact of VC investments via innovation and entrepreneurship between 1990 and 2001 is by Romain and La Potterie (2004). Using GLS estimation techniques, they find that technological opportunities, growth in R&D expenditure and the stock of knowledge positively influence a country's VC investments. They assert that an increased VC stock makes it easier to absorb the knowledge generated by universities and firms, improving aggregate economic performance. Herrera-Echeverri (2017) contends that public expenditure on R&D has a positive effect on VC investments in a study that covers 40 countries between 1998 and 2012 using the fixed effects method. He finds this to be especially true in countries with higher institutional quality and higher level of articles published by the scientific community.

Félix et al. (2013) evaluate the direct impact of the level of entrepreneurial activity on venture capital investments using an entrepreneurial activity index from the Global Entrepreneurship Monitor. Contrary to expectations, their results show that the entrepreneurial activity index has a negative and statistically significant influence on venture capital activity. They attribute this to a number of factors including measurement problems in the index used, the fact that low-growth entrepreneurial activities may explain most of the variation in the index which is less likely to attract VC, and the possibility that more entrepreneurial activity increases the amount of time venture capitalists spend on selecting projects with less time for management and monitoring activities.

Higher education levels are also likely to positively impact VC investments through a more productive stock of entrepreneurs with innovative ideas and greater need for capital to create and support their businesses. Wang (2019) introduces the population with tertiary education as an indicator of technological opportunities in his study and finds a significantly positive impact on venture capital investments.

3.5 Emerging Markets

The role of VCs in emerging markets where formal (regulations and markets) institutions may be lacking has been less evaluated than in mature markets due to limited data availability. The Asian markets that have developed VC activity (e.g., Singapore, Hong Kong, and Taiwan) can attribute their success to a number of factors. Essentially, these include government grants, incubators,

accelerators, a growing number of angel investors, and the presence of funds for early investments both locally and in the region. Indeed, Allen and Song (2002) find more investment in early-stage projects in Asia relative to Europe, where investments tended to be in late-stage projects.

Regarding the characteristics of emerging markets, Ahlstrom and Bruton (2006) who carried out semi-structured interviews with 65 venture capitalists in East Asian emerging economies find that VCs generally use networks to substitute for formal institutions such as the rule of law or enforcement regimes that are not yet well established in emerging markets. Hain et al. (2016) examine international VC investment flows from 2000-2012 in 22 developed and 15 emerging economies using the random effects estimation method. They also find that the driving forces of cross-border VC investment activities in emerging economies are widely unexplained by traditional mechanisms used to analyze VC flows in developed economies. They highlight that the formation of foreign-domestic syndicates is a necessary precondition for foreign VC inflows.

3.6 VC Activity Research in Africa

Research on VC activity in Africa so far has been comparatively limited and where available, focuses on specific countries or sectors. VC is considered a source of non-bank financing that has worked in developed markets for small and medium sized firms with difficulty accessing finance from traditional financial institutions and can be beneficial in African markets. The findings from the literature on VC in Africa remains consistent with expectations. Stronger institutions with business friendly legal and regulatory environments tend to positively impact the number of venture capital investments in Africa (Adongo, 2011; Adongo, 2012; Afful- Dadzie E & A, 2016; Oni, 2017). The growth of SMEs and the quality of their management has also been found to have a positive effect on VC in Africa (Van Deventer & Mlambo, 2009; Memba, Gakure & Karanja, 2012; Jilltoft & Westman, 2017).

Adongo (2011) empirically assesses factors that influence VC activity across 36 African countries in 2007. The main hypothesis of his paper is that macroeconomic, financial and regulatory factors help explain differences in VC activity in Africa. He measures VC by the number of investees funded in 2007 by venture capital firms following Gompers and Lerner (1998) and Kortum and Lerner (2000). The argument for using quantity of investments is that supply curves for venture capital tend to be fairly elastic such that changes in equilibrium should have a

bigger effect on quantity than on price. Furthermore, the price of VC investments, i.e., the anticipated rate of return in the VC market could not be measured. His primary source was the African Venture Capital Association (AVCA) that was complemented with data from several other sources such as the Venture Capital Funds Index 2005, the KPMG-South African Venture Capital Association (SAVCA) survey, and three infoDev publications.

Adongo (2011) uses a cross-sectional approach and OLS estimation to test his empirical model. Rule of law is used as a proxy for the institutional environment underlying IPOs, efficiency of financial markets and levels of uncertainty and is found to have a positive and significant impact on VC levels in Africa. R&D expenditure as a percentage of GDP as well as better information and transparency between investors and potential investees are also positively and significantly related to venture capital activity in Africa. Additionally, the capital gains tax rate is negatively and significantly related to VC activity which conforms to earlier findings such as by Porteba (1989) that capital gains tax rates affect the demand for VC by potential investees.

Adongo (2012) assesses the impact of the legal environment on VC between 2004 and 2010 using a microlevel sample of 396 investors in 3,367 VC or private equity funded firms across 50 African countries and a fixed effects estimation technique. His results indicate that a better legal environment increases market entry by investors and entrepreneurs. Seed, start-up or early-stage VC increases with better rule of law but expansion stage VC decreases. Additionally, VC increases where strength of property rights is weaker. These findings suggest that VC substitutes for debt financing from other sources such as banks in weaker legal environments.

Oni (2017) examines whether six determinants (IPO, market capitalization, unemployment rate, FDI, inflation rate, and trade openness) have significant explanatory influence on venture capital supply in eight sub-Saharan African countries over the period 2006 to 2015[15]. Using the random effects estimation technique, Oni finds that IPO and market capitalization have a positive and significant relationship with venture capital supply. However, the other factors do not appear to have any significant relationship with venture capital supply in the eight African countries considered.

[15] The African countries are Botswana, Ivory Coast, Ghana, Kenya, Mauritius, Nigeria, South Africa, and Uganda.

On single country/region analysis, Van Deventer and Mlambo (2009) explore and identify the criteria used by South African venture capitalists in their screening process. Using a Likert scale type of questionnaire, the venture capitalists were asked to rate the investment criteria identified in smaller studies abroad and report any additional criteria of their own. The results showed that they consider the entrepreneur's honesty and integrity, good market acceptance and high internal rate of return as the three most important factors when considering a venture. Just like overseas counterparts, management is considered vital in the decision making of new investment opportunities to maximize their success rate.

Memba, Gakure and Karanja (2012) explore the lack of firm growth due to inadequate finance in Kenya which stifles startups and other SMEs. From a random sample of 100 firms to whom semi-structured questionnaires were administered, their results showed a positive co-relation between VC and growth of SMEs. There was growth in sales, profits, assets and improvement in management of finance and other resources. The social impact of VC included employment opportunities which improved livelihoods and alleviated poverty among employees.

Jilltoft and Westman (2017) look at Kenya as a case study for VC in emerging markets. Their empirical findings show that the equity gap in Kenya hampers early-stage VC and is derived from a lack of experience and knowledge from investors and entrepreneurs. They recommend a more hands-on approach to the investment strategy of VCs, a more global mindset by entrepreneurs, an increase in the catalytic effect of DFIs in early-stage rounds, and a focus on enhancing entrepreneurial education by government entities.

In a comparative study, Afful-Dadzie E and A (2016) assess why most government funded VC fails in comparison to private VC in South Africa. Lack of transparency and unfairness in the selection process are cited as top reasons for this. They also note that government venture capital (GVC) schemes typically do not explicitly model uncertainties and usually do not have models that consider qualitative factors such as leadership experiences and product qualities in the selection process. They propose a model with a set of criteria relevant to early stage but high potential start-ups in GVC and analyze it using the TOPSIS[16] method in an intuitionistic fuzzy

[16]The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method that is based on the concept that the chosen alternative should have the shortest geometric distance from the

environment. This method appears beneficial in assessing fairness and transparency in the selection of start-up businesses for fund support in a government run venture capital scheme. They contend that their proposed model by design limits political influences in the selection process but acknowledge that the set of criteria proposed may not be exhaustive for the adequate selection of technology startups in a GVC program.

Overall, the empirical VC in Africa literature has focused mainly on micro level/ deal level and cross-sectional analyses. This is most likely due to data limitations. While the data for VC in Africa is still sparse, this paper attempts to conduct a macro-level study using novel, panel data collected by the AVCA starting from 2014. It seeks to capture the recent spike in VC financing experienced on the continent with a view towards identifying the key determinants of this trend.

4. Method and Data

4.1 Method

The decision to invest in one country is a selective process that is informed by observed and unobserved differences in country and firm level characteristics. Based on previous studies (Jeng & Wells, 2000; Groh & Wallmeroth, 2016) we choose to estimate the reduced form equation, where the number of venture capital investment deals is regressed against a set of observable factors which are believed to affect venture capital activity. The reduced form equation to be estimated is the following:

$$y_{it} = \alpha_t + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + c_i + v_{it}$$

$$= \alpha_t + X_{it}\beta + c_i + v_{it}, \;\; t = 1, \dots, T$$

y_{it} , dependent variable, is the number of venture capital investments variable of country i at time t. X_{it} is a $1 \times K$ vector of explanatory variables including macroeconomic fundamentals, size of the market, digital infrastructure and regulatory and institutional environment; it contains both time-variant and time-invariant variables. c_i is a random variable, which may or may not be correlated with X_{it}. It captures all unobserved time constant factors that affect y_{it}. c_i may include

positive ideal solution (PIS) and the longest geometric distance from the negative ideal solution (NIS). The NIS maximizes the cost criteria and minimizes the benefit criteria, whiles PIS maximizes benefit criteria and minimizes cost criteria. The alternatives are ranked and selected according to their relative closeness determined using the two distance measures.

cultural and institutional factors which influence venture capital investments and differ across countries but are quite stable over time. α_t is the time period intercepts, which, for short panels, can be treated as parameters that can be estimated while v_{it} are the idiosyncratic errors.

We estimate the reduced form coefficients of the above equation using the random effects estimation method with pooled ordinary least squares as a benchmark. With the random effects approach, we assume that c_i is not correlated with the predictors, and this allows for time invariant variables to play a role as explanatory variables. The targeted digital infrastructure, innovation, institutional quality, and government effectiveness variables tend to be quite slow changing over time, making the fixed effects estimation less suitable for our analysis. In order to confirm that the random effects method is the more adequate approach relative to the fixed effects method, we tested if the unobserved time-invariant factors are correlated with the explanatory variables using the Hausman (1978)'s test. The results of the Hausman test as subsequently presented in Table 5 show a non-rejection of the random effects estimation in all specifications as the preferred alternative, consistent and more efficient. In most studies that have looked at the drivers of venture capital investment, random effect estimation has proved to be the preferred estimation approach between the two (Oni, 2017; Groh & Wallmeroth, 2016; Félix et al., 2013)

4.2 Variables and Data

The study uses annual data of venture capital investments from 25 African countries[17] spanning the period 2014 to 2019[18]. The venture capital investments data were provided by the African Private Equity and Venture Capital Association (AVCA). Venture capital investments data cover all disclosure investments (early stages or expansion) made by venture capital firms across all sectors in Africa. These investments are announced publicly or at least on professional platforms. In this study, the dependent variable, which is venture capital investments, is measured in terms of the number of venture capital investment deals made in country i and in year t as recorded by AVCA. It is recognized that macroeconomic factors and business climate may have effects with differing intensity depending on the stage of the innovative enterprises' lifecycle at which venture

[17] Algeria, Benin, Botswana, Cameroon, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe.

[18] Although deals data were available for the period of 2014-2020, the corresponding independent variables data for year 2020 were not available. That is why the period of assessment is limited to 2014-2019.

capital is allocated (i.e., early stages or expansion). However, given the limited size of venture capital in most African countries, especially in the early stages, we sought to identify factors affecting the aggregate number of venture capital investments irrespective of stage.

4.2.1. Variable description

Explanatory variables included in the analysis are derived from the World Bank Development Indicators, World Governance Indicators, World Bank Ease of Doing Business, International Monetary Fund World Economic Outlook, International Telecommunication Union. The explanatory variables included in the estimation are:

a. Macroeconomic fundamentals

GDP growth and the inflation rate are included in this study to capture macroeconomic fundamentals effects on venture capital investment.

GDP growth

As mentioned in the literature section, the general health of the economy affects venture capital investments. When the economy is growing rapidly, there may be more attractive opportunities for entrepreneurs to start new businesses or expand existing businesses thus increasing the demand for venture capital investments. Growth in gross domestic product (GDP) is therefore a good driver of venture capital investment. Following the theoretical and empirical evidence of the positive relationship between GDP growth and venture capital investments, we anticipate that our study will also find a positive relationship between these variables.

Inflation

The inflation rate is another macroeconomic factor included in the analysis as a measure of macroeconomic stability. Higher inflation deters venture capital investment by undermining the value of investments and their return in real terms, chipping away at investors' purchasing power and its growth (Bonini & Alkan, 2011). We anticipate that higher inflation rates reduce venture capitalists' incentive to invest in deals due to a less stable macroeconomic environment.

b. Market size and access

An important element of venture capital investment decision making is the market size/return. The study includes a number of proxy variables to capture the magnitude of the demand for the goods and services produced by businesses raising venture capital. A bigger market means higher revenues generated by investees and thus higher business valuations. We use the size of the population, export growth as proxies for market size and market access, respectively. It is expected that these variables will positively affect venture capital investments.

c. Digital infrastructure

Digital infrastructure, measured here by the share of internet users in the population and international bandwidth usage, is critical for venture capital investments, as improved digital infrastructure of a country means a reduction in the costs of communication and of internet access, reliability enhancements, and increased coverage, which translates into wider and more effective delivery of services (including to more remote areas) by investees. We anticipate digital infrastructure to be positively associated with venture capital investments.

d. Innovation

Venture capitalists mostly target innovative companies with high growth prospects. Innovative venture firms are more likely to be venture capital funded (Engel & Keilbach, 2007) and countries with higher levels of innovation attract more venture capital investment. This study employs high-technology exports as a proxy for innovation intensity. High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Different authors have proved, in theoretical as well as empirical approaches, the relation between some indicators of innovation performance, including level of public and private R&D expenditure, and high-tech exports (Sandua & Ciocanel, 2014). Therefore, due to the lack of data availability on public and private R&D expenditure in Africa, this study uses high-technology exports.

The changes in high-technology exports in a given country could as well be explained by changes in venture capital investment in the sector, therefore, it is possible that high-technology exports variable is an endogenous variable with venture capital investment. However, in our

setting, it is less likely the case looking at the construction of the high-technology exports variable, which covers exports of well-established industries with high expenditures on R&D producing goods such as aircraft, computers, and pharmaceuticals (refer to the World Bank database), rather than startups in early or growth phase targeted by VC firms amidst the surge of VC funding of recent years in Africa. Still, we included further analysis with an instrumental variable for high-technology exports to address this potential issue. We use high-technology exports one year lagged as an instrumental variable for high-technology exports.

e. Institutional quality

Institutional quality plays an important role in attracting investors, and venture capital more specifically. Given the benefits of venture capital in terms of entrepreneurship growth, innovation and technological progress, and subsequently economic growth (Gompers & Lerner, 1998), favorable institutions and regulatory frameworks are crucial in order to attract venture capital and reap its broader benefits on the economy. A vast body of studies has been carried out to investigate the institutional drivers of venture capital investments, and how they may better explain the differences in the development and performance of the venture capital industry across different jurisdictions. These studies included institutional factors such as tax rates, labor market rigidities, legal rights, corruption, intellectual property protection, government effectiveness and minority investors protection. In the same vein, we included the following institutional variables:

Corporate tax

Tax is an important factor of venture capital investments. An increase in the amount of taxes to be paid on income contributes to lower the net rate of return for investors, bearing the same investment risk, thereby likely to discourage their investments. According to the World Bank Enterprise Survey data in 2018, firms in Africa report tax rates to be one of the most severe constraints to their growth. Complex and excessive taxation deters foreign investors, drives out domestic investors, curbs entrepreneurship, and results in deadweight losses due to tax compliance and tax avoidance costs. Conversely, favorable taxation stimulates entrepreneurship and early start-up businesses, thus attracting greater venture capital investments. The rate of corporate tax influences both venture capital supply and demand (Poterbba, 1989). For example, the decrease in corporate income taxes is favorable to the creation of new businesses and R&D activities, with a

potential impact on the increase in demand for risk capital. The supply of venture capital is also positively affected by a lower corporate income tax as it reduces the investors' required rate of return to investment. In line with previous findings in the literature, we expect a negative impact of excessive corporate tax rates on venture capital investments.

Labor market rigidities

Labor market rigidities present another obstacle to venture capital growth. More stringent labor laws are likely to make hiring employees more difficult for enterprises, as they deprive enterprises of the flexibility to dismiss employees, should the need arise. Further, large benefit payments, which typically accompany more rigid labor markets, make it more expensive to hire in the first place. Following Wang (2019), the study employs the labor tax and the contribution rate as a proxy for labor market rigidities. The labor tax and contribution are the amounts of taxes and mandatory contributions on labor paid by the business. It is expected that highly rigid labor market may negatively affect venture capital investments (Félix et al., 2013; Jeng & Wells, 2000)[19]. Another aspect of labor markets which is considered in the literature is unemployment (Groh & Wallmeroth, 2016; Félix et al., 2013). However, the unemployment rate is poorly measured in the countries included in this study. Hence, only the labor tax and contribution will be considered, and we anticipate a negative correlation between labor tax and contribution and venture capital investments.

Investor protection

A measure of corporate governance, the minority investor protection variable reflects the strength of minority shareholder protections against the misuse of corporate assets by managers for their personal gain as well as shareholder rights, governance safeguards and corporate transparency requirements that reduce the risk of abuse. The risks minority investors face in privately held companies can be complex and considerable. A dishonest majority investor has substantial opportunities to shape company decisions for personal gain and to the detriment of minority shareholders. Venture capital investments are attracted by environments where regulations and contract law do not prevent investors from having exclusive control rights (such as board and

[19] These studies do not include the M&A market as a determinant of venture capital activity as such variables are not available.

voting rights) in the enterprises they have chosen to finance (Schertler, 2003). The protection of investors is intended to prevent opportunistic behavior by the entrepreneurs following the investment, and by that induce the supply of venture capital (Cumming et al., 2016). We anticipate a positive relation between minority investor protection and venture capital investments.

Government effectiveness

Government effectiveness is another institutional variable included in our analysis. It captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (Kaufmann et al., 2010). Greater government effectiveness provides impetus to businesses to kick-off, evolve and expand therefore increasing the demand for venture capital investment. It also alleviates policy uncertainty and political risk, which are deterrents to investment. We anticipate finding a positive relationship between government effectiveness and venture capital investment as in Cherif and Gazdar (2009).

Further details concerning the definition and origin of the data are provided in Table 1. A full table listing each country along with the average value of each variable for the period 2014-2019 is provided in Table 2. Other variables that could have been included in this study but were not due to unavailability of data include growth in R&D expenditure, entrepreneurial activity index, levels/stock of entrepreneurs, tertiary education, total factor productivity, market capitalization

Table 1: Description and sources of variables

Variable	Dimension	Descriptions	Sources
Venture Capital Deals	[#]	Number of venture capital investment deals made in the countries of our sample over the period 2014-2019.	AVCA
GDP Growth	[%]	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank World Development Indicators
Inflation Rate	[%]	Inflation measures how much more expensive a set of goods and services has become over a certain period, usually a year. Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	International Monetary Fund World Economic Outlook.

Labor Tax & Contribution	[%]	Labor tax and contributions is the amount of taxes and mandatory contributions on labor paid by the business.	World Bank World Development Indicators
Corporate Tax	[%]	Corporation Tax is a tax charged on taxable income (Profits) of entities such as limited companies, institutions or organizations, etc. Taxable incomes (profits) for charging Corporation Tax include Profits from business undertakings Profits from conducting investments (except such dividends which are taxed differently as final taxes) Tax paid out of turnover of companies with perpetual unrelieved losses for three consecutive years.	KPMG and Country's tax authority.
Population	[#]	Annual population growth rate. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.	World Bank World Development Indicators
Export growth	[%]	Annual growth rate of exports of goods and services based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.	World Bank World Development Indicators
International Bandwidth	[#]	which refers to the maximum quantity of data transmission (rate) from a country to the rest of the world	International Telecommunication Union, World Telecommunication/ICT Development Report and database, and TeleGeography.
Internet Coverage		share of the population who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.	World Bank World Development Indicators
High-technology exports (current USD)	[#]	High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Weighted average. Because industrial sectors specializing in a few high-technology products may also produce low-technology products, the product approach is more appropriate for international trade.	World Bank World Development Indicators
Minority Investors Protection	[#]	Minority Investors Protection measures the strength of minority shareholder protections against misuse of corporate assets by directors for their personal gain as well as shareholder rights, governance safeguards and corporate transparency requirements that reduce the risk of abuse. It has three components: The extent of disclosure, the extend of director liability and easy of shareholder suits. The data come from a questionnaire administered to corporate and securities lawyers and are based on securities regulations, company laws, civil procedure codes and court rules of evidence. The ranking of economies on the strength of minority investor protec-tions is determined by sorting their scores for protecting minority investors. These scores are the sum of the extent of conflict-of-interest regulation index and the extent of shareholder governance index.	World Bank Doing Business
Government Effectiveness avg. percentile rank	[#]	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the Worldwide Governance Indicators (WGI).	World Bank Worldwide Governance Indicators (WGI)

4.2.2. Data description

The variables selected for the analysis are summarized in Table 3, with their correlation table provided in Table 4. The dependent variable is the number of venture capital investment deals y_{it} made in a given country in a given year. The choice of explanatory variables presented in Table 3 is in line with Jeng and Wells (2000), Groh and Wallmeroth (2016) and various other studies discussed in the literature review section[20].

Table 3 provides the summary statistics for the 11 independent variables as well as the dependent variable. All the variables in the sample have 150 observations, except for the high-technology exports variable, for which observations are limited to 141. Some of the key interesting variables that could have been included in our analysis have a significant number of missing data points, and because of the already limited observations of our sample we chose not to include them.

Table 4 presents the correlation matrix of observations over the period 2014-2019, for the variables used in the regression analysis shown in Table 5. The correlation matrix shows the pairwise unconditional relationship between the independent variables. The correlation coefficients are less than 0.5, suggesting no serious issues of multicollinearity.

[20] Note that there are a number of other interesting variables, especially those related to entrepreneurship, innovation and market capitalization, that are said to attract venture capital investment but were not included in this study due to data unavailability.

Table 2: Descriptive statistics of the independent variables for each country

	Period	VC Deals	GDP Growth	Inflation Rate	Labor Tax & Contribution	Corporate Tax	Population (million)	Export Growth	Bandwidth (,000 Mbit/s)	Internet Coverage	High-tech Export	Investor Protection	Government Effectiveness
Algeria	2014-2019	0.23	2.3	4.3	31	25	41	-1.4	486.2	46	5.1	20	35
Benin	2014-2019	0.17	5.1	0.003	26	30	11	6.5	33.7	15	2.1	41	32
Botswana	2014-2019	0.16	2.9	3.3	0	22	2.2	-4.5	12.7	42	33	60	69
Cameroon	2014-2019	0.55	4.6	1.6	18	34	24	2.8	13.9	22	21	27	21
Cote d'Ivoire	2014-2019	0.23	7.5	0.72	23	25	24	5.4	52.9	38	153	41	27
DRC	2014-2019	0.23	5.5	12	13	35	80	8	7.7	6.5	.	21	4.9
Egypt	2014-2019	9.3	4.4	15	26	23	95	15	769.4	44	140	51	28
Ethiopia	2014-2019	0.7	9.1	11	12	30	105	3.4	25.6	15	14	10	30
Ghana	2014-2019	3.5	4.9	13	15	25	29	7	186.1	34	59	60	46
Kenya	2014-2019	18	5.6	6.3	1.9	30	50	1.2	2754.2	18	81	62	41
Lesotho	2014-2019	0.17	1.3	4.9	0	25	2.1	2.9	3.0	27	0.92	32	22
Mauritius	2014-2019	0.53	3.6	2.1	7.7	15	1.3	0.39	48.4	54	14	72	79
Morocco	2014-2019	2.1	3	0.98	23	31	35	7.2	942.0	62	743	59	48
Mozambique	2014-2019	0.52	4.6	8	4.5	32	28	8.7	36.0	12	29	32	20
Namibia	2014-2019	0.17	1.6	4.9	1.8	32	2.4	2.4	10.0	37	25	56	59
Nigeria	2014-2019	15	2	12	13	30	189	9.7	192.5	35	136	70	14
Rwanda	2014-2019	0.91	7.2	3.1	5.8	30	12	17	21.4	19	5.8	40	59
Senegal	2014-2019	0.87	6.4	0.6	24	30	15	7.5	28.4	35	20	43	42
Sierra Leone	2014-2019	0.16	0.53	12	11	30	7.4	21	12.3	8.5	0.077	40	11
South Africa	2014-2019	21	0.97	5.2	4	28	57	1	377.9	54	2360	80	66
Tanzania	2014-2019	2.2	6.3	4.9	17	30	54	-0.39	12.0	19	52	50	27
Tunisia	2014-2019	0.89	1.8	5.3	25	25	11	6.7	250.2	56	852	57	48
Uganda	2014-2019	1.2	5.3	4.2	11	30	40	8.1	56.8	21	12	56	32
Zambia	2014-2019	1.1	3.4	9.9	10	35	17	17	25.1	20	69	56	30
Zimbabwe	2014-2019	0.59	1.1	44	5.5	25	14	3.3	51.5	24	14	53	11

Source: Authors' calculation based on a constructed dataset of indicators described in Table 1

Table 3: Summary Statistics of dependent and independent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
VC Deals	150	3.2	6.2	0	26
GDP Growth	150	4	3.4	-21	10
Inflation Rate	150	7.6	21	-2.4	255
Labor Tax & Contribution	150	13	9.2	0	31
Corporate Tax	150	28	4.5	15	39
Population (million)	150	38	42	1.3	201
Export Growth	150	6.2	18	-55	109
Bandwidth (,000 Mbit/s)	150	256.4	743.5	0.8	6719.50
Internet Coverage	150	31	17	3	74
High Tech Exports (USD million)	141	200	551	0.00055	2818
Investor Protection	150	48	17	10	90
Government Effectiveness	150	36	19	2.9	82

Source: Authors' calculation based on a constructed dataset of indicators described in Table 1.

Table 4: Correlation Matrix (Years 2014-2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) GDP Growth	1.0										
(2) Inflation Rate	-0.3	1.0									
(3) Labor Tax & Contribution	0.2	-0.1	1.0								
(4) Corporate Tax	0.1	-0.0	-0.0	1.0							
(5) Population (million)	0.1	0.1	0.1	0.1	1.0						
(6) Export Growth	0.3	-0.2	0.1	0.1	0.0	1.0					
(7) Bandwidth (,000 Mbit/s)	0.0	-0.0	-0.0	0.0	0.2	-0.0	1.0				
(8) Internet Coverage	-0.2	-0.0	0.2	-0.5	0.0	-0.1	0.1	1.0			
(9) High Tech Exports (USD million)	-0.2	-0.0	-0.0	-0.0	0.1	-0.1	0.1	0.5	1.0		
(10) Investor Protection	-0.3	0.0	-0.3	-0.3	0.1	-0.0	0.3	0.5	0.5	1.0	
(11) Government Effectiveness	0.0	-0.2	-0.3	-0.4	-0.4	-0.1	0.0	0.5	0.3	0.4	1.0

Source: Authors' calculation based on a constructed dataset of indicators described in Table 1.

5. Results and Discussion

In this section we illustrate the estimations and testing techniques used and discuss our main results. The functional specification accounts for non-linearities observed in the data by including the square of the corporate tax variable, and an interaction term between internet coverage and population size. Regressions are estimated using random effects estimation with pooled ordinary least squares (pols) as a benchmark. Since most of the variables are defined as percentages or ratios, interpretations of the estimated coefficients are the change in the number of venture capital investment deals as a result of a unit change in the explanatory variable. Table 5 presents results

from ordinary least squares, random effects estimations, as well as two-stage least-squares (2SLS) instrumental variables and random effect instrumental variables estimations, given the instrumentalization of the high-tech exports variable. The test of endogeneity showed that the inclusion of the instrumental variable, high-tech exports lagged by one year, corrects the aforementioned endogeneity problem induced by the high-tech exports' variable. The random effect instrumental variable (REIV) estimation is therefore presented in this study as the estimation technique which generates the most efficient and consistent estimates as opposed to the other estimation approaches considered. Hence, the interpretation of our main results will be drawn from the REIV estimations, although POLS, RE, and 2SLS results are also presented as a benchmark to observe stability of results across estimation techniques.

Some general conclusions can immediately be drawn. First, all estimated models present strong overall significance. The F and Wald tests for joint significance of all covariates allow us to clearly reject the null hypothesis that all coefficients are equal to zero. In the first two columns of Table 5, we present estimates of the pooled OLS and random effects. In the last two columns we present estimates of 2SLS and REIV where the high-tech exports variable is instrumentalized using the one-period lag of the high-tech exports' variable. Focusing on REIV going forward, macroeconomic variables GDP growth variable and inflation are shown not to be statistically significant.

The size of the market, which is measured by the size of the population and access to market measured by the growth in exports, show a positive relationship with venture capital investments. While the size of the population in isolation is not statistically significant, its overall effect is (as it includes the interaction term with internet coverage, statistically significant at a 5% level), suggesting that the effect of the population size on VC investments is a function of internet coverage: the higher the share of users, the higher the marginal effect of the population on VC investments (the joint test of population and its interaction with internet coverage is statistically significant at a 1% level). Intuitively, venture capitalists care not only about the size of the population but in conjunction they value broader internet access, which allows their investees to deliver their online services more widely. The export growth variable, although positive, is not statistically significant.

Table 5: Determinants of venture capital investments

	POLS	RE	2SLS	REIV
GDP Growth	-0.0258	-0.0628	-0.0376	-0.0762
	(0.0546)	(0.0476)	(0.0497)	(0.0494)
Inflation ate	-0.0058	-0.0044	-0.0072**	-0.0062
	(0.0041)	(0.0041)	(0.0034)	(0.0045)
Labor Tax & Contribution	-0.0755***	-0.0949	-0.0562***	-0.0743
	(0.0239)	(0.0667)	(0.02)	(0.0467)
Corporate Tax Rate	0.0537	0.7072	-0.1799	0.2838
	(0.3731)	(0.6638)	(0.3164)	(0.4895)
Corporate Tax Squared	-0.0034	-0.0128	0.0005	-0.0062
	(0.0069)	(0.0123)	(0.0058)	(0.0095)
Population (million)	-0.0037	0.0171	-0.0079	0.0125
	(0.0169)	(0.0263)	(0.0162)	(0.0261)
Export Growth	0.0082	0.0165*	0.006	0.0138
	(0.0106)	(0.0089)	(0.0106)	(0.0109)
Bandwidth (,000 Mbit/s)	0.0025***	0.001**	0.0024***	0.0016***
	(0.0005)	(0.0004)	(0.0004)	(0.0004)
Internet Coverage	-.1784***	-.1025**	-.1878***	-.129***
	(0.0343)	(0.0398)	(0.0354)	(0.0496)
Internet Coverage * Pop.	0.0025***	0.0022**	0.0026***	0.0022**
	(0.0006)	(0.001)	(0.0006)	(0.001)
Investor Protection	0.0675***	0.0791***	0.066***	0.0706***
	(0.0171)	(0.0302)	(0.0159)	(0.0246)
Government Effectiveness	0.0549***	0.0837**	0.0487***	0.0703**
	(0.0149)	(0.0407)	(0.0125)	(0.0327)
High-Tech Export (USD million)	0.0049***	0.0021***	0.0055***	0.0038***
	(0.0011)	(0.0007)	(0.001)	(0.0008)
Time variables	Yes	Yes	Yes	Yes
Constant	0.1325	-12.9145	3.8354	-5.5464
	(5.889)	(9.5697)	(5.1533)	(6.9321)
Observations	141	141	136	136
H-Test		2.89		13.65
[P Value]		0.992		0.324
R-squared	0.8064	0.747	0.835	0.818

Figures in parentheses are standard errors. ***, **, * denote estimated parameter is significantly different from zero at the 1%, 5% and 10% test levels, respectively.
Source: Authors' calculation based on a constructed dataset of indicators described in Table 1.

Digital infrastructure—here measured by the two indicators international bandwidth and internet coverage—is shown to be positive and statistically significant. International bandwidth, which refers to the maximum quantity of data transmission (rate) from a country to the rest of the world, is positive and statistically significant at a 1% level. The interpretation of the overall effect of the internet coverage variable (the share of internet users), which is statistically significant, includes the interaction term with the size of the population, reflecting the fact that its magnitude is

higher the larger the size of the domestic market[1]. In other words, even when internet coverage is higher, its effect on attracting VC funding would be much smaller if the domestic market size is small. These findings show that digital infrastructure is critical for venture capital investments, as improved digital infrastructure of a country means a reduction in the cost of communication and of internet access, reliability enhancements, and increased coverage, which translates into wider and more effective delivery of services (including to more remote areas) by investees. The evidence in this paper on the important role of digital infrastructure in attracting VC investments is also supported by the empirical analyses of the effect of internet and ICT on investments more broadly. For example, Asongu and Odhiambo (2020), using data from 25 countries in Sub-Saharan Africa, find that ICT modulates foreign direct investment to induce overall positive net effects on economic growth dynamics. Also, Choi (2003) shows that internet access, through a reduction in transaction costs, induces more investment by improving productivity.

High-technology exports, which is used as a proxy for innovation intensity, is positive and statistically significant at 1% level. This confirms our anticipation of the positive association between innovation and venture capital investment, as innovative firms promise high growth prospects which maximize the venture capital investors' expected return. Very few studies have looked at innovation and venture capital investments, but those that did found similar results. For example, Florida and Kenney (1988) found that high technology entrepreneurship is positively correlated with venture capital investments. Studies that have used the level of public and private R&D expenditure as a proxy for innovation also found that innovation is positively associated with venture capital investments (Herrera-Echeverri, 2017; Sandua & Ciocanel, 2014).

The examination of the features of the institutional environment that influence venture capital investments shows that the presence of stronger institutions and more favorable regulatory frameworks positively affects venture capital investments. In this study we use institutional variables such as tax rates, labor market rigidities, minority investor protection and government effectiveness. Minority investor protection is found to affect venture capital investments positively at a statistically significant level of 1%. This result follows the expectation that venture capital investors are likely to invest more in jurisdictions where their investments are strongly protected.

[1] Specifically, based on REIV estimation in Table 5, the overall marginal effect of internet coverage on VC activity is (-0.129+0.0022*population), which is positive for the range of population sizes under study.

Studies that support this finding include Aggarwal and Goodell (2014) and Grilli et al. (2018). This suggests that having laws that protect minority investors (e.g., having a say in decision making and a seat at the board) from the risk of dishonest majority investors who have substantial opportunities to shape company decisions for personal gain and to the detriment of minority shareholders contribute to increase venture capital investments in smaller enterprises, offering a boost to a segment of firms that generate substantial income and employment across the region.

An increase in the government effectiveness index contributes as well to venture capital investments. The government effectiveness index variable is positive and statistically significant at 5% level. The quality and capacity of public service, its independence from political pressures and the quality of policy formulation provide an enabling environment for entrepreneurs to expand and to yield higher returns, while providing reassurances to private investors on the stability of policies and political risk. This finding confirms the empirical findings of previous studies that government effectiveness plays a significant role for venture capital investment (Cherif & Gazdar, 2009; Cumming et al., 2016). The Corporate tax rate—which is a direct tax imposed by the government on income of corporations or analogous legal entities—and its square are not statistically significant (although their signs suggest a non-linear inverse U-shaped relationship with VC activity). Labor market rigidities proxied by the labor tax and contribution has a negative sign but is not statistically significant.

6. Robustness

There is close homogeneity of results between the POLS, RE, 2SLS and REIV estimations on key variables of interest that are statistically significant including high-technology exports, government effectiveness index, minority investor, internet coverage, and internet bandwidth, showing stability of our key findings.

In this section, we take into account the fact that Egypt, Kenya, Nigeria, and South Africa made up approximately 83% of venture capital investments in value (78% in number) between 2014 and 2019. We included a dummy variable to control for the sub-sample of these ‘big four’ countries as an additional robustness check, see Table 6.

Table 6: Determinants of venture capital investment deals [controlling for the 'big four' countries]

	POLS	RE	2SLS	REIV
GDP Growth	0.01	-0.0251	-0.0073	-0.0413
	(0.054)	(0.051)	(0.0486)	(0.0512)
Inflation Rate	-0.004	-0.0042	-0.0058*	-0.0058
	(0.004)	(0.004)	(0.0033)	(0.0041)
Labor Tax & Contribution	-0.035	-0.0392	-0.0305	-0.035
	(0.023)	(0.0354)	(0.0206)	(0.0284)
Corporate Tax	0.23	0.3003	0.0251	0.074
	(0.305)	(0.3729)	(0.2646)	(0.3354)
Corporate Tax_Squared	-0.004	-0.0046	-0.0014	-0.0017
	(0.005)	(0.0068)	(0.0049)	(0.0064)
Population (million)	-0.007	-0.0192	-0.0091	-0.0154
	(0.014)	(0.0129)	(0.013)	(0.0133)
Export Growth	0.004	0.0118	0.0024	0.0099
	(0.014)	(0.0083)	(0.0124)	(0.0099)
Bandwidth (,000 mbps)	0.001***	0.0009	0.0014***	0.0013**
	(0.0004)	(0.0006)	(0.0004)	(0.0006)
Internet Coverage	-0.103***	-0.0942**	-0.1296***	-0.1224***
	(0.03)	(0.0429)	(0.0273)	(0.0459)
Internet Coverage*Pop.	0.001	0.0015*	0.0014**	0.0017**
	(0.001)	(0.0008)	(0.0006)	(0.0008)
Investor Protection	0.044**	0.0339	0.0488***	0.0408*
	(0.017)	(0.0237)	(0.0153)	(0.0213)
Government Effectiveness	0.045***	0.0604**	0.0435***	0.0549**
	(0.012)	(0.0286)	(0.0111)	(0.0248)
Big 4 Countries	9.23***	9.8152**	7.0785***	7.3613*
	(2.599)	(4.436)	(2.1194)	(3.7804)
High Tech Export (USD million)	0.003***	0.0019*	0.0039***	0.0032***
	(0.001)	(0.0011)	(0.001)	(0.0009)
Time Effect	Yes	Yes	Yes	Yes
Constant	-4.573	-6.0437	-0.8566	-1.8415
	(4.858)	(5.6196)	(4.1012)	(4.8639)
Observations	141	141	136	136
R-squared	0.865	0.858	0.871	0.870

Figures in parentheses are standard errors. ***, **, * denote estimated parameter is significantly different from zero at the 1%, 5% and 10% test levels, respectively.
Source: Authors' calculation based on a constructed dataset of indicators described in Table 1.

The inclusion of the dummy allows us to closely examine the two sub-samples. Our expectation is that the reasons these countries receive much VC investments are the same as those being assessed in this paper. In other words, key determinants of VC activity are similar under both the sub-sample of 'big four' countries and the sub-sample comprising the other African economies covered. Table 6 presents the results of POLS, RE, 2SLS, REIV estimations with the 'big four'

countries' dummy included. In fact, As shown in Table 6, the key explanatory variables kept their original signs, and statistical significance albeit to a lesser degree. The 'big four' countries' dummy is positive and statistically significant, showing an upward shift of the intercept for these countries (i.e., keeping all else constant, 'big four' countries have experienced a higher number of VC deals). Interestingly, the marginal effects of the key explanatory variables are significantly lower, having been absorbed by the included dummy. This suggests that while the key determinants of VC activity hold for both sub-samples, the higher marginal effects when looking at the sample in aggregate is due to the higher magnitude of the impact of the VC determinants among the 'big four' countries. Note that one explanation of the somewhat diluted statistical power of the explanatory variables after the inclusion of the dummy is likely due to introduced multicollinearity given the high correlation between the 'big four' countries' dummy and the control variables such as internet coverage, population, internet bandwidth, which are 0.68, 0.74, and 0.45, respectively.

7. Concluding remarks and policy implications

This study presented novel findings on factors encouraging venture capital investments in Africa, examining a period where VC funding has significantly been ramped up on the continent and has shown resilience. Specifically, the empirical investigation has shown that determinants of venture capital funding are multi-faceted, spanning macroeconomic fundamentals, market characteristics and access, the state of digital infrastructure, innovation intensity and institutional quality in a given country.

These results suggest that any strategy aimed at attracting venture capital funding at the country or continental level must follow a multi-pronged approach, and bold actions should be undertaken to support VC activity in order to ultimately fuel digital transformation in Africa. The following are subsequent policy initiatives that can help policymakers improve VC funding in Africa:

- ***Reform institutional arrangements and regulatory frameworks.***

Evidence shows that government effectiveness in formulating and implementing policies and its independence from political pressures as well as the quality of public services delivery on one hand, and a more business friendly environment on the other hand (e.g., stronger corporate governance) all contribute to create a more favorable climate to attract VC financing, in line with the broader

literature on private investments in Africa (Asiedu & Gyimah-Brempong, 2008; Anyanwu, 2006). Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

- ***Invest in digital infrastructure.***

Broad internet coverage as well as high-speed and reliable internet access are essential for VC investees to effectively deliver their services and access markets. As mentioned earlier in the paper, there is a wide connectivity gap between Africa and other regions, requiring significant investments to be mobilized not only by governments but also the private sector to meet the challenge.

- ***Help accelerate the development and propagation of innovation.***

Policy measures to spur innovation across the economy should be introduced, whether intellectual property policies, preparing human capital to innovate (e.g., boosting STEM education, creating centers of excellence and innovation hubs), supporting R&D, or facilitating knowledge transfers.

Statistical significance could inform to an extent the prioritization of policy interventions, in particular given the limited resources that most African economies have. Digital infrastructure, investor protection, government effectiveness and the innovation proxy are all highly statistically significant with stable results across estimations suggesting that policymakers could more reliably prioritize these drivers of VC activity to formulate measures to attract VC funding. Note that given the different units of measurement across explanatory variables, marginal effects are not straightforwardly comparable and thus not relied upon in this prioritization exercise.

The agenda for future research could be directed towards a more disaggregated analysis, which would come with data challenges, looking at firm-level data to examine not only external factors affecting venture capital deals, but also more idiosyncratic determinants including but not limited to sectors, management teams skills, founders' gender, number of employees, company's age, product characteristics, access to credit, access to adequate infrastructure and geographical location.

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