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# Infrastructure Project Finance in Sub-Saharan Africa - A Comprehensive Analysis

Master Thesis in Business and Finance

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Infrastructure Project Finance in Sub-Saharan Africa - A Comprehensive Analysis
Master Thesis in Banking and Finance

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# Abstract

This thesis investigates infrastructure project finance in Sub-Saharan Africa over a 30-year period. Realizing that a significant data and knowledge gap exists, the research analysis aims at reducing both gaps. A thorough descriptive analysis provides a holistic picture of the infrastructure project finance activity in the region over the period from 1990 to 2020. A multitude of current and historic trends are uncovered within it. A brief quantitative analysis meanwhile evaluates factors which could influence project finance and leads to speculate that there is a two-way relation between infrastructure project finance and economic output.

## Executive Summary

Many policymakers and economists concur on the importance of infrastructure to facilitate sustainable and sustained growth as well as raising standards of living. Meanwhile, the high population growth around the globe is likely to increase the demand for a sound infrastructure endowment over the coming decades. The provision as well as maintenance of such assets will require large amounts of financing. Despite the importance of infrastructure, least developed countries often exhibit a significant infrastructure gap – both in terms of quantity and quality. Government inefficiencies, fiscal restrictions, and the shift of creditors since the Great Financial Crisis of 2007/08 are restraining factors to attract sufficient funding for large-scale projects. For Sub-Saharan Africa which lags behind in virtually all infrastructure dimensions, a higher infrastructure provision is especially relevant. The annual financing needs to overcome the infrastructure gap in said region are more than twice the amount that is being financed today. Project finance constitutes a possible method to resolve the funding gap in infrastructure. This financing method is tailored to long-term, high-risk, and large-scale projects and does not rely upon the project owner's creditworthiness. Aspects which render it suitable for infrastructure financing in low-income countries.

Knowledge and analyses on infrastructure project financing in Sub-Saharan Africa are sparse, causing the general comprehension in this area to be limited. The thesis aims at bridging both the data gap as well as the knowledge gap in this area. Firstly, data on infrastructure project finance was gathered, consolidated, and brought into a form suitable for research with statistical software. In a second step, once the dataset had been constructed, a holistic descriptive analysis touching on all aspects of the infrastructure project finance process in Sub-Saharan Africa in the period between 1990 and 2020 was conducted. This step included an analysis of the overall development of projects as well as the development on a country level, an examination of all parties involved in a deal, a financing as well as a sectoral review. The descriptive part was supplemented by a quantitative analysis, which shone light on certain aspects from the former analysis. On one hand, the statistical method of hypothesis testing was utilized to better comprehend whether certain variables are associated. On the other hand, a set of multiple regressions were conducted to gain an clearer understanding of factors which may influence total project value a country attracts.

The thesis found that project finance activity over the period of interest has moved in unison with world GDP, indicating that economic shocks and expansions influence this financing scheme. After the Global Financial Crisis of 2008 and after the Taper Tantrum resp. during the Euro Debt Crisis, project numbers plummeted. In 2008, a shift of infrastructure project

financings from low-income countries to higher income groups is visible, since investors likely were seeking to allocate capital more safely.

Furthermore, the analysis uncovered that there are vast differences depending on the project sector of an infrastructure asset in terms of procurement model, project cost, financing as well as sponsor country. For instance, Australia and Canada are highly focused on mining; the UK and the US are involved in many oil and gas assets; China often appears in transportation and the social infrastructure sector. Certain sectors showcase a much higher propensity to being held by foreign countries than others. Mining, for instance showcases high foreign-only ownership, whereas water and social assets are often held by host countries themselves. This may be explained by the economic viability and required expertise to conduct a project. For the social sector both are low which is why governments often appear as co-owners to allow for a project to even being realized. In contrast, mining allows for attractive returns given a high degree of expertise is present. Moreover, current trends became visible. In the power sector, for instance, an extremely strong momentum for renewable energy projects presented itself– more specifically solar assets. These assets virtually skyrocketed over the past decade. Simultaneously, brown energy projects declined and stood at low levels in 2020.

Through hypothesis testing it was additionally found that certain projects sectors are positively associated with certain host countries and more likely to receiving financing. Depending on a host country's income group affiliation, certain sectors are disproportionately more or less frequent. Besides, the loan amounts appear to be associated with both financing nation as well as loan type. For instance, China, South Korea, and Japan were found to be involved in more expensive projects. These findings are not surprising, however, proving the associations statistically was a valuable contribution to a better understanding of the underlying dynamics.

Lastly, while not inferring any causal relationships, the multiple regression allows to speculate on certain factors which may enhance or inhibit project financing in a country. The regression results suggest that GDP is positively associated with infrastructure project finance and so are labor productivity and financial development. Meanwhile, higher degrees of corruption are negatively associated with total project value. All of these can logically be defended. This is not the case for export quota which also exhibits a negative association with project value. A reversed regression moreover implied that the relationship between project value and GDP runs in both direction and that there is likely a feedback loop. This finding corresponds to the findings of other authors who suggest a two-way relationship.

The thesis contributes to a more profound understanding of infrastructure project finance. While not inferring causal relationships, it does unearth current and historic trends and dynamics which may prompt further research or facilitate policy recommendations.

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# List of Abbreviations

| | |
|---|---|
| Anova | Analysis of variance |
| BOO | Build-Own-Operate |
| BOT | Build-Own-Transfer |
| CCGT | Combined Cycle Gas Turbine |
| DBFO | Design-Build-Finance-Operate |
| DFI | Development Financial Institution |
| DM | Developing market |
| ECA | Export Credit Agency |
| EM | Emerging Market |
| EPC | Engineering-Procurement-Construction |
| GDP | Gross Domestic Product |
| GFC | Great Financial Crisis |
| ICT | Information and Communication Technology |
| ILO | International Labor Organization |
| IMF | International Monetary Fund |
| LIDC | Low Income Developing Countries |
| LNG | Liquefied Natural Gas |
| MDFI | Multilateral Development Financial Institution |
| MLA | Multilateral Agency |
| OECD | Organization for Economic Cooperation and Development |
| PPA | Power Purchase Agreement |
| PPP | Public Private Partnership |
| SDG | Sustainable Development Goals |
| SPV | Special-Purpose-Vehicle |
| SSA | Sub-Saharan Africa |

# Introduction

Infrastructure is widely considered a crucial factor for a country's development. Policy makers, academics and governments around the world agree on its importance as an enabler for a nation's basic functioning as well as a driver of economic growth, improved business opportunities, lower inequality, and higher standards of living. A solid base of infrastructure is especially important for the world's poorest regions. Without the necessary infrastructure facilities, sustained and equitable development cannot be attained.

The least developed regions often showcase a significant infrastructure gap. This is especially true for Sub-Saharan Africa, a region that hosts 43% of the world population below the international poverty line and almost 70% of the world population with no access to electricity (Messervy (2018)). Moreover, Sub-Saharan Africa lags behind other poor regions in virtually every infrastructure respect, such as transportation networks, water and sanitation, electricity or industrial facilities (Lakmeeharan et al. (2020)). A lack of fundamental facilities fosters a multitude of grave issues. No access to clean water or electricity implies that hospitals cannot be provisioned if they exist. The absence of educational facilities such as schools or universities perpetuates a poor educational standard within a population. A factor which repeatedly has been identified as a crucial driver for a country's economic growth. Finally, inadequate transportation or telecommunication networks decreases labor mobility and business opportunity (Pottas (2012)).

Over the next 10 years, the annual financing needs to overcome the infrastructure gap in Sub-Saharan Africa are estimated at 93 billion USD – more than twice the amount of what is being financed today (Calderón, Cantú and Chuhan-Pole (2018)). Some researchers argue that the funding is available but not invested due to structural problems inherent to underdeveloped countries (McKinsey (2020)). Bridging this gap will thus pose a massive challenge for Sub-Saharan Africa over the coming decade. One financing method which could potentially ease the region's budget constraints is project finance. Project finance is an ideal means to finance large-scale, long-term, and high-risk infrastructure projects in developing markets as the financing does not rely on the creditworthiness of the project owner (Gatti (2012)). Given the high debt levels present in said region, this financing method circumvents fiscal restrictions and allows for infrastructure to being built even in countries where governments are highly indebted. The ways in which data on infrastructure project finance is collected, however, renders a more profound understanding of and research in this area difficult. Data collection is done in an unsystematic and qualitative manner, thus, making it suboptimal for quantitative analysis. This lack of good-quality data is why a profound understanding of the infrastructure project finance activity is yet to be gained.

Contributing to bridging this knowledge and data gap, the thesis firstly hand-collects data from various sources and bring it into a form suitable for quantitative analyses. Furthermore, it conducts a thorough descriptive analysis of infrastructure project financings in Sub-Saharan

Africa between the year 1990 and 2020. This venture aims at providing insights into historical facets of infrastructure development, the challenges encountered and current trends. For the 30-year period, various aspects such as main host countries, sectoral and income group distribution of projects, as well as involved stakeholders are examined thoroughly. The descriptive analysis aims at unearthing, describing, and visualizing overall developments of this financing scheme in infrastructure. A brief empirical analysis identifies associations in select areas and facilitates a better understanding of factors that may foster or impede the number of project financings. This last section provides guidance on the directions which future scientific endeavors could take.

The paper is structured as follows: Section 1 and 2 introduce the concepts of infrastructure and project finance, respectively. The ensuing third section provides a review on the most relevant strings of literature related to the topic. The data and methods are explained in section 4 before proceeding to the main chapter 5, which conducts a descriptive analysis of infrastructure project finance in Sub-Saharan Africa. Section 6 then provides a brief quantitative analysis, and the final section 7 concludes the thesis.

# 1. Infrastructure

Many policymakers and economists concur on the importance of infrastructure to facilitate sustainable and sustained growth – which is believed to benefit the poor disproportionately. Additionally, the high population growth around the globe is very likely to increase the demand for a sound infrastructure endowment. This section will discuss the definition of infrastructure and its sectors, attend to economic features, and examine why its relevance is going to increase over the next decades. In the last segment the viewpoint of an investor is assumed to examine the features of *infrastructure* as an alternative asset class.

## 1.1 Definition & Characteristics

Even though, most people understand the term infrastructure and could name a few sectors or facilities surmised in infrastructure, asking for a definition may cause them to be at their wit's end. This, however, is not a proof of the topic's complexity but rather a proof of the absence of a universally accepted definition. In the literature, there is no consensus on a single definition for infrastructure as much as there is no consensus on which sectors constitute infrastructure.

The Oxford English dictionary defines infrastructure as: "*The basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise.*"

While the OECD's definition reads: "*The system of public works in a country, state or region, including roads, utility lines and public buildings*". To simplify, infrastructure builds the veins through which economic activity flows.

Turning to the academic literature, various other definitions of infrastructure can be found focusing on distinct aspects. For instance, Torrance (2009) differentiates between three sub-groups, namely (1) transport infrastructure like roads, railways, or air travel where a user fee applies; (2) regulated infrastructure, such as the provision of gas, water, or electricity with service contracts and availability fees; and (3) social infrastructure including educational, health or housing facilities for which an availability fee is paid by the government. More common in the literature is the categorization of social and physical (sometimes referred to as economic) infrastructure, where the former describes social service facilities such as schools, universities, hospitals, housing, offices, prisons, or sport facilities (Kasper (2015)). On the other hand, physical infrastructure refers to the physical asset endowment of an economy that enables a basic functioning. Examples thereof are power grids, renewable energy, water and sewerage facilities, communication networks or transportation networks. Furthermore, Pottas (2012) differentiates between the assets' impact and states that physical infrastructure paves the way to growth, while social infrastructure contributes to an increase in quality of life.

Since there is no consensus on which sectors constitute infrastructure, the definitions sometimes extend to natural resources like in the case of Kumari and Sharma (2017, p. 49) who state: "*Broadly, infrastructure includes water supply, sewerage, housing, roads and bridges, ports,* *power, airports, railways, urban services, communications, oil and gas production, and mining*."

For this thesis, a broad sectoral definition of infrastructure is applied which is provided by the structure of the data collected. Some of them are undisputedly part of a country's infrastructure, yet others such as mining or agriculture & forestry could be disputed. The eleven sectors which will be considered infrastructure henceforth are: (1) Agriculture & Forestry; (2) Industry; (3) Leisure & Property; (4) Mining; (5) Oil & Gas; (6) Petrochemicals; (7) Power; (8) Telecommunications; (9) Transportation; (10) Waste & Recycling; (11) Water & Sewerage. All sectors can be considered physical infrastructure, except for leisure & property as the sole social infrastructure sector.

## 1.2 Economic Considerations

Applying an economic viewpoint, infrastructure has a couple of interesting characteristics which make it distinct from productive capital as Kasper (2015) points out. First of all, infrastructure is extremely capital-intensive yet less labor-intensive as compared to productive capital such as machinery. The two are complementary insofar as more infrastructure facilitates higher capacity of productive capital, thus, infrastructure has a symbiotic or even enhancing relationship with general economic activity. Irreversibility is a common feature of infrastructure and productive capital, indicating that once the capital investment has been made into either of the two, it cannot be changed to the other nor can it be relocated (Kasper (2015)). Furthermore, inherent features to infrastructure are economies of scale, monopoly structures and sometimes economies of scope (Henckel and McKibbin (2017)). For instance, once a telecommunication network has been built and a user basis exists, a marginal user does incur the same revenue as the other users but close to zero costs to the operator, allowing for economies of scale. The same holds true for toll roads.

This contrasts with an often-applied definition that infrastructure is a public good, which leads to the question what kind of good such assets constitute – are they a public, a private or a club good? Various papers refer to infrastructure as public good which implies that they are non-rivalry and non-excludable (e.g., Ayogu (2007)). Considering toll roads, electricity, or telecommunication this does not apply as all of them are excludable – and toll roads possibly even rival if there are too many users resulting in congestion. In consequence, these assets would be categorized as private goods or common goods. However, military defense structures are normally considered to be social infrastructure[1]. A citizen will be equally defended by the military service no matter if he pays for the military defense or not (i.e., non-excludable) and because being defended is not rival, this constitutes a public good (Frank (1997)). Thus, the simple answer to the above question is: it depends on the infrastructure asset and how it is priced.

[1] Military defence is often named as one of the only examples for a pure public good (Frank (1997)).

## 1.3 Topical Relevance

Globally, the demand for infrastructure has increased over the past years and is set to increase further. While the infrastructure's maintenance and upgrading are cost drivers for developed countries, emerging and developing countries incur high expenses in the planning and construction of assets.

Kasper (2015) identifies four reasons for a rising and changing demand. First of all, demographic developments such as an ageing population in developed countries, urbanization and global population growth are driving forces. An ageing population showcases a higher inclination to utilize public transportation, has growing needs for health care and retirement homes but at the same time causes lower tax revenues, tightening the fiscal budget available for provision or maintenance of infrastructure. Furthermore, urbanization leads to an ever-lower population living in rural areas and a higher concentration in cities. Hence, telecommunication services or power grids in remote areas become less economically viable as the customer base steadily decreases and is spatially dispersed. Cities, on the other side, register higher demand for transportation networks due to congestion but face scarcity in space.

Second, global warming and environmental changes will influence infrastructure. If the prevalence of draughts increases, desalination plants for water will come to the fore. A consensus exists on the environmentally harmful impact of coal, gas, and oil plants. Yet, other infrastructure assets such as highways have indirect effects by upholding the demand for $CO_2$-emitting devices such as vehicles with internal combustion engines. Over the next years, desalination, electronic mobility, and renewable energies will play a central role requiring vast investments. Since infrastructure spans every aspect of an economy, it will be at the center for sustainable growth and a lever to reach the Sustainable Development Goals (SDGs).

Thirdly, digitalization and technological developments may alter the basic needs of populations and require infrastructure to come in new shapes and forms. 20 years ago, telecommunication was in its infancy. Nowadays it not only allows for communication within and across countries and the transfer of data, but it also enables new business opportunities and has even facilitated widely adapted payment methods in developing countries such as Kenya or Tanzania.

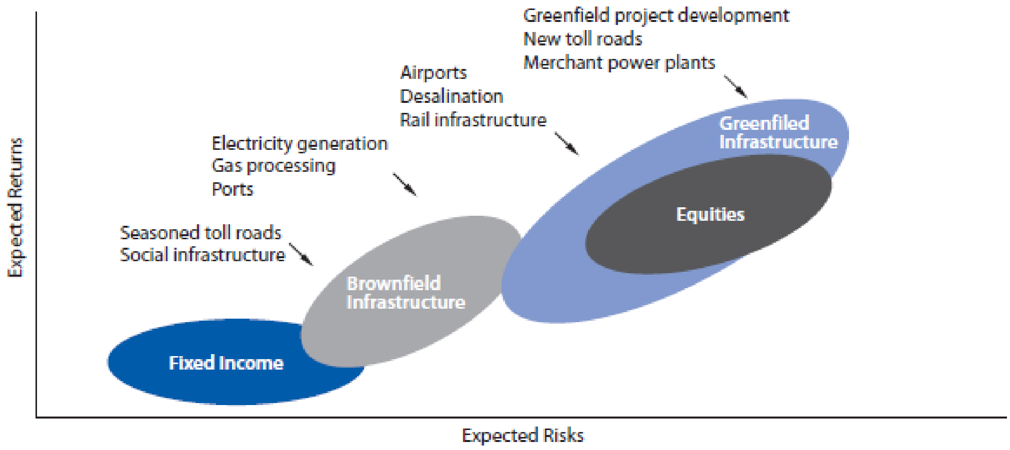
The fourth and last identified factor which pushes the demand for infrastructure is economic growth, which is especially pronounced in emerging markets and newly industrialized countries. International trade, globally dispersed supply chains and increased industrial production are all factors that move forward in unison with global economic growth, requiring higher investments for a reliable infrastructure. Although the relevance is high and set to rise further, global infrastructure investments have decreased from 9,5% of GDP in 1990 to 7% of GDP in 2005 as Kasper (2015) states. Heathcote and Mulheirn (2018) estimate the current infrastructure investment level to be at 3% of global GDP and state that closing the investment gap of USD 15 trillion will require the annual investment to rise to 3.5% of global GDP.

## 1.4 Infrastructure as an Asset Class

Infrastructure should not solely be viewed from the finance-seeking or supplicant perspective but also as an attractive investment opportunity. In recent years, this asset class has become more popular with institutional and private investors, who have realized that some distinct features make it especially well-suited for diversification, risk management and inflation protection (AFME (2015)). It constitutes part of the alternative assets, which Preqin (2021) estimates to grow annually by roughly 10% until 2025. Despite the dump in 2020, infrastructure has proved to be a robust investment with asset under management amounting to USD 655 billion. Applying an economist's perspective, certain characteristics as identified by Inderst (2010) are especially interesting for investors. Firstly, barriers to entry are high as many of these sectors are highly regulated by governments or enjoy monopoly power. This in turn leads to excess returns. Furthermore, infrastructure assets are often very resilient to shocks. Economic crises and recessions seldomly influence how much electricity or water a household utilizes, thus, the demand for these services is inelastic and the correlation with other assets is low. This, additionally, makes infrastructure investments a good inflation hedge. An additional feature are economies of scale due to the high initial fixed cost but low variable and operating cost – the cost of one additional person connected to the power grid is vanishingly small. The long time horizons, between 10 up to 99 years, during which returns can be generated is another factor rendering infrastructure a very attractive investment opportunity. Finally, once construction is completed, default rates for these assets are generally very low.

All of the above-named characteristics are in general true for physical infrastructure rather than for social infrastructure, even though there are some exceptions. However, it is a generalization and certain sectors have in fact proved sensitive to economic cycles. Covid-19 poses an interesting example, where formerly stable sectors experienced a significant decline in returns caused by demand shocks. The pandemic which led to closed borders and forced governments around the world to implement health measures such as lockdowns and curfews, caused demand for roads, public transportation, and air travel to virtually diminish. Abadie, Brake and Welsh (2021) argue that a lasting shift to micro mobility may result from the pandemic. High uncertainty with respect to the freight industry raises questions on the implications for port owners if supply chains become more regional. They also state that the recent shift to home-office may lead to a significant downsizing in office buildings but at the same time warehouses were more intensively needed due to high online shopping activity in developed countries. Even formerly insensitive sectors such as power have experienced demand shocks due to the shutdown of entire industries. Despite the higher vulnerabilities during the pandemic, the asset class's risk-return profile has overall proved attractive. Often, infrastructure assets are differentiated as either greenfield (i.e., early-stage assets which are newly build) or brownfield (i.e., mature assets which are operational) (Inderst (2010)). For greenfield assets both expected risk and return are higher, while brownfield assets showcase a more conservative profile which is depicted in Figure 1.

Figure 1: Illustrative Risk-Return Profiles of Infrastructure Investments Relative to Traditional Asset Classes




The graph depicts four asset classes' expected risk-return profile including greenfield and brownfield infrastructure.
Source: Inderst (2010)

Depending on maturity, sector and economic cycle, the expected risk-return profiles vary significantly but despite recent moderation they are still often in the double digits (Inderst (2010)). Empirical analyses, historical performance data and benchmarks are sparse, which has on the one hand to do with infrastructure being a relatively young asset class. On the other hand, the absence of a uniform definition of which sectors constitute infrastructure impedes consistent data collection. Nonetheless, there is a consensus that it is attractive for portfolio diversification across regions and sector, as an inflation hedge and to generate long-term, stable cash flows (Inderst (2010)).

## 1.5 Risks of Infrastructure

The characteristics mentioned before in combination with further particularities cause infrastructure to have several risks inherent. Before either planning a project or making an investment decision, they need to be understood and thoroughly assessed. For instance, even though long horizons allow for long-term cashflows, they create high risks – mainly in greenfield assets. Broadly, four subcategories of risks can be distinguished. Project-related risks, financing risks, country-specific risks, and systematic risks.

Project-related risks vary strongly over the life cycle of an asset as Inderst (2010) analyses. The risk that the construction phase unearths cost overhauls, counterparty problems, government inefficiencies or delays is ensued by operational, management and maintenance risks once the construction has been completed. If ownership, legal documents as well as regulatory aspect are not taken care of with the greatest care and accuracy, they have the potential to jeopardize the entire project. Financing risks include issues with attracting debt financing, refinancing, currency exchange, leverage as well as interest rate risks. For example, since the financial crisis, interests have been historically low which led to a growth in infrastructure investment. If the rates were to be raised, debt financing of highly leveraged infrastructure projects would become more costly, lowering equity returns (Sappin (2019)). While project-related and financing risk categories can be accounted for by careful planning and a thorough understanding of the project and financing mechanisms, country-specific risks are more difficult to mitigate. They comprise political risks such changes to government policies as well as uprisings and wars, changes to the taxation scheme as well as social risks like corruption or opposition. Political risk guarantees from multilateral organizations can help alleviating these dangers. Lastly, systematic risks such as droughts from environmental change, scarcity of resources or supply chain disturbances represent risks that cannot be accounted for and are thus reflected in the capital costs. A single risk materializing or a combination of different risks can cause a project to default.

# 2. Project Finance

In certain countries, infrastructure financing is seen as a government task. However, many developing countries are unable to raise the necessary investments themselves due to high debt levels and budgetary constraints. Hence, they must revert to private investors (Gatti (2012)). Project finance serves as a solution to ease the investment needs of these countries and allows for financing of large-scale and high-risk infrastructure assets.

There are other financing schemes such as balance sheet finance, corporate finance, or sovereign borrowing. However, these methods are not in the scope of the thesis at hand, which will solely focus on project finance as a method to fund infrastructure projects. The following section which will map out project financing mechanisms is primarily based on Dentons (2018) and BSIC (2020).

## 2.1 Definition & Characteristics of Project Finance

There is no single, broadly accepted definition for project finance. Nonetheless, the definition used by Dentons (2018, p. 13) which is provided below includes some important aspects.

*Definition:* "The financing of the development or exploitation of a right, natural resource or other asset where the bulk of the financing is to be provided by way of debt and is to be repaid principally out of the assets being financed and their revenues."

Project finance in a narrow sense describes the long-term, yet temporally pre-defined structured financing of large-scale investment projects (e.g., infrastructure) which is not dependent on the creditworthiness of the sponsors (Gatti (2012)). In contrast to corporate finance where a company receives funds, in a project finance scheme the funds are targeted solely for a specific project. To that end, a project company is incorporated – often a special purpose vehicle (SPV), sometime referred to as single purpose vehicle or single-purpose company. Parties involved in a project finance deal share the risk equitably and in such a way that the party who is best suited to deal with a specific risk also carries that risk, hence the method is well-suited for high-risk assets (Gatti (2012)). Some of the distinct characteristics of project finance are: (1) Debt-heavy structure; (2) Future cash-flow reliance; (3) Contractual settling of cash flows; (4) Project model; (5) Non-recourse financing / limited-recourse financing; (6) Off-balance sheet structure. Each of these aspects will be elucidated further.

### 2.1.1 Debt-Heavy Structure

A distinct feature is the high level of debt used in these schemes. A typical debt-equity split for project finance is 70-30 but debt levels can be as high as 90% or even 100% of the project cost (ESCAP (2008)). However, complete debt-financing is rare as the lenders usually require a capital injection from the project owners (referred to as sponsors) before granting loans. Sponsor equity helps in aligning incentives and serves as an insurance for the lenders.

### 2.1.2. Future Cash Flow Reliance

Project finance relies on future cash flows for the repayment of debt and equity. Therefore, lenders and equity investors scrutinize the contractual terms and assess the future cash flow's reliability and stability before making an informed investment decision. Also, the underlying asset or the rights to use it (e.g., through concession agreements) act as collateral. The high risk of infrastructure on the employed capital – caused among other factors by the long time horizon – makes project finance a suitable method. As no cash flows are generated during the construction phase, the debt interest is usually only paid after the project has been completed and the asset is operational.

### 2.1.3. Contractual Settling of Cash Flows

Until a project has been finalized (i.e., infrastructure is completed and operational) there are normally no revenue streams. Nevertheless, offtake agreements which settle how and by whom the future revenue is generated and how it is shared between the involved parties, are signed during the construction. Once the construction is completed and some sort of output is generated, these agreements enter into force.

### 2.1.4 Project Model

The concession agreement between the project company and the host government (or another principal) determines the project model. Globally, many projects are structured as a Build-Operate-Transfer or as a Build-Own-Operate model. The Build-Operate-Transfer (BOT) model implies that the project company is responsible for financing and building a project. Upon completion it operates and maintains the facility for a pre-determined period to recover invested capital and repay its debt. Once the contractual period has expired, which usually lasts between 10 to 30 years, the project company transfers the facility and all operating rights back to the government. On the other hand, under a Build-Own-Operate (BOO) model the financing and construction is also organized by a project company, however, upon termination of the contract, no transfer of all operating rights to the host government takes place and the concession or contract can be renewed. Thus, the main difference is that under a BOO model, the re-transfer of the project assets does not take place.

### 2.1.5 Limited Recourse / Non-Recourse Finance

The recourse (i.e., claim) that the lender has to the assets of the borrower is a key difference between corporate finance and project finance. In corporate finance, the lender has recourse to a large pool of assets, whereas in project finance, the asset pool is very limited.

Normally, the financing is non-recourse or limited recourse, meaning that the lender has either no right to seize other assets of the borrower in case of default, or in the case of limited recourse, the lenders may secure completion and use performance guarantees. The terms are often used interchangeably, yet non-recourse financing is extremely rare. Hence, most project financings can be categorized as limited recourse finance, which might entail the right to rescind or the right to claim damages for breaches of the project agreement. Considering that during project financings a project company is incorporated which has the purpose of building a single asset, all other assets of the sponsors which are not part of the project are protected from recourse. In consequence, the lender's right to claim damages from the borrower tends to have little effect as there are no further assets to be claimed.

### 2.1.6 Off-Balance Sheet

For large-scale, long-term projects this form of financing is regularly applied by governments and companies. Thanks to the incorporation of a project company (e.g., SPV), the project remains off the balance sheet of the owners, allowing them to retain their debt-equity ratios in an acceptable range. Just like the companies, a government would usually prefer to keep infrastructure projects off its balance sheet as to not limit its fiscal leeway.

## 2.2 Sources of Project Finance

The main sources of the funds in project finance schemes are direct financing through debt and equity contributions, alongside government grants. In that regard, equity refers to the capital invested by the sponsor/owner of the project as well as third-party investors. Third-party equity investments can originate from governments, private investors such as private equity funds, companies, or local investors. The rate of return of equity providers is known to be high in project finance and it tends to be higher than the rate of return on the debt. Taking into consideration that in case of default, the debt providers are serviced before the equity providers from the bankruptcy proceedings, the higher equity cost is justified (ESCAP (2008)).

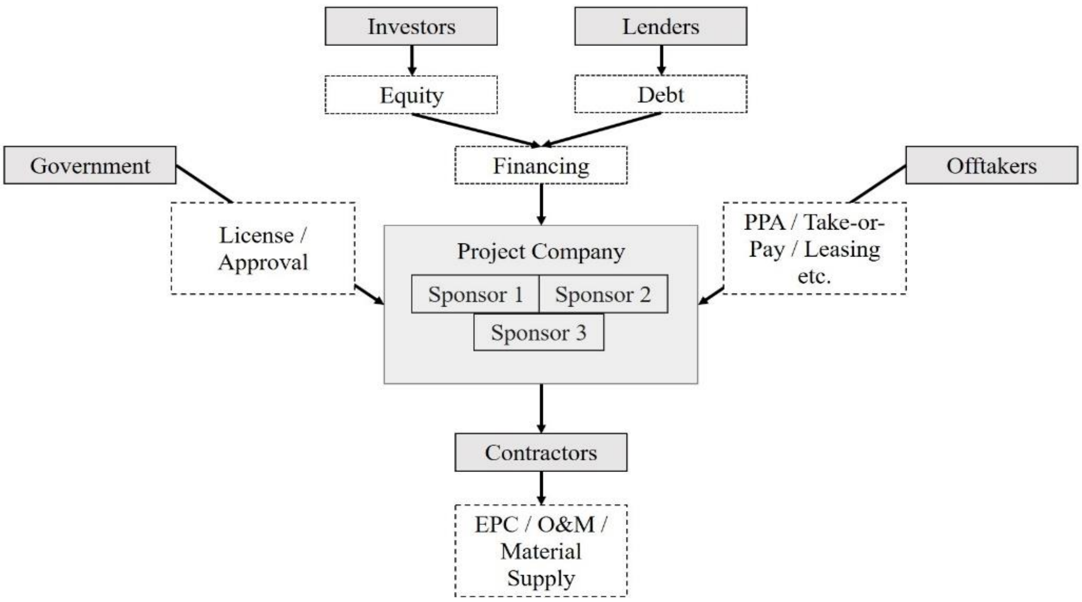
Debt denotes capital borrowed from commercial banks, development financial institutions, export credit agencies, governments, international agencies, or other financial institutions (World Bank (2020)). The debt usually has a fixed, long-term maturity and a fixed interest rate structure. Just like the cost of equity, the cost of debt is known to be high. Interest rates are set at levels which should offset risks inherent to e.g., infrastructure projects, namely uncertainty due to long time horizons and political risks. The initial phase bears the highest risk of default. Once the construction has been completed and cash flows are generated, the risk profile improves significantly, and the cost of capital can be decreased by refinancing the loans at lower interest rates. The main loan types for debt contributions are syndicated loans, commercial loans, bilateral loans, subordinated loans, bridge finance, bond instruments and other forms of borrowing from the capital market (ESCAP (2008)). Indirect financing through capital markets has gained momentum in recent years with novel products such as project bonds or project shares emerging. However, it is not widely applied in the initial project phases when no cash flows are generated. During that time, syndicated loans from commercial and investment banks are very common and so is funding from export credit agencies and multilateral agencies. After the completion of an assets, refinancing through the capital market may take place.

Government grants as well as grants from export credit agencies or multilateral financial institutions are a further financing instrument often appearing in such deals. They tend to be used for specific goals. Examples are to achieve either public service obligations or social objectives, to correct for market failures or imperfections, create positive externalities, and to realize projects which are economically viable and socially beneficial but might otherwise not be realized.

## 2.3 Involved Parties & Stakeholders

One aspect rendering project finance complicated are the many parties involved in a single deal. Even though all parties fundamentally work towards the success of a project, their individual

Figure 2: Project Finance - Structure and Parties Involved




Source: Own illustration along BSIC (2020)

objectives can differ greatly. Moreover, many project financings involve parties from different countries, hence, include various and at times conflicting jurisdictions. To allow for an orderly execution, the roles of all involved parties will be defined in an early stage. Figure 2 illustrates the structure of a project financing schemes. In the grey boxes, the involved parties are depicted, namely the sponsors/owners forming a project company, the government, the offtakers as well as the contractors. The white dashed boxes illustrate contracts that are typically encountered in such schemes. Lastly, the white dotted boxes focus on the financing. Even though the illustration is simplified, it should provide a sufficiently detailed picture. In the following, each party will be discussed separately.

### 2.3.1 Sponsor & Project Company

The driving force and most important stakeholder in a project financing is the sponsor[2], who simultaneously acts as borrower, often is an equity provider (i.e., shareholder or owner) and sometimes even a debt provider. In some cases, sponsors are additionally involved in the construction or offtaking of an asset. Companies, individuals, governments as well as agencies can act as sponsors. They tend to develop the project, bring the expertise, and are involved in organizational aspect such as applying for licenses and permits.

Oftentimes, various sponsors are implicated in a project financing, incorporating a project company together. Such project companies can take the legal form of a company (e.g., Special Purpose Vehicle or SPV), a joint venture, a partnership, or a limited partnership. Clearly, the legal framework in host countries have a strong influence on the legal form and at times even determine it. Some host countries impose restrictions on foreign ownership of assets in critical industries or sectors such as power or water. Other host countries require a local company within the sponsor group. Even if a country does not impose such a condition, it can be preferable to involve a local entity as it helps in rendering more trust from lenders and alleviates concerns of unfair disadvantages and discrimination. Joint ventures with multiple borrowers tend to be tricky in terms of desirability from a lenders perspective as their respective liability needs to be resolved. In such cases, lenders require joint and several liability indicating that all parties are equally obliged to carry out the project and can be prosecuted individually. An SPV – a newly incorporated company just for the purpose of the project – simplifies the question of liability and ensures that the lender does not face any risk from unrelated projects. Additionally, it is a preferable solution to the sponsors as it shields their other assets from legal prosecution or seizure by the lenders in case of default (cf. limited-recourse finance). Therefore, incorporating an SPV is often the default setup.

### 2.3.2 Non-Sponsor Equity Investors

Aside from the sponsors, other companies or funds can inject equity into a project. Those third-party equity investors have a purely financial stake which aims at generating an alpha. Their investment time frame tends to be longer than that of other invested parties. At times, they engage in the oversight of the project on board level but often have no interest in organizational aspects.

### 2.3.3 Lenders

A variety of different entities and institutions can be involved in project financings, ranging from commercial banks, investment banks, asset & investment managers, over (multilateral) finance institutions such as national or regional development banks, to export credit agencies. A closer description of the above-mentioned parties is provided in Section 4. Due to the large-

[2] Sponsors are often referred to as (project) owner

scale nature of the projects, various debt investors and various loan types will typically be used in each financing. Thus, the debt investors normally span across many countries. As in the case of sponsors, the involvement of local banks is desired because a local anker increases trust from foreign lenders.

### 2.3.4 Government

The government of the country where the asset is domiciled (i.e., host government) often has a role in the project financing, but the extent of the involvement varies from case to case. In most instances and at the very least, the host government or some government agency will be required to issue permits or approvals – repeatedly and at various stages over the project life cycle. Most prominently in infrastructure projects, the project company and a government authority sign a concession agreement allowing the company to use the asset for a pre-specified period and subject to particular terms (BSIC (2020)).

In other cases, governments or state agencies act as offtakers or purchasers of the asset upon completion of construction. For foreign investors to deem projects in developing or emerging markets more secure, the host government could become an advisor, shareholder, or sponsor to the project, or else may award government grants. In this thesis and along the definition of BSIC (2020), projects in which the government acts as co-sponsor along a private entity are considered a Public-Private-Partnership (PPP).

### 2.3.5 Contractors

Contractors are companies that are primarily involved during the construction of the assets. To that end, the construction company plays a key role and is usually employed by the project company directly. The most common type of contract is an Engineering-Procurement-Construction (EPC) contract, in which the construction company is fully responsible for the timely completion of the asset. Reputation, experience, and good knowledge of the host country or having a local partner are imperative. Other contractors include suppliers who are responsible for supplying raw materials, equipment, or services. In contrast to the construction company, suppliers may not only have a role during the construction phase, but certain supplies might still be needed after the completion of the facility (e.g., fuel supply).

### 2.3.6 Offtakers

In the context of infrastructure project finance, an offtaker is the party who leases or operates the asset or buys a project's output upon completion. Normally, the project company does not itself operate the asset or facility after it becomes operational. Yet, sometimes, one of the sponsors will simultaneously be the offtaker, justifying the initial interest in the project. More commonly, however, a separate, specialized company or government authority will take care of the operation and maintenance. For projects generating an output like power or gas, the company enters long-term contracts with one or more purchasers. Such contracts often set out output and operational requirements for an infrastructure asset. On one hand, the project company guarantees a certain output to the offtaker. On the other hand, the offtaker agrees to purchase a specific amount and to make payments to the company. Thanks to the agreement, the project company generates revenue streams which are used to service the debt and repay the capital cost, cover maintenance costs, and generate a return for the equity investors and sponsors. Oil projects are sometimes an exception since the products are sold in the market and no offtaker is defined in advance. However, in the more regular cases, the offtaker and the project company enter an offtake agreement, which defines the offtake model (e.g., Leasing, Power-Purchase-Agreement, Operation, Concession, Take-or-Pay, Take-and-Pay etc.) as well as mechanisms of price and volume (BSIC (2020)). For a definition of the offtake models, please refer to Section 4.

## 2.4 Advantages of Project Finance

Clearly, this method of financing exhibits high complexity and involves numerous parties. Additionally, it is more expensive, more time-consuming and requires a higher level of expertise throughout the whole process than e.g., corporate finance. Also, the cost of borrowing tends to be higher in project financing than in corporate finance schemes. Yet some distinct features cause sponsors to prefer it. Project finance is often applied for large-scale and expensive projects, which one party may not stem by itself. Borrowing constraints and corporate size are inhibiting factors which normally render the implementation of large projects for single companies impossible. However, project finance allows to circumnavigate such restrictions as it allows a sponsor to keep the debt off the balance sheet (through the incorporation of an SPV) and to retain a healthy debt-equity ratio. Thanks to the off-balance sheet nature, none of the parties is constrained for future financing needs and the clear separation between the sponsors' other interest and the project funds is believed to mitigate agency cost and information asymmetries (Pinto (2017)). Additionally, it facilitates risk sharing with other parties, which is especially relevant for large-scale projects. Deciding on a risk-sharing principle for the investments upon which all sponsors agree is often difficult due to different risk appetites. Limited recourse project finance in combination with an SPV represents an attractive solution as it resolves optimal risk-sharing issues. Also, local laws and regulations can make project finance the more attractive route – if not the only route. For example, tax advantages may apply rendering such schemes highly attractive. On the other hand, certain countries' legal and regulatory framework apply ownership restrictions on project assets forcing sponsors to incorporate an SPV in the host country to execute the project.

Host governments may have reasons to find project finance desirable, too. It serves as a mean to attract foreign as well as private investments, which helps to reduce public sector borrowing. This is especially relevant in low-income countries with high levels of debt. Secondly, applying project financing allows for spillover effects into the host country by acquiring new skills and know-how, training the local workforce, and gaining relevant expertise.

# 3. Literature Review

This section provides a closer look at existing empirical literature on infrastructure and its effects on economic growth as well as other development indicators. It then proceeds to discuss Sub-Saharan Africa and its infrastructure endowment – or rather the lack thereof and its implications. Lastly, the focus will be put on project finance for infrastructure in Sub-Saharan Africa.

## 3.1 Influence of Infrastructure Provision

A large body of literature examines the effects infrastructure has on certain aspects of economic development. It can broadly be split up in two different strings of literature. Firstly, various authors estimate the output elasticity[3] of infrastructure spending, namely the effect of higher infrastructure spending on economic output, normally measured by GDP. A second string focuses on physical stock of infrastructure (e.g., length of road network) and tries to assess its influence on economic indicators such as employment, equality, or GDP.

Most of the reviewed papers assume a positive relationship between infrastructure and economic development, however, in none of the cases, causality can be identified irrevocably or without any caveats. Already works as early as 1989 by Aschauer (1989) suggest that infrastructure and productivity growth are positively correlated. Even though the mentioned paper has been criticized for empirical flaws, it has brought about a large body of literature which tries to estimate the influence of infrastructure on economic growth. Since data on infrastructure spending often is not available, many authors revert to measure the influence of public spending and public capital as a proxy for infrastructure spending (Kasper (2015))[4]. For example, Crafts (2009) estimates the output elasticity of infrastructure using an aggregate production function along the neoclassical growth model of the form:

$$Y = A(K_{pub}) * f(K, L, K_{pub})$$

Here, the output Y denotes GDP, $A(K_{pub})$ is the indirect influence of public capital (i.e., infrastructure) on total factor productivity and $f(K, L, K_{pub})$ is the direct effect of infrastructure $K_{pub}$, capital K and labor L. He finds that public capital has on average a positive influence on output. However, this positive effect is partly offset by the taxation which is needed to finance public capital. Similarly, Stupak (2009) states that a higher public capital stock has a *direct* positive effect on output in the short-term and an *indirect* positive effect in the long-term. The long-term effect is explained by the fact that people and businesses can raise productivity thanks to better infrastructure provision which in turn frees up time. This time can be used for additional economic output or leisure. For the US, he finds that a 1% increase in public capital

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[3] Output elasticity denotes how responsive output is to changes in levels of input such as capital or labor (Calderon, Moral-Benito and Servén (2015) )

[4] An issue with using public capital and public spending as a proxy for infrastructure is that in recent years the private sector has played an increasingly important role in its provision (Calderón and Servén (2008)). However, even if they are suboptimal proxies for infrastructure, the review will include such papers.

stock is associated with a 0.12% surge in private-sector economic output. A similar result is attained by Calderon, Moral-Benito and Servén (2015) who estimate the output elasticity of infrastructure with an aggregate production function supplemented by the input factor infrastructure capital. For their cross-country dataset which spans 88 countries over the period from 1960 to 2000, they use a panel time series approach through which they estimate the long-run aggregate production function. Their findings imply that a 10% increase in infrastructure assets comprising the sectors transport, power, and communication, increases GDP per capita by between 0.7% and 1%. According to them, the results are robust to other specifications, economically and statistically relevant and in accordance with results from meta-studies.

Analyzing a multitude of papers, Esfahani and Ramírez (2000, p. 444) state that "infrastructure-GDP interactions yield two-way causality in most countries". The authors state that one of the most frequent limitations in empirical papers is the failure to account for simultaneity bias. When controlling for simultaneity between GDP and infrastructure, they find a substantial one-way effect running from infrastructure to GDP. The output elasticity of infrastructure is estimated to be larger than its proportionate cost share in GDP. This indicates that infrastructure's marginal productivity overcompensates for its provision cost.

Straub, Vellutini and Warlters (2008) who examine the contribution of infrastructure investment on economic growth in East Asia, find a reverse effect in various countries. In the neoclassical growth model, if infrastructure is a variable along other forms of capital and labor, then it is not a trigger for growth but rather a consequence of it. They suggest no direct link to growth in most countries under scrutiny[5], yet an indirect link by easing bottlenecks and constraint as very likely. In the case of East Asia, the infrastructure needs were successfully addressed which is partly explained by the high levels of savings in the region, allowing for targeted investment. Easing such bottlenecks especially in developing countries leads to large welfare gains for the poor population. Overall, for the first string of literature, the findings seem to suggest a positive influence of infrastructure spending and economic output, even though various authors recognize a feedback loop.

An example for the second string is Perkins, Fedderke and Luiz (2005) who analyze the relationship between South Africa's economic infrastructure and long-term economic growth. Their analysis includes physical stock of various infrastructure sectors, such as transportation, telecommunication, and power. First of all, the authors suggest that infrastructure development is not a linear process but proceeds in phases. Strong growth in one sector usually comes at the cost of another sector. Furthermore, changes in the economic structure influence infrastructure development. For instance, an improved telecommunication network with a sharply increased customer base in the early 2000s boosted the electricity needs in South Africa. The authors additionally look at the sequence of different sectors in South Africa and state that the railway network came first and was then followed by the roads network. Thereafter, the provision of electricity and telecommunication infrastructure came into the fore, ensued by air travel.

[5] An exception is Thailand, where Straub, Vellutini and Warlters (2008) suggest a direct link.

Developments in one sector, hence, cannot be viewed detached from other sectors as they are strongly intertwined. With the rise of a telecommunications network, for example, a reliable power supply becomes more crucial. Also, only an intact road network would allow to access even remote areas and provide electricity to the rural population. In South Africa, GDP growth seems to drive infrastructure development rather than the other way around. Nonetheless, the authors suggest that roads build an exception since they have a strong causal impact on GDP growth. Thus, the authors conclude that the relationship runs in both directions, and they derive that higher infrastructure needs due to increased GDP growth must be taken care of by governments. Failure in doing so could severely hamper further growth due to bottlenecks or inhibit the exploitation of certain sectors to achieve growth and development.

Along the previous findings of the relative importance of roads, a variety of authors focus strongly on transportation networks. Intact transportation reduces transportation costs, decreases barriers to market access and has a cost reducing effect by decreasing inventories, all of which allow for better economic efficiency (Henckel and McKibbin (2017)). Banerjee, Duflo and Qian (2012) look at the two decades after China opened up to trade and find that regions' proximity to traditional transportation networks have a small but positive effect on GDP per capita, number of firms and leads to higher average profits of firms. Apart from this, they find that income inequality is higher in these regions. The effect, though, is small and they conclude that proximity to transportation networks does not have a large effect on relative economic performance. Alder (2016) applies a different viewpoint: He compares India's and China's spatial developments and connects them to their respective road networks. In a counterfactual analysis he applies the Chinese road network to India and concludes that China's tactics of connecting intermediate cities could lead to significant regional as well as aggregate growth gains in India. India showcases a much higher urban-rural disparity, and the rural areas would disproportionately benefit from a road network comparable to that in China.

Yet, infrastructure provision not only exhibits positive externalities within a country but also across borders. Henckel and McKibbin (2017) suggest that there are positive spillover effects from infrastructure growth in a country to its neighbors, namely a 1% growth is associated with a 0.4% to 0.7% growth in a bordering nation. For landlocked countries that are poorly endowed with resources the effect is believed to be larger. The exception is SSA, where the authors do not find this effect. Calderón and Servén (2008) who focus their study on SSA, assess the influence of infrastructure quantity and quality on growth and inequality. They find robust results indicating that infrastructure assets have a positive impact on long-term growth and a negative impact on income inequality[6] in said region.

Good quality and quantity of infrastructure under the right circumstances not only is relevant to reach full economic growth potential by lowering production cost and increasing productivity, but it is also an important factor for inclusive growth by facilitating better market access and increasing returns of the existing capital (Henckel and McKibbin (2017)).

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[6] I.e., income inequality decreases and a higher level of equality is achieved.

Inclusive growth implies that the advantages of an intact basic asset endowment within a country benefit the majority of inhabitants. If this condition is met, pro-poor growth is attained which can lead to lower income inequality and less poverty in a nation (ILO (2009)). Furthermore, infrastructure can create jobs directly, during the construction, operation, and maintenance of an assets, as well as indirectly, through the provision of electricity, water and ICT networks which allow to found businesses and create jobs. Functioning transportation networks additionally increase income streams as they allow for people to trade goods more cheaply and provide labor mobility (ILO (2009)). It also facilitates a development from low to higher productivity through better functioning manufacturing and services sectors.

Clearly, the endowment with good quality and good quantity infrastructure has manifold influences on a country and can even cause positive spillover effects for neighboring countries. For countries with a lower relative provision of basic facilities, the marginal productivity gain is larger than for countries who are comparatively better endowed (Henckel and McKibbin (2017)). Therefore, attaining a higher provision in low income developing countries will be an area of focus, especially in Sub-Saharan Africa.

### 3.2 Sub-Saharan Africa & Infrastructure

Sub-Saharan Africa is the world's poorest and least developed region by virtually any economic indicator. 49 of the 54 African countries constitute Sub-Saharan Africa which populates roughly 1.1 billion people amounting to 14% of the world population (IMF (2021)). 41 of these countries belong either to the low-income or low-middle income group as categorized by the World Bank. Aside from poverty, the region is often associated with civil unrest, wars, famines, and the spread of infectious diseases. These associations, however, would not do the region justice as it is gaining importance on the global geopolitical stage and has seen drastic improvements in social, governmental, and political aspects. Not only has the region established multilateral organizations to promote peace and regional cooperation, but it has also strengthened intercontinental relationships to improve trade. In 2018, China was the largest bilateral trading partner to Sub-Saharan Africa, followed by India (FDFA (2021)). Over the past years, average GDP growth rate was at 6% and various countries belonged to the fastest growing economies prior to the Covid-19 pandemic. Ethiopia, Kenya, Uganda, Ghana, Ivory Coast and Kenya even belonged to the 10 fastest growing economies in 2020, despite the global health crisis (Winkler (2020)). Having said this, overall, the Covid-19 pandemic caused the region to contract by an estimated 1.9% – the worst record in history. It is conjectured by the IMF (2021) that the region will only recover after 2022, making it the slowest growing world region in 2021.

Despite the strong improvements over the last decades, Sub-Saharan Africa (SSA) remains the world region with the poorest quality and quantity of infrastructure. Median access rates to electricity, water and sanitation or transportation networks are by far the lowest and display large disparities between rural and urban areas indicating that growth has not been inclusive and proportionate (World Bank (2017)). Access to clean drinking water and sanitation, for instance, is not only a most fundamental facet of infrastructure, but since 2010 it also constitutes a human right (UN (2010)). Aside from being a main factor for survival and health, clean water allows for cooking, washing, and cleaning, but also for irrigation of agriculture and thus, food production. According to Ritchie and Roser (2019) it is estimated that unsafe water accounts for 6% of all deaths in low-income countries. Yet in Nigeria, Chad and Madagascar, unsafe water is estimated to account for more than every tenth death. Even though, vast progress in the provision of water has been achieved, 9% of the world population does not have access to an improved water source. The region with the lowest access is concentrated in SSA. Access to safe water has indeed risen from 51% in 1990 to 77% in 2015 but compared to other world regions which display rates above 93% it remains low (World Bank (2017)).

The electricity infrastructure provides an interesting example to showcase the urban-rural rift in SSA. According to the World Bank (2017) overall, 35% of people had access to electricity in 2014 which is a 2.5-fold increase from 1990 when it was 14%. However, looking at the shares of urban and rural areas, a large disparity manifests itself. In 2014, 63% of the urban population had access to electricity, whereas only 19% of rural population did so.

Going hand in hand with the lack of electricity, SSA faces a substantial undersupply of ICT services. Kodongo and Ojah (2016) project that insufficient electricity and ICT provision hampers business productivity by around 40% every year and that ICT investments of USD 9 billion annually would be needed to catch up with the rest of the world. According to them, the internet penetration rate stood at 6% in 2012 which is much lower than the average 40% rate for developing markets (DMs).

Insufficient provision of infrastructure raises further problems as Pottas (2012) mentions. Inefficiencies in intra-continental trade due to poor transportation networks are estimated to raise the cost of goods traded in SSA by a third. Additionally, restrained accessibility to and within the region prevents the rest of the world from building more intense business relations with Africa. He furthermore asserts that the discovery of natural resources in East and Southeast Africa alongside the large demand from Asia for minerals, iron ore, platinum and other resources is making the provision of intact infrastructure critical. The symbiotic relation between commodities and infrastructure is characteristic for various countries in said region. Global demand drives the development of facilities to mine or extract commodities which in turn drives the continent's economic growth. However, an abundance of resources in combination with lacking democratic institutions, as the natural resource curse suggests, has been causal for stagnant long-term growth. SSA poses a good example of the downsides of natural resources as Janda and Quarshie (2017) explain. Once a country detects large reserves of commodities, revenues generated from the resources are invested inefficiently, wages in the public sector surge which often prompts corruption to spike. As African countries have seldomly managed to harness resources themselves and failed to deploy the revenues into non-resource sectors to generate profits elsewhere, they cannot exploit their resource-richness and

translate it into better infrastructure. Even though China's involvement in Africa is highly debated, some researchers suggest that China's "*Infrastructure for Resources*" model, allowing for an expansion of infrastructure through countries' resource wealth, has reverted the resource curse in e.g., Angola (Durovic (2016)).
Because of the critical undersupply, the African continent has the highest global infrastructure investment demand, conjectured at annually USD 130 – 170 billion (Arbouch, Canuto and Vazquez (2020)). Estimates of Dornel (2014) amount to USD 93 billion per year, which corresponds to 15% of Africa's GDP. Of this amount, one third will need to be invested in operation and maintenance of existing assets and two thirds are projected for the construction of entirely new projects (Pottas (2012)). The African Development Bank (2018) has approximated the yearly investment gap to be between USD 68 - 108 billion. This gap could be reduced by a third through optimization of operations and efforts in overcoming this gap would lead to positive overall effects (Dornel (2014)). The World Bank (2017) for instance estimates that closing the investment gap would increase GDP per capita in SSA by 2.6% annually. Project finance could be a means to bridge this investment gap and facilitate more financing.

## 3.3 Project Finance in Sub-Saharan Africa

Historically, African countries tended to finance infrastructure through fiscal capacity and with the help of donations. Since the beginning of the millennium as Gurara et al. (2012) state, a couple of countries pursued national development agendas by improving infrastructure and hence, increased public spending. However, as overall debt levels have been high in recent years, fiscal capacity in these countries is restricted. For this reason, various low-income countries in Sub-Saharan Africa were unable to realize critical infrastructure projects. Given the high debt level and limited fiscal capacity of many low-income, developing countries (LIDCs), financing in the form of grants and concessional loans from multilateral agencies (MLA), export credit agencies (ECA) or governments are crucial components for the infrastructure sector. Additionally, it is important for them to improve public spending efficiency, mobilize domestic resources, receive help from foreign partners, and crowd in the private sector (Gurara et al. (2012)). Project finance is an ideal means to achieve these objectives and to finance risky infrastructure projects in low-income countries.
Recording an increase of almost 280% between 2000 and 2014, Pinto (2017) concludes that project finance lending for infrastructure has become more widely accepted. Region-wise, the driver of this increase are Western Europe and Eastern Asia. Of the dataset, less than 5% of all infrastructure project financing loans are recorded in Africa. This is similar to the conclusion of Dornel (2014), who finds that in the decade between 2003-2013 more than 5000 project finance deals were closed around the world totaling USD 2 trillion. Only a small fraction of these deals was closed in SSA, namely 158 projects at a total debt of USD 59 billion, corresponding to merely 3% of the overall value.

Clearly, the region struggles to attract a higher share of investments. The World Bank (2017) identifies a variety of challenges, broadly to be categorized as government challenges and financial challenges, which are responsible for the investment gap in SSA. The government challenges include weak regulatory environments, policy uncertainty and corruption. On the financing side, problems arise due to underdeveloped financial market, currency exchange risks, long project durations and cost overruns. Sheppard, von Klaudy and Kumar (2006) suggest that private investments could be increased either if foreign exchange risks are lowered or if local capital markets could participate more. Private capital and foreign expertise will be crucial factors for the investment gap to narrow. Meanwhile, Nigeria and Kenya are the only countries where the financial markets are developed enough for local commercial banks to provide financing in infrastructure projects. Normally, the participation of commercial banks is needed in closing project finance deals and to attract private investments. Development Finance Institutions (DFI) and Multilateral Development Finance Institutions (MDFI) are, however, still the largest lever to attract foreign private funds: They have the expertise and professionalism to understand countries' particular needs and structure investments (Wezel (2004)). An additional difficulty many countries face since the Great Financial Crisis of 2007/08 is the changed investor base as Arbouch, Canuto and Vazquez (2020) state. Commercial lending – the most common lending source – has significantly declined due to higher liquidity requirements in Basel III which increased the cost of lending for banks. Even though, pension funds and private equity funds have concurrently shown a higher interest in the asset class infrastructure in Africa due to the high growth potential on the continent, it does not make up for the decline in bank lending.

Despite the relative difficulty in attracting financing and the high indebtedness of many governments in SSA, the region does not showcase more defaults than other places. Quite the contrary as shown by a Moody's (2018) report assessing default rates of project finance bank loans in infrastructure around the world. Default rates in Africa stood at 5.3% between 1990 and 2016. For Latin America, the default rate was at 12% over the same period, more than double that for Africa. Asia exhibited defaults in 8% of all infrastructure project financings, still exceeding Africa. It is possible that only a low number of projects in Africa make it through the feasibility study and seek financing. Those tend to be highly structured and very safe projects, which – once they receive financing – are likely to be successful (Messervy (2018)). This also corresponds to the findings of Lakmeeharan et al. (2020). They suggest that only around 10% of all announced project in SSA reach financial close – and these are the best structured and safest deals. Thus, low default numbers and a low rate of projects progressing further than the planning phase go hand in hand. The authors assume that the absence of a long-term and holistic infrastructure vision in combination with limited knowledge on how to do a business plan or conduct a feasibility study often leads to poor project management and delays. Inefficient government agencies' often cause additional delays which leads to project cost rising and problems in finding offtakers. On the investment side, agreeing on a risk allocation poses a major problem, that may hinder financing.

The totality of deficiencies and fiscal constraints aside underdeveloped financial markets in these LIDCs are a hinderance for project finance to reach its full potential in facilitating a higher long-term growth (Chan-Lau, Kelhoffer, Zhang (2016)). Solving some of these deficiencies would allow for infrastructure project finance to be more effective, better the infrastructure endowment and ultimately, lead to higher growth and increased standards of living.

## 4. Data & Methods

### 4.1 Data Overview

The data in this paper was on one hand derived from the Project Finance database of SDC Platinum[7] and on the other hand, supplemented with hand-picked data from a multitude of sources. The data from SDC platinum was retrieved in unformatted text and brought into a form suitable for economic and econometric analysis. To that end, each of the roughly 2276 projects was single-handedly considered, cross-referenced with further sources, and complemented with additional data. Cross-referencing with other databases on infrastructure project finance available, the total number of projects was found to be comparable. The dataset has no claim to completeness, but it should provide a good approximation of the project finance activity in Sub-Saharan Africa between 1990 and 2020. As mentioned earlier, other infrastructure financing schemes exist, thus, the project financing data base does not provide a complete picture of infrastructure investments or activity in SSA.

In the database, the maximum time frame, all infrastructure sectors, all project statuses, and all financing statuses available were selected. This resulted in a dataset comprising 2276 project financings in 47 countries of SSA which span a period from 1972 until 2020. As only two projects were announced in 1972 and other than these two, the earliest announced projects date to 1990, the 1972 projects are excluded from the analysis. This results in 2274 projects considered for the analysis and therefore translates into a data frame of 2274 observations and 184 variables.

Depending on the variable, the completeness of the data varies. For instance, there is information on the sponsors in 1850 projects and financing information for 814 projects. The data quality on offtakers is rather sparse which is why the descriptive analysis will be brief. Additionally, it is not clearly stated whether the project and financing costs are inflation adjusted. Thus, an inflation-adjustment has been conducted which resulted in a strongly decreasing cost trend over the time frame. Due to doubts regarding the correctness of this adjustment, it was undone. Therefore, for the rest of the thesis, inflation adjustment of the monetary amounts will be assumed which is believed to be a reasonable assumption given the database stems from Refinitiv and Thomson Reuters.

For the quantitative analysis, more variables are included, namely GDP growth, GDP per capita, income group, corruption index, financial development index, labor productivity, export quota, contract enforcement and an index on political stability and absence of terrorism. All of them were retrieved from the World Bank database except for the financial development index which was accessed through the IMF database and labor productivity which was retrieved from the ILO.

[7] All data from SDC Platinum was retrieved on 18.12.2020

## 4.2 Explanations & Definitions

### 4.2.1 Countries

The data includes 47 of the 49 countries in Sub-Saharan Africa. The two exceptions are South Sudan (independent since 2011) and Comoros, both of which did not record any infrastructure project financings over the past 30 years in the data. Djibouti, Somalia, and Mauritania are included because they belong geographically to SSA even if they are part of the Arab League. All countries appearing in the data and recording infrastructure project financings in the considered period are listed in the below table in alphabetical order. For a map of the region of interest, please refer to the Appendix A. 1 Graph A 1.

Table 1: Table of all Sub-Saharan Countries Appearing in the Data

| | | | | | |
|---|---|---|---|---|---|
| Angola | Benin | Botswana | Burkina Faso | Burundi | Cabo Verde |
| Cameroon | Central African Republic | Chad | Congo, Dem. Rep.[8] | Congo, Rep. | Côte d'Ivoire |
| Djibouti | Equatorial Guinea | Eritrea | Eswatini | Ethiopia | Gabon |
| Gambia, The | Ghana | Guinea | Guinea-Bissau | Kenya | Lesotho |
| Liberia | Madagascar | Malawi | Mauritania | Mauritius | Mozambique |
| Mozambique | Namibia | Niger | Nigeria | Rwanda | São Tomé and Principe |
| Senegal | Seychelles | Sierra Leone | Somalia | South Africa | Sudan |
| Tanzania | Togo | Uganda | Zambia | Zimbabwe | |

Source: SDC Platinum

### 4.2.2 Project Models

Each project is procured in one of six different project models[9], which are defined below. Preliminary, it needs to be said, that the literature has various definitions for these models and the delimitation is often blurry.

- *Public-Private-Partnership:* A blurry delimitation applies regarding Public-Private-Partnerships (PPP). The used definition of BSIC (2020) states that an infrastructure project financing qualifies as a PPP if the government acts as a sponsor and a private sector entity does so, too. If a project's sole sponsor is either a government or a private company, it does not qualify as PPP for the remainder of this paper. This contrasts other definitions which state that any partnership where a private entity builds public work

[8] Formerly known as Zaire until 1997

[9] Also referred to as project delivery structure or procurement model

qualifies as PPP (Gatti (2012)). Another definition says that any concession agreement between a government and a private party qualifies as PPP. Insofar as there is almost always a government involved for granting an approval, a concession or mining rights, virtually all infrastructure project financings would qualify as PPPs except for the solely government-sponsored ones. Applying such a definition would be in stark contrast to other sources regarding the frequency of this project model in SSA. Thus, the definition of BSIC (2020) is aligned with the data and with cross-referenced sources and will henceforth be applied.

- *Privatization*: Privatization of infrastructure denotes the case where a government brings a private company to build, operate, maintain, and own priorly state-owned or state-run infrastructure. This can happen either by selling existing infrastructure to a private firm or by selling the assets to the private firm and letting them develop and own a new infrastructure facility (Reed (2012)).
- *Acquisition:* An acquisition takes place if a priorly uninvolved party becomes a majority shareholder (sponsor) in the SPV and takes over the concession agreement (Sànchez and Delgado (2020)). The uninvolved party can be a single company or a consortium of companies. This implies that the ownership or the right to use an infrastructure asset changes hands.
- *Build-Operate-Transfer (BOT)*: As defined in Section 1, the (BOT) model implies that the project company is responsible for financing, building, maintaining, and operating a project or facility. The ownership remains with the host government (Sambrani (2013)). After a pre-determined period of operation and maintenance, usually between 10 to 30 years, the project company transfers the facility and all operating rights back to the government. Variations of this model are called Build-Own-Operate-Transfer or Build-Own-Transfer.
- *Build-Own-Operate (BOO)*: The Build-Own-Operate model is similar to the BOT except that no re-transfer to the government is foreseen, i.e., that the concession agreement can usually be renewed after the former agreement expires (Dentons (2018).
- *Design-Build-Finance-Operate (DBFO)*: The DBFO model describes a project delivery model in which the project company is awarded a contract to first conceptualize and design, subsequently build according to this design, before lastly financing and operating a facility for a pre-determined period. The government retains ownership, thus it is a variation of the BOT (Practical Law (2020)).

### 4.2.3 Main Providers of Finance

In the Sub-Saharan data, up to four loan types per project can have a maximum of 19 financing providers. Each provider has been categorized into one of six categories. The definitions and explanations in this section are primarily based on World Bank (2020).

- *Commercial/Investment Banks*: Commercial and investment banks are a main investor of infrastructure projects. Most often, these institutions act as part of a syndication process granting a syndicated loan. In the data, the mandated lead arranger[10] is usually a foreign investment bank such as BNP Paribas, ING or Société Générale. This is the case because commercial banks in developing or emerging markets often lack the expertise or capacity to take on the role of lead arranger and enter such long-term and complex projects. Local commercial banks are mostly involved as junior members in syndicated loans.
- *Asset/Investment Manager:* Asset and investment managers are financial professionals who invest their clients' funds to earn as high a return as possible. They have developed an appetite for infrastructure since the financial crisis of 2007/08 and increased their investments ever since (AFME (2015)).
- *Export Credit Agencies:* Export Credit Agencies (ECAs) issue export financing or export insurance and guarantees. Export financing normally takes the form of credits (export credit loans), whereas export insurance takes the form of a credit insurance or a credit guarantee. Traditionally, ECA offered grants, insurances, or export credits with an implicit or explicit government guarantee. However, nowadays, ECAs have expanded their product range to further financing instruments and promote foreign trade (Serv (2021)).
- *Development Finance Institutions & Multilateral Development Finance Institutions:* Development Finance Institutions (DFIs) and Multilateral Development Finance Institutions (MDFIs) normally have an official mandate by either a government or a region to promote development. These institutions offer long-term financing in combination with expertise knowledge on infrastructure projects. The capital often enjoys government guarantees or is sourced from development funds. Thanks to these characteristics, they are trusted on capital markets allowing to raise large amounts of capital and, thus, giving loans at competitive rates (OECD (2021)). DFIs and MDFIs include national and international development banks.
- *Sovereign Wealth Funds/ State Investment Banks*
  Sovereign wealth fund and state investment banks are investment funds owned by a state. Generally, these sovereign wealth funds are born out of resource rich countries and tasked to manage the states' wealth sustainably (Blundell-Wignall, Hu and Yermo (2008)). Examples thereof are the Qatar Investment Authority or the Norwegian Oil Fund. Such funds counteract volatility of fiscal revenues or accumulate savings for future generations. They invest capital around the world and are thus, frequent investors in infrastructure projects.

[10] The mandated lead arranger or MLA is the institution which is responsible for arranging the syndication process for a loan (Reudelhuber (2015)).

- *Private Equity Funds:* Private equity funds denominate collective investment schemes of private equity firms. Often, such funds seek direct investments in non-publicly listed assets and would want and equity stake in an infrastructure project. Since the GFC, their appetite for infrastructure has increased (AFME (2015)).

### 4.2.4 Loan and Equity Types

A project can have up to four different financing types in the data. They include both loan and equity financings. In order to understand the descriptive analysis better, they will briefly be explained.

- *Bilateral Loan*: A bilateral loan denotes debt financing between two parties, namely a lender (e.g., bank, company) and a borrower (infrastructure sponsor). As only two parties are involved, each loan can be negotiated and shaped accordingly.
- *Bridge Loan:* A bridge loan is a short-term loan which is utilized to overcome a short-term lack of financing normally extended for a one-year period. They are an interim aid until longer-term financing is secured (The Economic Times (2021)).
- *Concessional Loan*: The OECD (2003) defines concessional loans as "loans extended on terms substantially more generous than market loans". The lower cost of debt is achieved through low interest rates and/or grace periods.
- *ECA Loans and Grants*[11]: These are loans as well as grants provided by ECAs. Covered loans describe loans which have a cover from either a multilateral agency or an ECA. A frequent cover type is the political risk insurance which protects against losses arising from civil unrest, war, expropriation, and irredeemable currencies (IISD (2020)).
- *Government Loans and Grants:* Governments – whether it is the host or a foreign government – are important providers of equity as well as debt. In the data, they provide financing either as debt financing (i.e., loans) or equity (i.e., grants).
- *Multilateral Agency Loans and Grants:* These are loans as well as grants provided by Multilateral Agencies (e.g., World Bank, African Development Bank).
- *Public Bond*: In addition to debt financing through loans, which are broadly used in project finance, bond markets constitute a possibility to raise debt. After the financial crisis in 2008, this form enjoyed more popularity due to stricter regulations on bank lending (Deloitte (2021)).
- *Sponsor Equity*: The term *sponsor equity* refers to equity capital injected either by a sponsor or a co-sponsor of the infrastructure project financing. Usually, debt investors require some sponsor equity as a security and to align incentives before granting loans (AFME (2015)).

[11] Grants denote a money transfer between a government, ECA or MLA and a project company for a specific purpose, namely the infrastructure asset, where no repayment is expected (Gatti (2012)).

- *Syndicated Loan*: As infrastructure projects tend to be very expensive, they often surpass any single institution's ability to finance it. Therefore, investment banks and commercial banks build syndicates. Reudelhuber's (2015, p. 3) definition reads: "A syndicated loan is where more than one bank collectively lends to the same borrower on common terms and conditions reflected in, and underpinned by, one loan agreement which is signed by all parties." In syndication processes, one investment bank is the mandated lead arranger who organizes the distribution of loan tranches and often takes a large ticket itself.
- *Third Party Equity*: Aside from sponsor equity, third parties sometimes wish to be involved with an equity stake in a project which is possible. Their time horizons are often longer as compared to debt-providers.

### 4.2.5 Offtake Contracts

The offtake contract is an agreement between the project company and one of the sponsors or a third party which gives the latter the right and obligation to acquire the output or product of a facility (Denton (2018)). In the data, different offtake contracts appear, however, there are four main categories and one broader category including different agreement types that rarely appear. This section is primarily based on Salih and Salih (2017)).

- *Take or Pay*: Under a Take or Pay contract, the offtaker agrees to buy a product or output from the project company for a pre-determined period at a set price. Even if the project company cannot deliver the output capacity which the offtaker requested, the offtaker must pay implying an unconditional payment obligation with respect to the capacity component. Furthermore, the contract defines a sum agreed on by both parties in case the offtaker for some reason becomes unable to continue buying the product or output (Dentons (2018)). In rare cases, the agreement states that the offtaker is obliged to pay even if the project company produces nothing.
- *Take and Pay*: This contract type is similar to a Take or Pay contract, however, it obliges the offtaker to buy the output or product from the project company only and only if it produces and delivers the agreed-upon output capacity. If the project company fulfills its obligations of the contract but the offtaker does not want to or cannot take the output, he is still obliged to make the payment.
- *Leasing*: The project company can lease a facility to an offtaker. Under this contract the offtaker takes on all the risks and simultaneously receives all the rewards of ownership but pays a rent to the project company.
- *Power Purchase Agreement (PPA):* A PPA is a contractual agreement between an energy-producing project company and an offtaker (energy buyer) who is often state-owned. By means of the agreement, the project company and the offtaker define the output capacity which will be delivered from the producer and bought by the buyer. This type of contract is usually signed for periods of 10-20 years (World Bank (2021)).

- *Other agreements (steam supply, tolling):* There is a variety of other offtake agreements which are specific to certain sectors or facilities. They are comparable to PPAs but concern water and other output types. These contracts will not be defined in further detail.

## 4.3 Methods

The data collection on project finance is generally not done systematically which is indicated by the qualitative and unformatted nature of the preliminary data. Generally, data collection on project finance is in its infancy – even more so in certain world regions. Clearly, a main reason for the scarcity of reliable information is that e.g., clear definitions of infrastructure and sectors constituting it are still amiss. Furthermore, a degree of opaqueness with regard to concession processes as well as financing is an inherent feature of infrastructure.

Meanwhile, the qualitative nature makes quantitative analysis challenging. As visible from the past section, the data consists mostly of multilevel categorical variables which lack any intrinsic order, thus restricting the array of available quantitative methods. A high number of levels, often exceeding 10, is a further complicating factor. Most variables except for dates, project cost and financing amount are factors or character variables. Thus, the descriptive analysis focuses strongly on visualizing and describing the data which at times appears repetitive. Additional information and explanation attempts are included to lighten the information overload. Easy statistical measures such as means, medians and the like will be supplied where possible and meaningful. For the quantitative analysis, some hypothesis tests and a set of multiple linear regressions will be performed. Both descriptive and quantitative analysis were conducted in RStudio. This section is primarily based on Schmuller (2017) and Stock and Watson (2012).

### 4.3.1 Network Analysis

As an addition to the descriptive part, a network analysis has been conducted to visualize the links between financiers and host countries. Network analyses are used to examine the relationships and interactions within social, informational, or physical systems (Luke (2015)). Given the nature of the data, it is possible to visualize which sponsors or financiers are connected to which host countries. To conduct a network analysis so-called nodes and edges are required. The former denote the various entities – in this case all sponsors/financiers and host countries. Meanwhile, edges have information about the links or relationships between the nodes. In the example at hand, the edges visualize which sponsor is linked to which host country or which financier provides funds to which host country and how often these links occur.

### 4.3.2 Contingency Tables and Mosaic Plots

For the hypothesis tests, contingency tables with frequencies as well as table, row and column proportions are used. Contingency tables are useful for multivariate categorical data as they compare the co-occurrence of two sets of variables as compared to a randomized case (i.e., under the assumption that there is independence between the variables) (Wnuk and Kozak (2009)). Therefore, this method will be relied upon to infer the association between two multivariate categorical variables. As contingency tables for categorical data with many levels are somewhat difficult to read, mosaic plots will be used to visualize contingency tables. Mosaic plots allow to easily recognize whether the co-occurrence of two sets of variables appears more often than expected under independence (i.e., null hypothesis) as these pairings are shaded in blue. If a pairing appears less often than expected under independence, the mosaic plot indicates this with a red shading. Pearson Chi-squared tests are used to calculate the p-value in order to accept or reject hypotheses. One can reject the null hypothesis if the p-value is smaller than the chosen significance level $\alpha$. The Chi-squared test is a score test that evaluates whether the actual co-occurrence of two variables is statistically significantly different from the co-occurrence one would expect under independence.

### 4.3.3 Dummy Coding and Anova

The use of an explanatory categorical variable in a regression analysis is slightly more complicated than the use of a continuous variable. A common system that is usually applied is called dummy coding. This is a method where categorical variables are transformed into a set of dichotomous variables, meaning that they can either take a value of zero or one. If the categorical variable has n different levels, statistical software such as R creates n-1 dichotomous variables which take values of either 0 or 1 as well as one variable which is coded with the value zero. This latter variable is the reference level in the regression and all other dummy-coded levels are interpreted relative to it. Thus, the regression analysis basically compares the reference level to either the absence (0) or presence (1) of another categorical level and assesses the influence of either absence or presence of it. When estimating a regression model where all explanatory variables are dummies, but the explained variable is continuous, it is referred to as analysis of variance model, normally referred to as Anova. An Anova tests whether the means of different samples are statistically so different that the null hypothesis of independence between the categorical explanatory variable and the explained variable can be rejected (i.e., it can be rejected that the different levels of the categorical variable have an identical influence on the explained variable) (Schmuller (2017)).

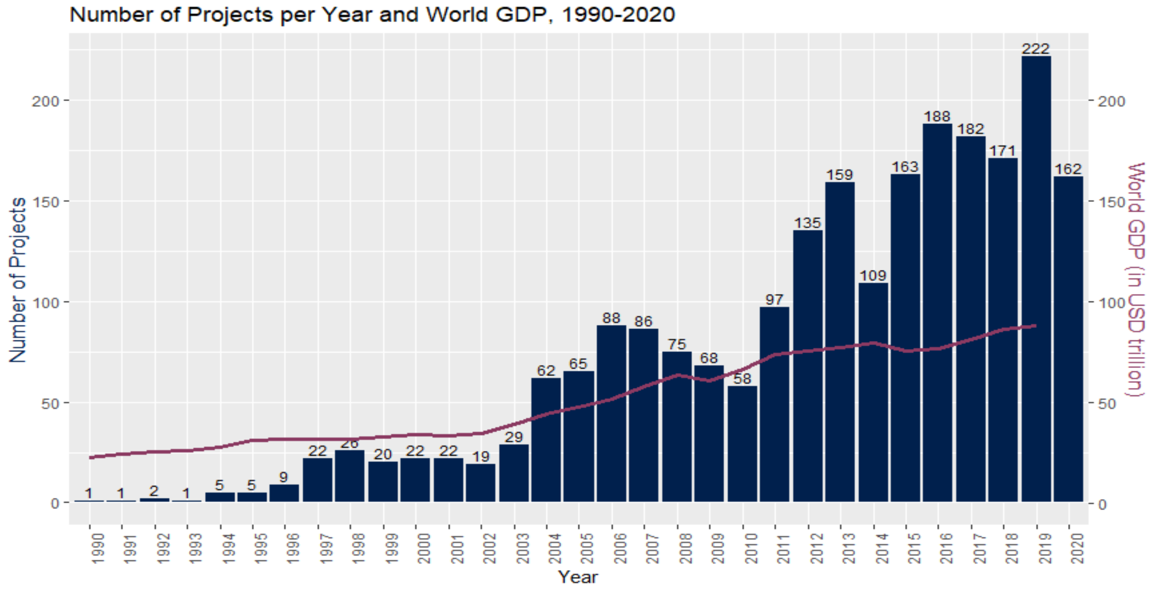
# 5. Descriptive Analysis

In this section, a comprehensive descriptive analysis of the project finance data in Sub-Saharan Africa between the years 1990 and 2020 will be conducted. It aims at providing an overview over the general activity and country-level dynamics, then proceeds to conduct a review of sectors and subsectors, offtakers, contractors as well as financiers and sponsors. Seeking to reduce the knowledge gap in this field of study, this part constitutes the main chapter of the thesis. In total, 2274 projects are recorded in the data, containing every type of project status, including cancelled or inactive projects. These projects amount to 26 counts and are included to provide a complete overview but will be excluded from the data at a later stage.

## 5.1 Overview

During the period of interest, an overall positive trend with certain weakening cycles is observable, as depicted in Graph 1. From 2003 to 2004 the number of projects more than doubled and this expansion lasts until 2007. However, after the Great Financial Crisis (GFC) of 2007/08, some years with lower project numbers ensue. It is estimated that the GFC caused the GDP in Africa to drop by 5-7% mostly because bank lending and foreign direct investments from developed countries plummeted (te Velde (2009)). After a recovery and a renewed increase in project numbers, the year 2014 records a significant decrease which is followed by a quick recovery. It is highly possible that the Euro Debt Crisis and the Taper Tantrum[12] were

Graph 1: Number of Projects per Year plotted against World GDP




Graph 1 showcases the years between 1990 and 2020 on the x-axis and the number of projects on the left-hand side y-axis. The right-hand side y-axis indicates the world GDP in USD trillions until 2019. It is observable that the downwards trends in infrastructure projects somewhat correspond to the world trends.

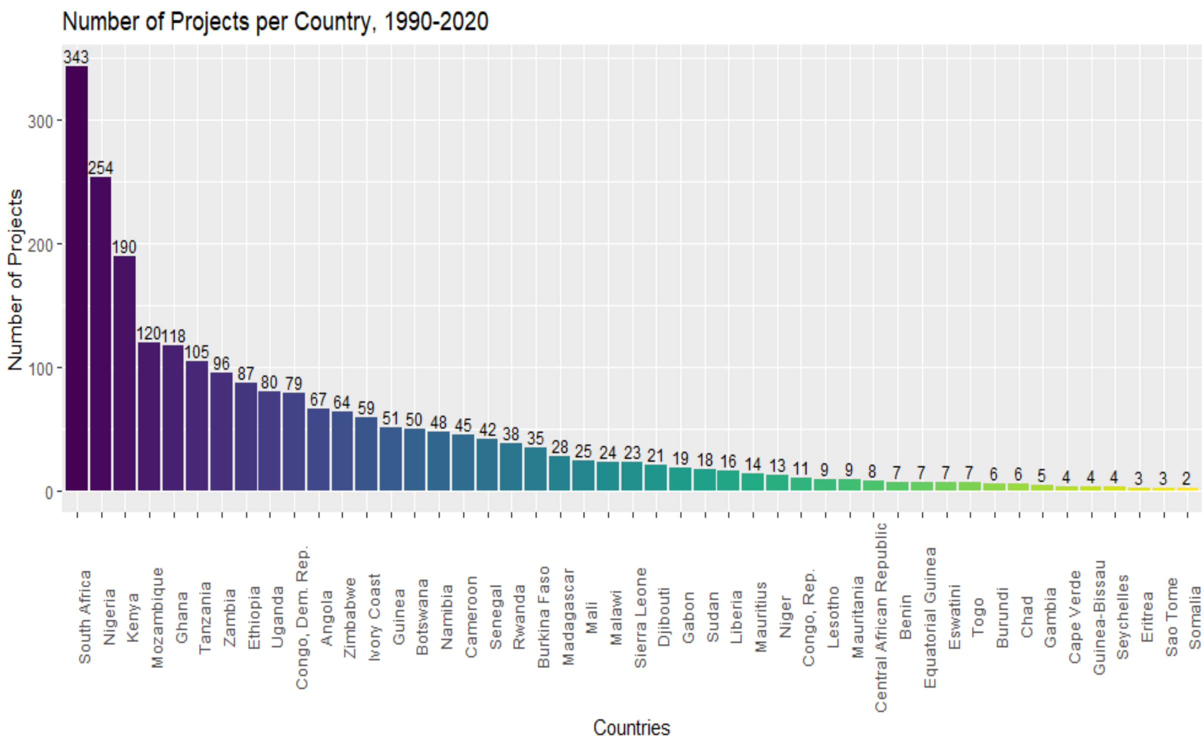
Source: Own Illustration based on SDC Platinum Database & World Bank World GDP Data

[12] After the Fed announced to taper the quantitative easing policy, bond yields rose & investors became wary. South Africa was considered fragile to capital outflows, bank lending to EMs/DMs dropped (Avdjiev and Takats (2014)).

among the factors causing the 2014 decline. The year 2019 registers a record number of 222 infrastructure projects, dropping to a lower number during the Covid-19 pandemic. World GDP in USD trillions is plotted on the right-hand axis, where similar yet less pronounced cycles can be discerned (i.e., World GDP dropping after 2008 and after 2014).

For various African countries, the year 2015 was marked by strong economic growth and recorded high foreign capital inflows (Calderón, Cantú and Chuhan-Pole (2018)). One factor which has been cited as a cause for higher foreign investments targeted at Africa during that time, are the low interest rate levels in developed markets. In the years after the GFC, interest rates stood at historically low levels and some countries even introduced negative interest rates (e.g., Switzerland and Japan). Low levels in home markets might have incentivized investors to place their capital elsewhere – for instance in infrastructure projects in Africa, which promise high rates of return (Sappin (2019)).

Graph 2: Number of Projects per Country



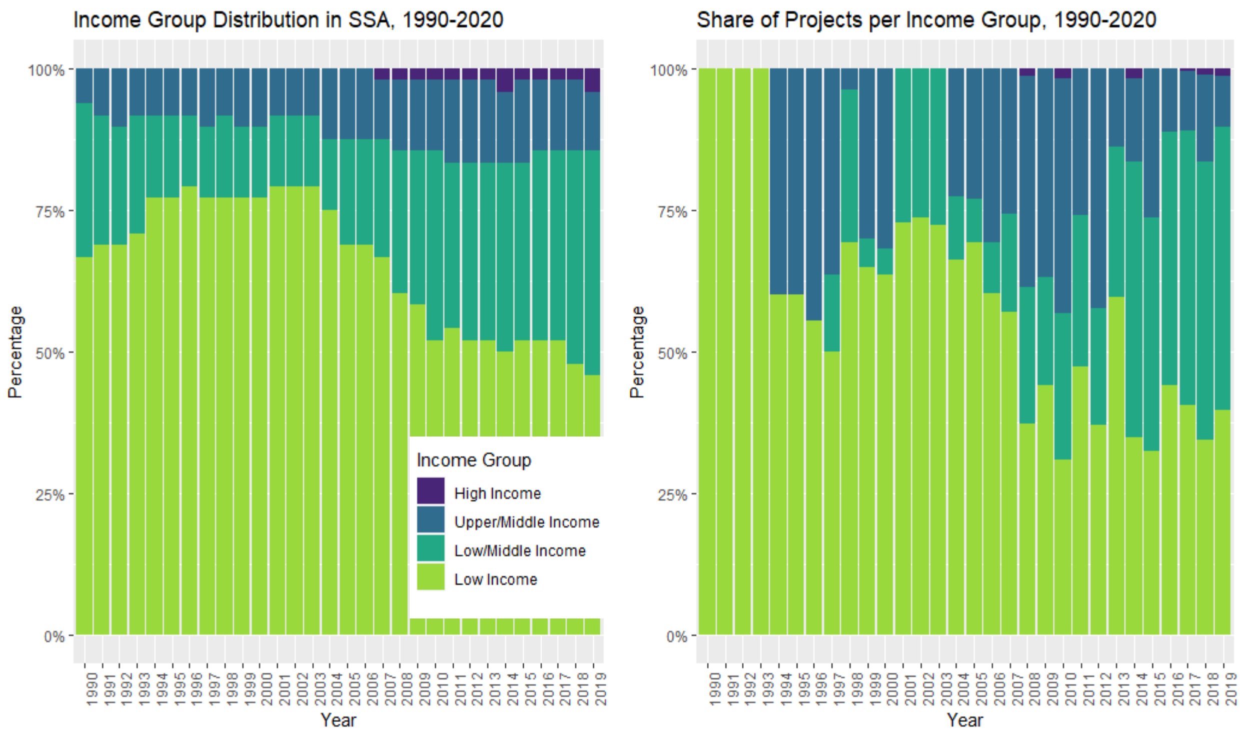

Graph 2 depicts the total number of projects for each country during the considered period from 1990 – 2020. The numbers on top of each bar indicates the total project number of each respective country.

Source*:* Own Illustration based on SDC Platinum

Graph 2 demonstrates that the distribution of the number of projects across countries differs significantly. Certain countries such as South Africa attract a substantially larger share of projects than others. Out of the 2274 projects, 343 pertain to South Africa, followed by Nigeria with 254 projects. Additionally, Kenya, Mozambique, Ghana, and Tanzania all record above 100 projects in the period between 1990 and 2020. 47 of the 49 Sub-Saharan countries record two projects or above except for South Sudan and Comoros who both feature no projects at all.

Investigating the distribution of the projects according to income group affiliation is interesting. Note that in the subsequent paragraphs, the data for 2020 is excluded as no income group data is yet available. Overall, the share of projects in low-income countries amounts to 47% (i.e., 973 projects), the share of the low-middle income countries is 32% (695) and 21% (434) for the upper-middle income countries. Recording 10 projects over the observed period, the high-income group's share is merely 0,5%. This low share is not surprising as no country in SSA belonged to the high-income group between 1990 and 2007, and only one or two per year thereafter. In 2019, Mauritius and the Seychelles are considered high-income according to the World Bank database.

Graph 3: Comparison between Income Group Distribution per Country and Project Share per Income Group




The left-hand side of Graph 3 shows the income group distribution of countries in SSA for each year between 1990 and 2019. The right-hand side of Graph 3 exhibits the share of infrastructure project financings per income group in SSA for each year. This allows for a comparison between the overall income group distribution of SSA and how the project financing deals have been distributed according to income group.

Source: Own Illustration based on World Bank Income Group Distribution of Countries & SDC Platinum

In Graph 3, on the left-hand side the income group distribution of SSA countries per year is depicted and on the right-hand side the distribution of infrastructure project financings per income group. Interestingly, the upper-middle income countries account for more project financings than could be expected from the group's overall share. This is very pronounced in the five years from 2008 onwards during which time the group's project financing shares were between 25% and 42% per year. Project finance normally utilizes a mix of private and public debt but accessing public funds is often regarded a first step to attract private funds. After the

GFC, many African countries struggled to gain access to bank loans as financial institutions from developed countries allocated their capital more safely (AFME (2015)). Upper-middle income countries have a lower probability of default and are often home to better developed financial markets than the lower income groups. Additionally, the non-existent to low sovereign credit ratings for most SSA countries, made attracting debt finance after the GFC extremely difficult. Not surprisingly, the data seems to suggest a positive effect between entering a higher income group and number of project financings. This is especially prevalent for Cameroon, Ghana, Ivory Coast, Kenya, and Ghana as can be seen in Appendix Graph A 2.

## 5.2 Project Model

Compared to other world regions where the Build-Own-Transfer (BOT) model is most common, the Build-Own-Operate (BOO) model showcases the highest prevalence in SSA with a share of more than 82% of all projects. A reason might be that through this project type, the host government transfers the risk entirely to the private sector party (i.e., project company). Despite having the usage rights contractually granted during the contract period, which can be seen as an insurance for the project company, they still face political risks, which is a main inhibiting factor for project financing in SSA (Sheppard, von Klaudy and Kumar (2006)).

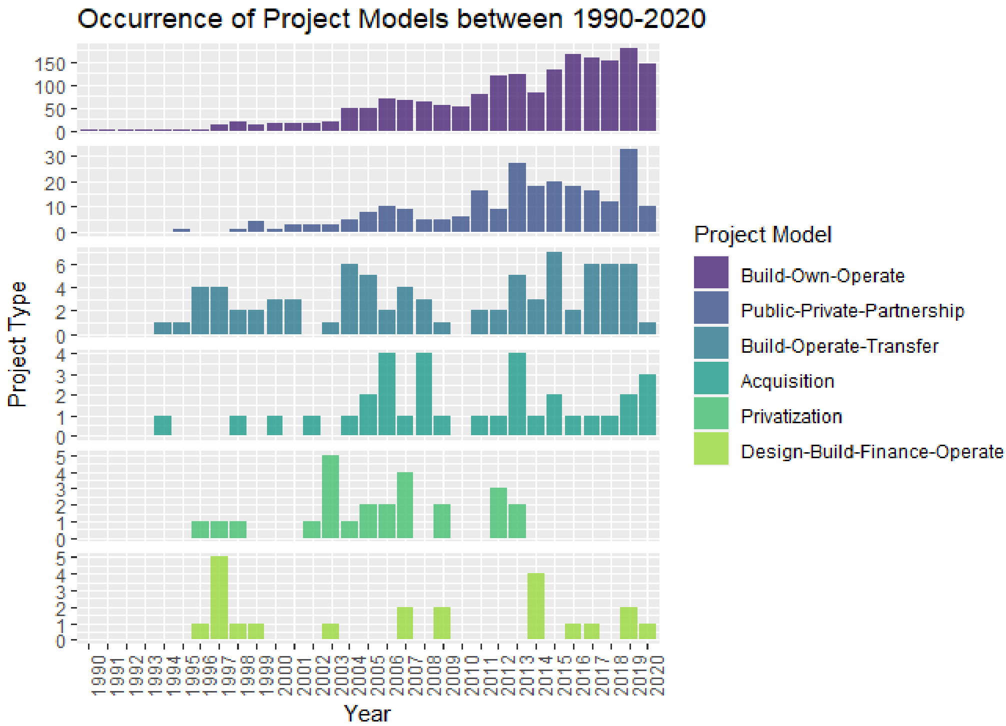
The second most common project model is the Public-Private-Partnership (PPP) scheme, in which the host government or a government entity assumes the role of a co-sponsor. The first PPP is recorded in the year 1995 and ever since the early 2000s, this project delivery model has increased including certain weakening cycles as visible in Graph 4. Approximately, every tenth project is planned as a PPP. Those projects capitalize on the strengths of both the public and the private sector and often attract many private investments because the government involvement is perceived as a risk insurance. PPPs, for instance, tend to exhibit less project delays and cost overruns than other project types (Yescombe (2017)). Lakmeeharan et al. (2020) suggest this procurement model to ease the fiscal constraints in SSA. In that way, projects which are less profitable could be conducted by governments, whereas economically viable assets could be shift to the private sector through PPPs and concessions. This would prevent the crowding out of private-sector financing.

The BOT is the third most frequent delivery model with a share of only 3.6%. Acquisitions, Privatizations and the Design-Build-Finance-Operate (DBFO) model are comparatively rare, accounting for a combined share of 3.6%.

Interestingly, depending on the project sector, certain delivery models are more common as visible when looking at the co-occurrence of two variables in a mosaic table[13]. For instance, acquisitions occur preliminary in mining and oil & gas. Asset privatizations take place disproportionately in telecommunications. Additionally, both procurement models mostly take place in low-income countries but since 2013 the data exhibits no more privatizations. Despite

[13] Please refer to Appendix A.2 Graph A 3 for the mosaic plot visualizing the co-occurrence of project sector and procurement model.

Graph 4: Occurrence of Project Models, 1990-2020




Graph 4 is a multi-panel plot showing the development of different project models' occurrence between the years 1990 and 2020. Note that the y-axis differs depending on category. The panels are vertically sorted according to frequency with the Build-Own-Operate being by far the most observed model in the data.

Source: Own Illustration based on SDC Platinum

being used in every sector throughout the years, the BOO is applied less for transportation and leisure & property than could be expected if sectors and project models were independent. These are exactly the two sectors for which PPPs are used more frequently. Roughly 40% of all PPPs occur in the transportation sector, followed by the leisure & property sector which accounts for a 25% share. For leisure & property, which constitutes social infrastructure, the PPP delivery mechanism is not surprising. Often, social infrastructure is desirable, however, it has lower rents than other sectors (Jefferies (2009)). Thus, a PPP can be used to build socially desirable infrastructure thanks to the government involvement. Power, mining, and oil & gas assets are procured much more seldomly in a PPP than independence between project sector and delivery model would imply. It does make sense that project sector and delivery model are not independent of each other as certain procurement models would be insensible for certain sectors. For instance, mining is almost never done as a PPP because high expertise is needed, and high rents are possible. These features make it interesting for private firms with a high specialization in the sector.

## 5.3 Project and Financing Status

The project status exhibits how far the project is advanced. Generally, three phases can be distinguished as Ehlers (2014) states: (1) Planning; (2) Construction; (3) Operation and Maintenance. In the data, the earliest stage after *rumored* is the *announcement* of a project. After the announcement, steps like the *feasibility study* or a *planning permission* ensue. Once the *government approval* has been granted, the project company would normally try to get a rating from a rating agency to start raising capital or negotiating with banks and investors (Ehlers (2014)). All these steps take place in the planning phase. Thereafter, the construction phase is entered which is the riskiest stage as unexpected events can have adverse effects. Upon finalization of the infrastructure asset, it receives the status *operational* or *completed*. As soon as it is operational, cash flows begin, and debt can be serviced[14].

As stated in Section 3, SSA had low default rates for infrastructure project loans according to Moody's (2018). This is certainly also explained by the low number of projects which make it further than the feasibility study stage. In the data, for over 50% of the project financing deals the corresponding project status is *announced* and a very low 1.5% are either *cancelled, inactive* or *halted*. A possible explanation for the low number of cancelled projects may be that stopping a project before the financing was granted and the construction has begun, could cause it to disappear from the data altogether. In general, for infrastructure assets it is not unusual that a project is delayed for years, stopped, or sold to other sponsors.

Turning to finalized assets which showcase the status *completed, operational* or *sale completed*, 155 data points remain. Most of them are in South Africa, followed by Angola, Nigeria, Ethiopia, and Tanzania. Interestingly, considering every project status as in Graph 2, ten countries record more projects than Angola. However, when examining the rate of completion[15], Angola exhibits the highest share of finalized infrastructure assets with over 22%. One conspicuous aspect about these projects is that Chinese companies are involved in half of all completed projects, principally as a contractor. It is known that Chinese development banks award non-concessional loans to governments such as the Angolan or Ghanian governments and in return Chinese companies are contracted to construct the infrastructure (OECD (2012)). It could be hypothesized that China was a driver to complete projects in Angola, where it is involved in two thirds of the completed projects, as well as in Ethiopia, where Chinese companies where contractors in 11 out of 13 completed projects. A variety of other countries with completed assets exhibit the involvement of China (refer to Appendix Graph A 4).

Evidently, the project status and the financing status go hand in hand and are mutually dependent. The status of the financing can take one of six levels as can be seen from Table 2[16].

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[14] For an overview of all project statuses and their relative frequency in the data, please refer to Table A 1. in the appendix.

[15] I.e., comparing projects of all project statuses with projects that have the status "completed", "operational", or "sale completed":

[16] All sorts of deviations from 100% are due to rounding errors.

Table 2: Relative Frequencies of Financing Statuses

| Financing Status | Relative Frequency (in %) |
|---|---|
| Rumored /Pipeline | 57 |
| Mandated | 13 |
| Partially Financed | 2 |
| Conventionally Financed | 3 |
| Financed | 24 |
| Cancelled | 0.4 |

Source: Own Calculations based on SDC Platinum

Here, too, more than half of all projects have not received any financing. For 13% the financing has been mandated, and roughly 30% received some form of financing. Meanwhile and not surprisingly, the projects for which financing was cancelled correspond to the inactive, halted, or cancelled assets when looking at the project status.

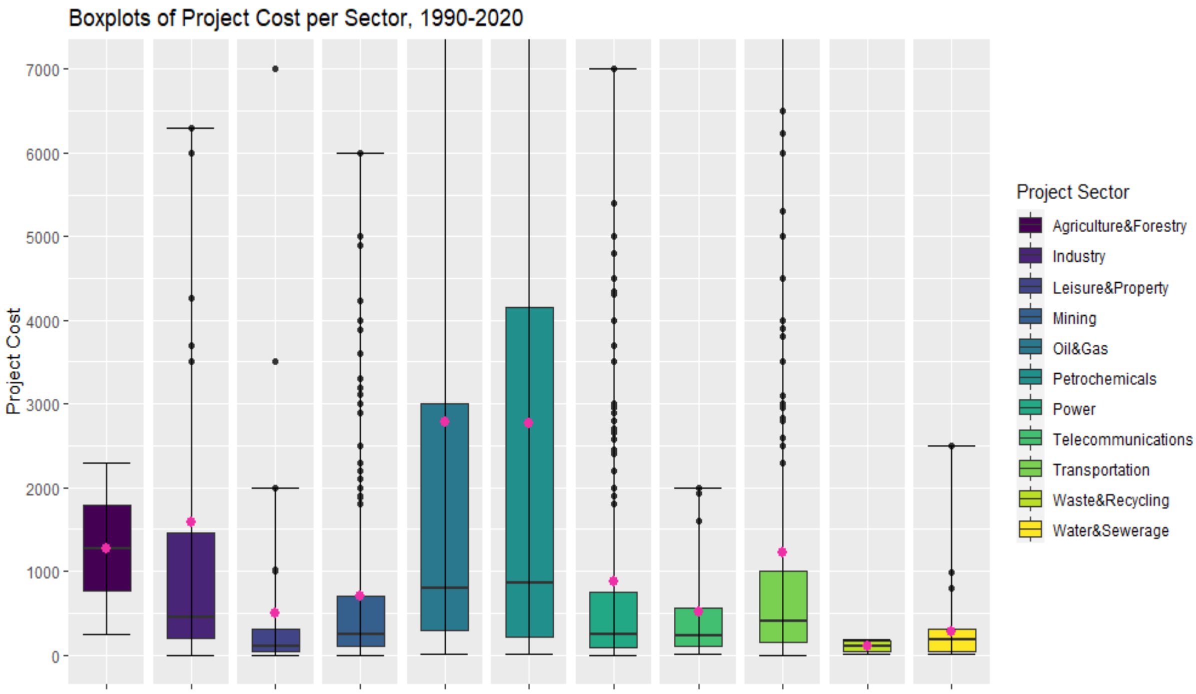
## 5.4 Project Cost

There is considerable variation in the cost of projects depending on the sector they belong to, including some extremely expensive projects. The lowest project cost within the data is USD 0.5 million, the median is USD 300 million, and the mean is USD 1129 million. By far the most expensive venture is the Grand Inga III project in the Democratic Republic of Congo (DRC), which is estimated to cost USD 80 billion. The expansion of two existing power plants should ultimately supply the entire Sub-Saharan region with an output capacity of 40,000 megawatts (SDC Platinum Database (2020)). As a comparison, all nuclear power plants in Germany combined generate a capacity of 8,000 MW indicating that upon completion the Grand Inga will exceed this by a factor five (Hydro Review (2021)).

Overall, six projects exhibit estimated costs of USD 30 billion and above of which two are in the power sector, two are LNG projects (oil & gas sector), and the remaining two belong to transportation and industry, respectively. However, none of these projects have reached financial close or begun construction. A total of 31 projects is estimated at a value greater or equal to USD 10 billion of which around half are in the oil & gas sector.

To better understand the cost dynamics, Graph 5 shows boxplots of the project costs per sector, with the outliers included. Boxplots summarize five statistical values, including median, first and third quartile – visualized through the box – as well as minimum and maximum value – visualized by the whiskers or potential outliers. Note that whiskers only visualize minimum and maximum values if no extreme outliers are present, otherwise they are defined as the first data point outside of the interquartile range. Moreover, the pink point indicates the mean. It is visible that the project cost for most sectors is skewed right, shown by the longer part of the boxplot above the median than below it. Additionally, the mean is above the median for most sectors, which is an additional indicator of right-skewedness. Some extreme high costs are causing the skewedness. Agriculture & forestry and waste & recycling are approximately symmetrical with the mean and the median being roughly identical. However, these sectors showcase very low project numbers of two and six, respectively. The mean cost is highest for the oil & gas and the

Graph 5: Boxplots of Project Cost per Sector, 1990-2020




Graph 5 depicts boxplots for the project cost per sector including outliers (black dots). Boxplots exhibit the four statistical values minimum, first quantile, median, third quantile and maximum. The pink dots indicate the mean cost for each sector. For oil & gas, petrochemicals and transportation, the maximum is not visible because the scaling was adjusted.

Source: Own Illustration based on SDC Platinum

petrochemical industries. Both of which exhibit additionally the largest spread indicating that costs vary greatly across projects[17].

## 5.5 Sectors and Subsectors

Given the absence of a generally accepted definition of infrastructure sectors, the eleven sectors from the data including the 87 subsectors will be employed. Each project is assigned to at least one sector but can be assigned to two different sectors – a primary and a secondary sector. Table 3 lists all project sectors according to their appearance in the data and additionally exhibits the cumulative number of projects which are assigned to a primary and a secondary sector. Due to the possibility that a project is assigned to two different sectors, the sum of the percentages is more than 100% (i.e., 107%). In the cases where a primary and a secondary sector are assigned, they are overwhelmingly identical. For instance, most power projects are assigned to a primary sector in power with a subsector in solar, wind or water energy. The corresponding secondary sector then often is power with the subsector *Renewable energy source*. However, if the two assigned sectors differ, it is often the case that a mining, oil & gas, waste & recycling, or industry project additionally showcases a power aspect. Especially for mining, the integration of power projects makes sense as the extractive industry is highly energy

[17] For a boxplot of project cost per country, please refer to Graph A 5 in the Appendix.

intensive. Thus, mining projects have started to integrate power sources in their assets to generate the needed power where the mine is located. An ever-growing share of these power sources are renewable to offset the carbon emissions from mining (Ali (2019)). Even though, a power-mining aspect is visible in the data, the integration of renewable sources is rare.

Table 3: Table of Sectors, Relative Shares, Primary and Secondary Sector Appearance

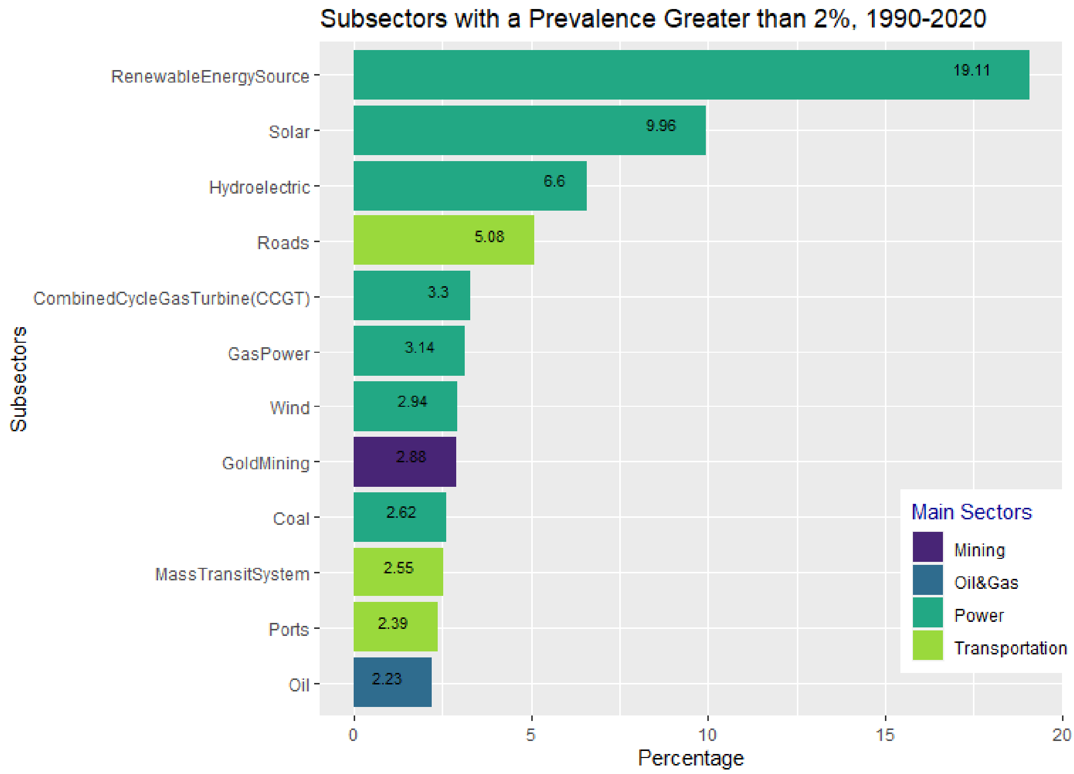
| **Sector** | **Relative Share** | **Primary Sector Cumulative Appearance** | **Secondary Sector Cumulative Appearance** |
|---|---|---|---|
| **Power** | 43.8% | 955 | 673 |
| **Transportation** | 16.3% | 363 | 26 |
| **Mining** | 13.8% | 311 | 44 |
| **Oil & Gas** | 9.9% | 217 | 31 |
| **Leisure & Property** | 7.6% | 169 | 8 |
| **Industry** | 4.4% | 97 | 11 |
| **Water & Sewerage** | 3.5% | 73 | 13 |
| **Telecommunications** | 1.9% | 42 | 2 |
| **Petrochemicals** | 1.5% | 32 | 3 |
| **Waste & Recycling** | 0.7% | 13 | 2 |
| **Agriculture & Forestry** | 0.1% | 2 | 0 |

Source: Own Calculations based on SDC Platinum

From Table 3, it is visible that around 44% of the infrastructure projects can be assigned to the power sector. With a share of roughly 16%, the transportation sector records the second largest share of projects, followed by the extractive industries such as mining (14%) and oil & gas (10%). Leisure & property summarizes the totality of social sector projects, which accounts for approximately 8% of all projects. The remaining five sectors all record shares below 5%. The relative importance of power projects corresponds to an observation by Gurara et al. (2012). They find that LIDCs conduct a lot of power projects which may be explained by the straightforwardness in charging end users. Pricing schemes for roads or water are more difficult in terms of charging and control mechanisms than they are for electricity. Moreover, water & sewerage projects are often difficult to procure in LIDCs as governments lack the expertise and the private sector lacks the incentives due to their lower economic profitability.

A more profound understanding of the data is provided when looking at the subsectors. There are a total of 87 subsectors which can be found along the main sectors to which each belongs in Table A 2. in the appendix. Meanwhile, Graph 6 depicts the main subsectors – i.e., those for which the share is more than 2% in the data. Accounting for almost one fifth of all projects, renewable energy source is the most common subsector. Not surprisingly, it is followed by solar and hydroelectric which both constitute renewable energies. Wind energy, a further renewable energy source comes in sixth place after power projects related to gas (i.e., gas power and combined cycle gas turbine (CCGT)) but before coal power. With roads, mass transit systems and ports, three transportation subsectors are represented. Note that mass transit systems is the umbrella term for buses, trains, or underground systems and the like. Gold mining and oil are also among the 12 most common subsectors.

Graph 6: Subsectors with a Prevalence Greater than 2%, 1990-2020




Graph 6 depicts the 12 most common subsectors i.e., those which occur in more than 2% of all projects. The number in the bar indicates the share in percentage and the colour indicates to which main sector each subsector corresponds.

Source: Own Illustration based on SDC Platinum

In the following, all analyses will focus on the primary main sectors of each project as it is available for every data point. The only exception is power where the secondary sector is considered. A more thorough analysis of the five main sectors – power, transportation, mining, oil & gas, and leisure & property, follows suit. For this part, the 26 cancelled or inactive projects will be excluded, resulting in a decreased total of 2248 observations. For each sector, an overview of the subsectors, development over time and origin of the most frequent sponsors are briefly addressed. The focus of the power sector will be a bit broader.[18]

## 5.1 Power

Accounting for around 44% of all projects, the power sector is the most prevalent sector in the data. Overall, power projects have increased strongly from the 1990s until 2020. In the nineties, 13 countries register a total of 20 power projects. One decade later, 25 countries register 171

[18] Graph A 6 from the Appendix provides an overview over the development of all 11 sectors over time.

power projects – a more than eightfold increase in power assets[19]. Between 2010 and 2019, 742 power projects in 44 countries are listed and more than half of these are classified as renewable energy source.

Evaluating countries' respective development, four distinct groups can be identified. Firstly, countries which have registered very few to no projects over the considered time horizon. This group makes up the largest share of SSA. Secondly, countries which have gradually seen their power projects increase since the late 1990s or early 2000s, such as Mozambique, Uganda, or Zambia. Third, countries that started announcing their first energy project financings in the 2010s and document an increase only over the past couple of years. Among those are Zimbabwe, Ivory Coast, Tanzania, and Ethiopia. Lastly, South Africa, Ghana, Angola, and Rwanda have experienced an increase followed by a decrease. Graph A 7 from the Appendix visualizes the power sector development of each country. Despite registering a decrease over the past couple of years, South Africa is still a main sponsor of power projects aside the UK, the US, and France. The former three have been main sponsors since the 1990s. France has become a main sponsor mostly during the 2010s. Driven through a surge in the past decade, Kenya, Nigeria, and China also appear frequently as sponsors.

### 5.1.1 Renewable Energies

Renewable energy assets were the main driver for power projects over the past 5-10 years. Looking at the development of renewables, an almost exponential growth is visible which has been strongly driven by solar energy projects. Solar energy has emerged as a main renewable energy sector over the course of the 2010s. In contrast, hydroelectric and geothermal power exhibit a much longer history with some assets built as early as 1997. During the 1990s, only four countries – Ghana, Namibia, Senegal, and Uganda – built renewable energy projects. Half of these projects were hydroelectric, the other half geothermal assets. In the noughties[20], the variety of subsectors grew slightly with wind and biomass joining in. The very first solar asset was announced in 2004 but shall remain the only one for the decade as depicted in Graph 7 on the right-hand side. This changes drastically in the 2010s: by the end of the decade solar energy assets account for more than 75% of all announced renewable energy projects[21]. Drastic, too, is the overall increase in this decade. The data records 490 renewable energy projects, a tenfold increase from the 47 projects one decade earlier and a more than 100-fold increase compared to two decades prior. As compared to the overall income group distribution, a higher share of renewable project financings is recorded in the upper-middle income countries than would be expected. Upper-middle income and low-middle income countries account for over 50% of all renewable energy assets in most years of the 2010s.

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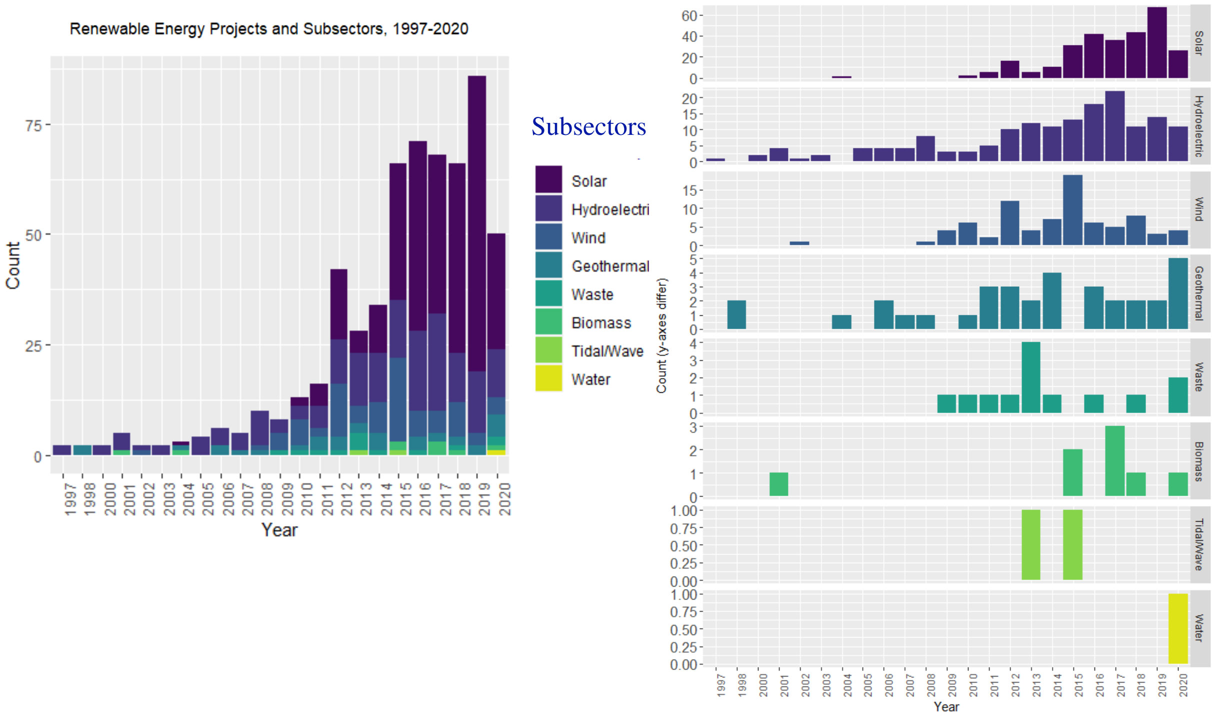
[19] Mozambique, South Africa, Uganda, Zambia, and Nigeria all had north of 10 projects during that time.

[20] *Noughties* denotes the decade from 2000 to 2009

[21] Since 2010, solar panels have strongly increased the share of light energy converted to electricity, from 12% in 2010 to 19% and in some cases almost 30% in 2020 (Belton (2020)).

It is also interesting to look at single country's renewable energy strategies. For instance, Botswana has adapted a biomass strategy in 2008, which becomes visible when considering the power assets that are recorded (Zhou et al. (2009)). On the other hand, Chad, Gambia, or Namibia have solely focused on solar power since 2016. In contrast, Cameroon, the DRC, and Gabon have mostly aimed for hydroelectric power. According to Kasper (2015) wind, water and solar energies will require heavy investments over the next decades. She states that it is theoretically possible to generate all globally necessary energy from these three sources. However, a hinderance is that wind, water, and solar energy do provide variable output which is met with an ever-larger demand for reliable energy supply. Thus, brown energies are often viewed as more reliable, however, the data does indicate a strong momentum for renewable sources in SSA.

Graph 7: Development of Total Renewable Energy Projects and Subsectors, 1997-2020




The two parts of Graph 7 illustrate the development of the renewable energy sector overall (left-hand side) as well as the development of the single subsectors (right-hand side).

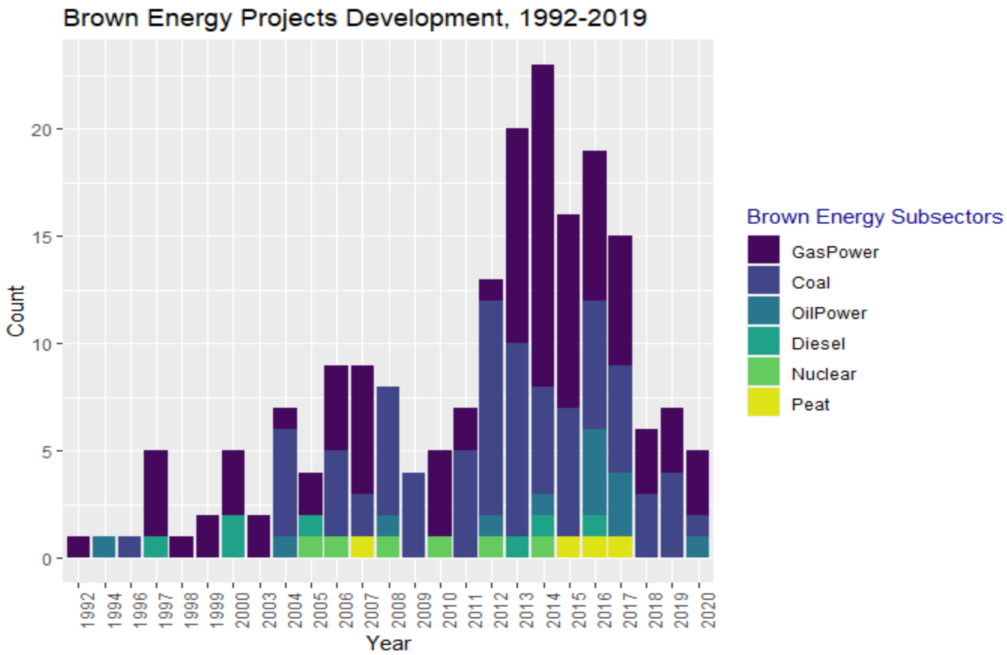
Source: Own Illustration based on SDC Platinum

### 5.1.2 Brown Energies

Brown energies are present in project financings but much less common as compared to renewables. Gas, coal, oil, diesel, and peat belong to the brown energy sector. Despite its low carbon emissions, nuclear energy is highly debated and will be included with the brown energies. The reason is that uranium is finite, thus not renewable and because nuclear power plants generate harmful waste as a byproduct.

Gas is the most frequent brown power source which is not surprising as it is considered a transition energy source which could have an especially large impact in developing countries. Through gas, these markets should transition away from fuel earlier, hence, reach a more sustainable path (bp (2020)). Coal, the second most frequent brown energy source in the data, is considered most detrimental for the environment. According to Kasper (2015) oil, gas and coal are the main sources for industrially produced $CO_2$. The data shows that since 2012, coal projects have steadily decreased in SSA, and so have gas projects since 2014. The data also exhibits six nuclear energy projects of which four are in South Africa and two in Kenya. As depicted in Graph 8, over the past three years, very few projects have been registered – and those were exclusively coal, gas, and oil. Since 2014, a general weakening cycle in brown energies is observable.

Graph 8: Development of Brown Energy Projects, 1992-2020




Source: Own Illustration based on SDC Platinum

## 5.2 Transportation

Over 16% – or more than every sixth asset – belongs to the transportation sector with roads constituting the largest subsector. Mass transit systems is the second largest subgroup, closely followed by ports. During the 30-year period, every tenth transportation project was an airport. Bridges and container terminals together account for roughly 10%. As mentioned earlier, PPPs are a frequent procurement model for the transportation sector, accounting for one fourth of all assets. The development of the transportation sector can be seen in Graph 9.

When looking which country had most transportation deals, Nigeria sticks out. The country exhibits the highest activity in each subsector except for container terminals and roads. For the latter, Kenya and Uganda list the highest number of deals – followed by Nigeria. Starting from 2005, Nigeria has been building a lot of transportation infrastructure and is the country registering most projects in this sector. Probably not entirely coincidentally, 2005 was also the year when Nigeria fully repaid its government debt and was the first African country with no debt. The debt had accumulated since the 1980s when oil prices dropped, and it increased thereafter due to a succession of military rules and corruption (Polgreen (2006)). The repayment of Nigeria's dues was the starting point of reforms to fight poverty and build better infrastructure.

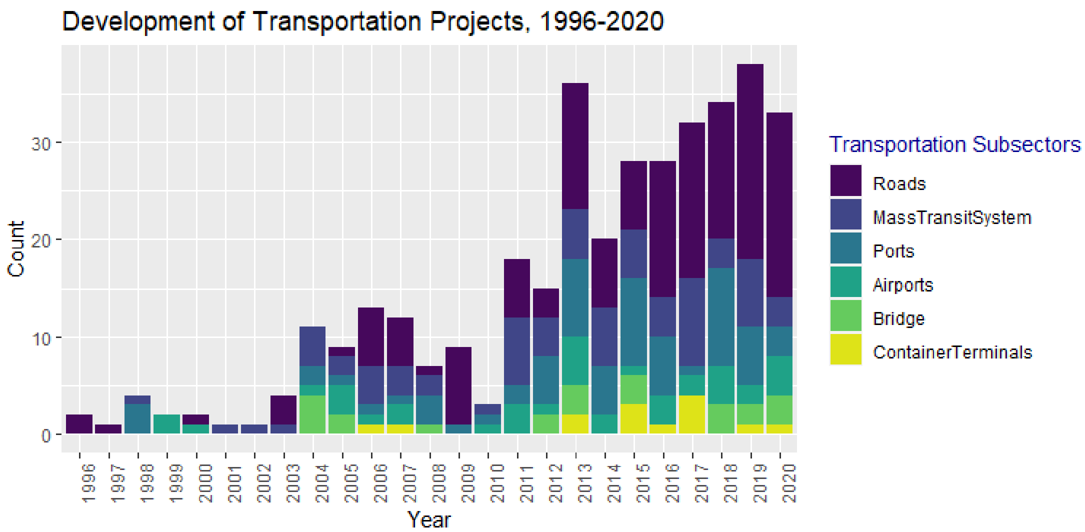
Table 4: Transportation Subsectors, Project Counts, and Overall Share in Percent

| Subsector | Project Count | Share in % |
|---|---|---|
| **Roads** | 147 | 40.5 |
| **Mass Transit Systems** | 73 | 20.1 |
| **Ports** | 68 | 18.7 |
| **Airports** | 38 | 10.5 |
| **Bridge** | 23 | 6.3 |
| **Container Terminals** | 14 | 3.9 |

Source: Own Illustration based on SDC Platinum

Turning to the origin of the project owners, the main sponsors are South Africa and Nigeria, followed by China and Tanzania. South Africa, Nigeria and Tanzania have all registered high transportation activity in their respective countries. A reason why China is heavily invested in transportation projects in SSA is the Belt and Road Initiative (BRI)[22]. The BRI was announced

Graph 9: Development of Transportation Projects, 1996-2020




Source: Own Illustration based on SDC Platinum

[22] China's Belt and Road Initiative is a long-term investment program which promotes the transportation connectivity between Asia, Europe, and Africa. It comprises the land based new silk road (six corridors) and the maritime silk road (BRI (2021)).

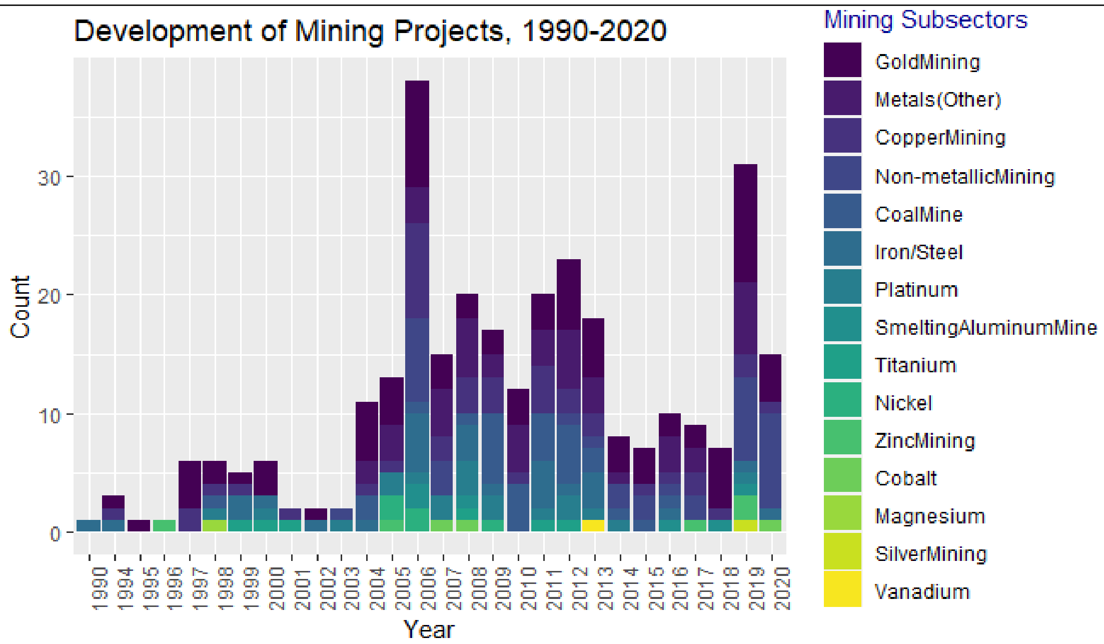
in 2013 and by 2020 most countries in SSA were signatories to it. The only exceptions are Botswana, Burkina Faso, Central African Republic, Eritrea, Eswatini, Guinea-Bissau and Malawi.

## 5.3 Mining

Given the vast mineral deposits present in SSA, the relative importance of mining as third most common sector is not surprising. It accounts for roughly 14% of project financings. Among the most common commodities in SSA are gold, copper, iron, uranium, diamonds, and bauxite with many mines located in DRC, Ghana, Nigeria, and Zambia (Ahmed, Bryant and Edwards (2020)). In the data, the countries inhabiting most mining projects are South Africa, followed by DRC, Botswana, Tanzania, Mozambique, Ghana, and Zambia.

Globally, the demand for minerals has increased which is reflected in the extension of the mining sector in SSA. From Graph 10, a strong increase in projects is visible starting from 2004 with a spike in 2006. This corresponds to the five years after 2003 during which metal and oil prices nearly tripled (Kimani (2009)). The surge was driven by the subsectors gold, copper, iron/steel and non-metallics like diamonds. After 2013, the number of mining projects decreased for five years due to a commodity price shock in 2014[23] before spiking again five years later. This time gold, metals like bauxite and non-metallic mining such as diamonds propelled the spike.

Graph 10: Development of Mining Projects, 1990-2020




Source: Own Illustration based on SDC Platinum

[23] According to Stocker, Baffes and Vorisek (2018) the commodity price shock between 2014 and 2016 was one of the largest in modern history. Among other factors, it was caused deteriorating demand prospects, a booming oil production and efficiency gains in the oil sector, causing break-even prices to plunge.

Every fourth mine is focused on gold, which is the most common mineral in SSA (Ahmed, Bryant and Edwards (2020)). The gold hotspots are Burkina Faso, Ghana, and South Africa. Accounting for over 10%, *metals (other)* which includes bauxite, uranium, and rare earths, is the second most common subsector. Thereafter, copper and coal follow and on fifth place is *non-metallic mining* which includes diamonds, graphite, and phosphate. The five above-mentioned subgroups combined account for more than 75% of all mining projects.

Canada, Australia, and the UK are heavily involved in the mining sector. The three countries alone are involved in over two thirds of all projects in some way or another. When solely looking at how often they appear as sponsors, at least one of them appears in 50% of all projects. South Africa is also a main sponsor of the extractive industry, but the country is also the single largest host country for mining assets. Even though, the extractive industry oftentimes exhibits lucrative returns, often they do not benefit the local communities. The reason is that a lot of mining rights and contracts were negotiated during civil wars or transition governments which was marked by little transparency. Over the past decade many African countries have fought to review mining contracts to negotiate better conditions (Kimani (2009)). For instance, Tanzania has settled on annual payments from Australian and Canadian mining companies which are used to directly benefit the local community by e.g., building hospitals and the like.

### 5.4 Oil & Gas

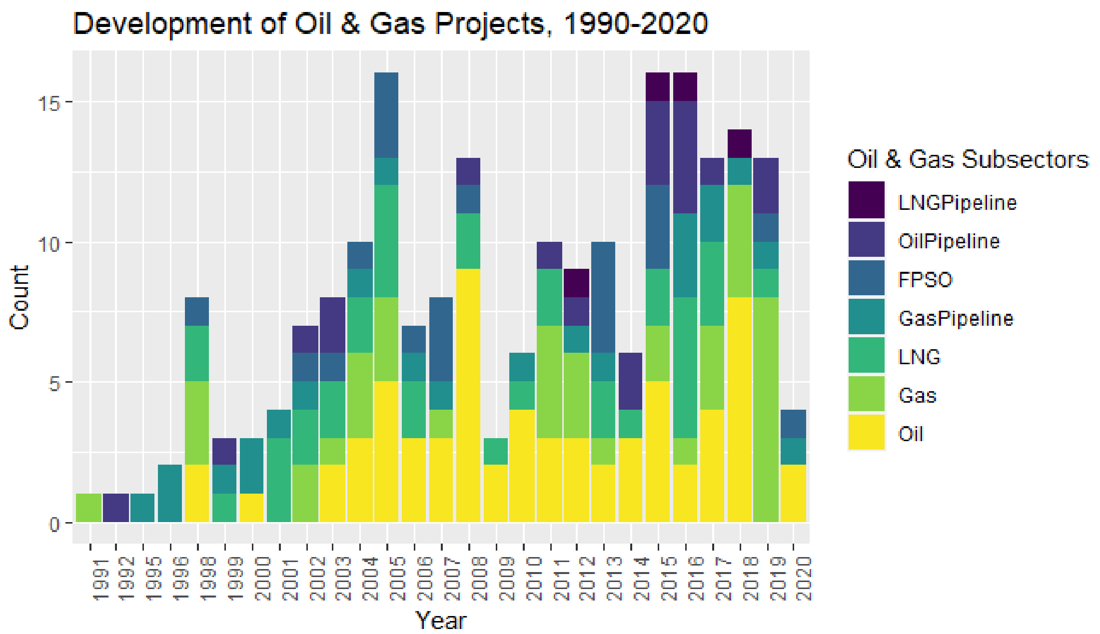
In Graph 11, similar to the mining sector, the oil & gas sector experienced a surge when resource prices increased strongly in the middle of the noughties. After the GFC, project financings collapsed and accelerated again in the 2010s. The demand shock of 2014 which affected mining also manifests itself in the oil & gas assets. The years 2015 and 2016 mark the peaks.

By far most projects were announced or conducted in Nigeria, a country which is one of the world's largest oil producers because of its vast reserves (Polgreen (2006)). Nigeria lists three times as many projects as Ghana, the second most active country. South Africa, Angola, and Mozambique rank just below by amount of oil & gas infrastructure project financings.

The most frequent subsector is oil accounting for 30% of all projects. Every fifth project is recorded in the gas subsector, right before the LNG subsector which records a share of 18%. Until 2002, oil & gas appeared almost exclusively in low-income countries, however, thereafter it has gradually shifted to low-middle and upper-middle income countries. Since 2014, more than two thirds of all projects are in these income groups. This may be explained by some countries like South Africa, Nigeria or Angola entering higher income groups during these years.

Considering the main sponsors, a strong propensity for international owners becomes obvious. The UK appears most often in oil & gas projects, followed by Nigeria, and the US. Together, the UK and the US are involved in more than half of all oil & gas projects.

Graph 11: Development of Oil & Gas Projects, 1990-2020




Source: Own illustration based on SDC Platinum

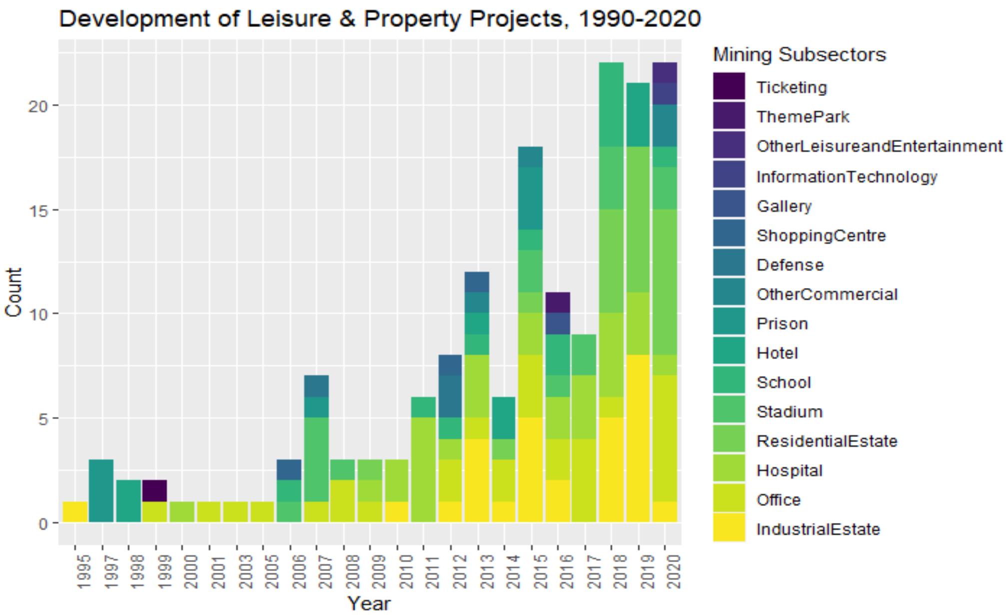
## 5.5 Leisure & Property

As leisure and property is the only social infrastructure sector in the data, it will briefly be discussed, too. This sector has grown strongly over time. In the 1990s, South Africa was the only country doing project financings for social infrastructure and the country overall accounts for 25% of these assets. However, since the mid-2000s, other nations, such as Kenya and Ethiopia have joined in. The main subsector is industrial estate, which entails the development of special economic zones or free trade zones. Other frequent subsectors are office buildings, hospitals as well as residential buildings.

Overall, the leisure and property projects are often owned by countries themselves which becomes obvious when looking at the sponsors. There are fewer non-SSA countries than for the other examined sectors. However, China appears as the second most frequent sponsor – which again is probably explained by the BRI. The country has signed Memoranda of Understanding with various countries and to underline the newly built friendship China conducts infrastructure projects labelled as “China-aided” or “friendship” projects. Hence, it is strongly involved in building special economic zones, hospitals, stadiums, and residential buildings in SSA signatory countries.

For social infrastructure, PPPs make a lot of sense as those are usually essential buildings, however, they constitute rather a public good. Oftentimes and in stark contrast to other sectors, no monopoly rents are possible. In consequence, for such infrastructure assets to be built, hinges on the government appearing as sponsor. In the data, roughly 30% of all leisure and property projects are conducted as a PPP, which is a very high share given that this procurement model only appears in 10% of all cases. Until the 2010s, social projects were predominantly conducted by upper-middle income groups. An explanation might be that these countries tend to have a higher fiscal capacity and are therefore better able to finance social infrastructure. Also, social infrastructure normally ensues other sectors, as hospitals or schools would only be built once provision of electricity and water are a given. Stadiums and business buildings presuppose a certain development and financial capacity and are normally not prioritized in extremely poor countries.

Graph 12: Development of Leisure & Property Projects, 1990-2020



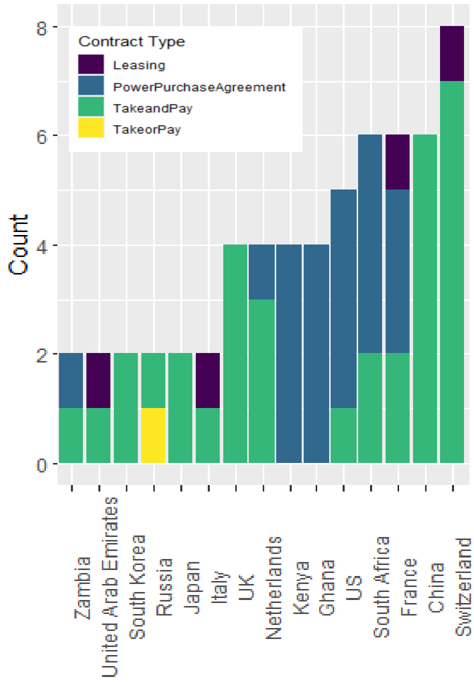

Source: Own Illustration based on SDC Platinum

## 5.6 Offtakers

Offtakers are companies or entities which are contractually obliged to buy the output of an asset upon completion. Data on offtake contracts is only available for 216 projects. In total, 233 offtake contracts are present in the data, as one project can have up to three contracts. In 68% of the contracts, the offtaker originates from the host country where the infrastructure asset is located, thus, in 32% the offtaker is from a foreign country. Of the offtake contracts which are held by foreign countries, almost 40% are from the mining sector. In Graph 13, Switzerland is the main non-SSA offtaker nation, followed by China and France who both have the same number of contracts. The US and the UK are also among the top five offtakers outside SSA. Certain host countries not only act as offtakers in their own projects but also in neighboring countries such as South Africa, Ghana and Kenya. Furthermore, the most widely used contract type overall is a power purchase agreement (PPA) which makes up two thirds of all contracts, followed by a Take-and-Pay contract accounting for 30% of the contracts. Leasing, Take-or-

Pay and other types of agreements appear rarely. PPAs are most frequently used in the power sector (i.e., 90% of all PPAs pertain to the power sector). On the other hand, Take-and-Pay contracts are most frequently used in the mining (45%) and in the oil & gas (26%) sectors.

Graph 13: Main Contract Types Used by Main Offtake Nations




Graph 13 depicts the main non-SSA offtakers, the contract counts and the contract types.
Source: Own Illustration based on SDC Platinum

## 5.7 Contractors

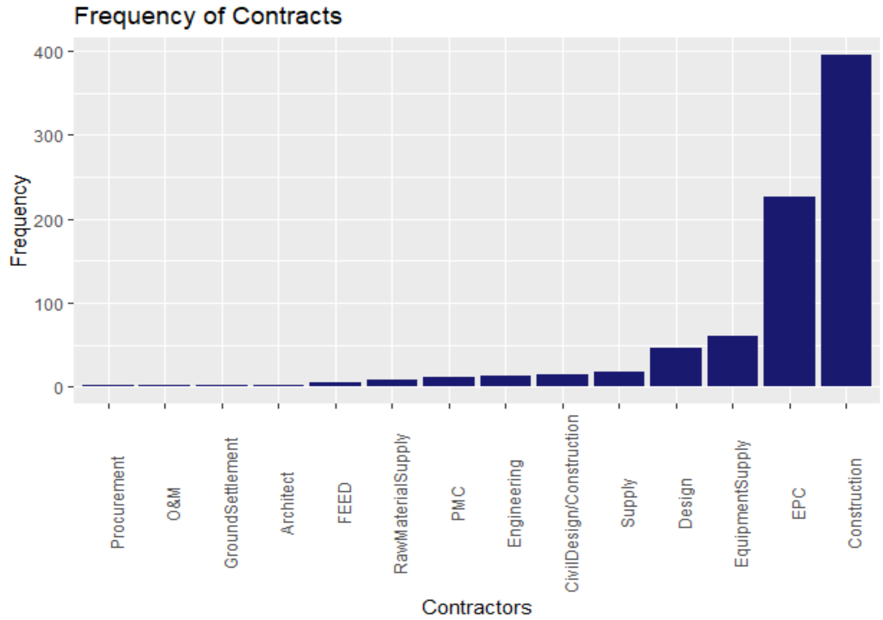
Contractor data is available for 560 projects, totaling at 815 distinct contracts. Regarding the type, construction contracts are awarded in about half of all cases as depicted in Graph 14. Engineering, procurement, and construction (EPC) contracts record more than 200 occurrences. In these contracts, the project company transfers the construction risk of the infrastructure asset to the contractor, who guarantees completion of a well-functioning asset at a predetermined date for a predetermined cost (Gatti (2012)). Thus, they are frequently used for project financings due to the risk-transfer to the contractor. After the EPC contracts, equipment supply, design and other supply contracts ensue.

The available data is interesting, insofar as it showcases one specific country that is highly active. Said country is China, which overall accounts for almost 60% of the contracts. This share went from below 2% during the 1990s, to one third in the noughties. In the 2010s, Chinese companies accounted for over two thirds, and in the year 2020, the country's companies were contractors in a staggering 95% of all available contracts. With only one tenth of the contracts China accounts for, the US and South Africa are jointly the second most common contractor nations, followed by the UK, France, Australia, and Germany. This extreme imbalance between contractor nations may be explained by the fact that Chinese banks are frequent lenders to Sub-Saharan countries[24], but they in return require Chinese companies to be contracted for the building process (OECD (2012)). The total known contract value which went to Chinese companies exceeded USD 16 billion. All other contracts combined stood at a value of under USD 10 billion. A reason why China is such a prominent contractor might have to do with it not being bound to OECD rules as a non-OECD country. Those rules stipulate what number of workers should originate from the host country. Not having to adhere to those rules would allow China to bring workers from China, which could in turn have a positive impact on a its GDP. Even though such concerns are sometimes raised, the OECD (2012) states they have not been

[24] China is Africa's most important partner for the infrastructure sector even outpacing the World Bank (OECD (2012)).

backed by evidence. For China – who has years of experienced working with African workers – it is cheaper to hire local workers than bring Chinese ones, the paper concludes.

Graph 14: Frequency of Different Contract Types




Source: Own Illustration based on SDC Platinum

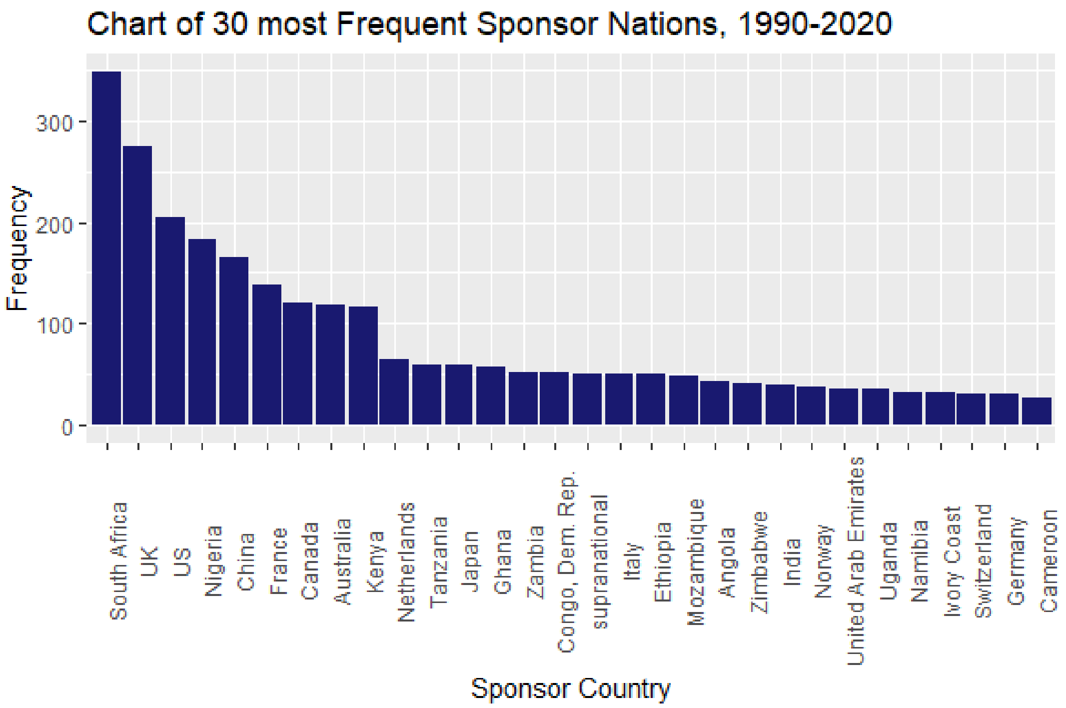
## 5.8 Sponsors/Owners

One project can have up to six sponsors in the data and overall, 110 nations appear with an addition of *supranational* sponsors (e.g., World Bank, MDFIs etc.). As stated earlier, the sponsor is usually the most important party in a project financing scheme, initiating the project and taking care of permits and concessions along the way. As it is such a crucial role, it often makes sense that at least one sponsor originates from the host country. In the SSA dataset, out of 1810 projects where data is available, in 1070 projects at least one of the sponsors is from the host country, amounting to a share of 60%. As stated earlier, the mining sector showcases a high foreigner-only ownership. Meanwhile, local entities are highly active in the transportation and water & sewerage sectors, where foreign-only ownership is rare.

When scrutinizing the legal statuses of the project sponsors, over a third are private companies, followed by public companies in 25% of all cases. Governmental institutions appear in roughly 20% as owners or co-owners. Subsidiaries owning a project are somewhat less common and appear in 16% of all cases. Finally, Joint Ventures constitutes the legal form which appears in a mere 2% of all cases. Nevertheless, these shares should be taken with a grain of salt as joint ventures are not always reliably reported in the data. In various cases, each constituent of a joint venture is individually listed as a sponsor.

Joining all sponsors together allows to understand which nation appear most often throughout the whole timeframe. Not surprisingly, South Africa ranks first. On the second and third rank, the United Kingdom and the United States follow, respectively. Nigeria, which also had the second most projects of all SSA countries is third. China and France are both frequent project owners in SSA, too, as depicted in Graph 15.

Graph 15: Chart of 30 most frequent Sponsor nations, 1990-2020




Graph 15 depicts the sponsor nations which appear most often and indicates the number of times a single nation appears on the y-axis.

Source: Own Illustration based on SDC Platinum

To gain a clearer understanding, the dataset was sliced into three decades, namely the nineties, noughties and 2010s. The US is already represented in 1990, the UK in 1992. Both countries have increased their sponsoring strongly during the second half of the nineties, owned less projects in the early 2000s and increased again after 2004. China, on the other hand, appears in the data for the first time as sponsor more than a decade after the US. The country has gotten involved more heavily throughout the 2010s. After the strong increase of resource prices between 2004 and 2008, Canada and Australia – who both have been identified as resource- and mining-focused – spike as project sponsors. Towards the end of the noughties, the two countries' activity as sponsors retracts.

When analyzing which countries act as sponsors or owners in which Sub-Saharan infrastructure project financing, for some owners language and colonial history play a role. A good example is Portugal. It appears in 17 infrastructure project financings out of which 11 are recorded in former Lusophone countries (i.e. Mozambique, Angola, Cape Verde, Tanzania). For Brazil, 60% of the project financings where it is involved are in Lusophone countries – namely Angola and Mozambique. The Netherlands is a sponsor in around 150 projects – one third of which are located in former colonies. Nevertheless, it is difficult to pin such relations down to colonial history as many different factors such as political interests and international relations play into it. After World Wars I and II, foreign aid to poor countries has been split between donor countries. This made sense insofar as certain countries had traditionally good relationships and as help might have been substantially less targeted otherwise. With the end of the Cold War, however, substantial political shifts took place and countries which had no colonial history and were formerly less involved such as Sweden appeared on the world stage as donors (Phillips (2013)). Thus, inferring reasons why certain countries are more heavily involved with certain other countries is a multidimensional and extremely complex topic where a multitude of factors play in. This would go beyond the scope of this thesis and is therefore left for future research.

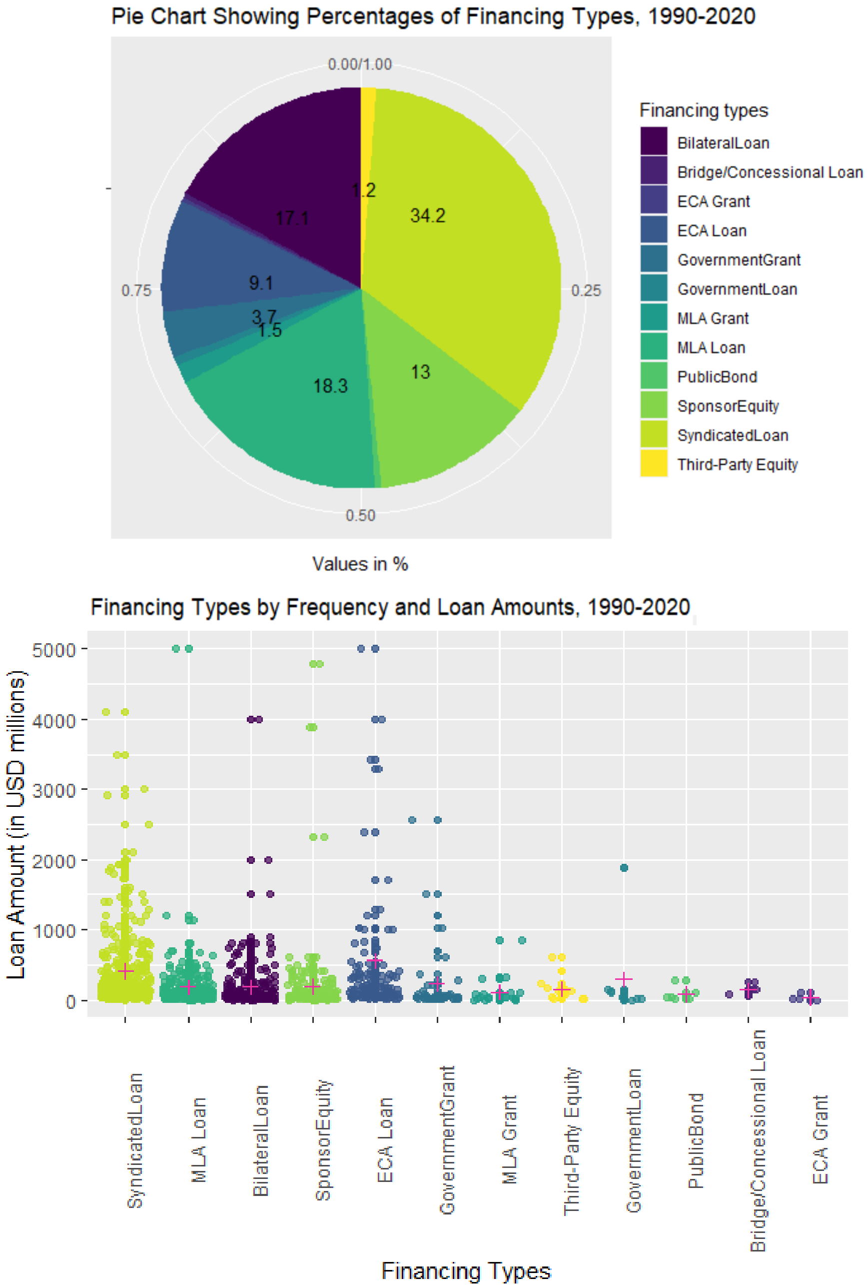
## 5.9 Financing

Given the large project costs, financing of a single deal is highly complex with a variety of different loans and many institution types involved. This section is split into a first part which looks at loan size and type, and a second part which discusses the financing institution types and their origin. In the data for SSA, 816 projects out of the 2248 projects contain information on the financing and a maximum of four distinct loans per data point are possible.

### 5.9.1 Financing Type & Size

Most of the financing types are loans and, consequently, debt financing. Apart from debt, sponsor equity and third-party equity as well as different types of grants occur. According to Gatti (2012), syndicated loans are the most common loan type for project financing deals as larger sum can be granted due to the involvement of a lot of banks. This corresponds to the examined data, where syndications amount to over one third of all loans as depicted in the upper half of Graph 16. Loans from multilateral agencies (i.e., MLA loans) such as the World Bank, African Development Bank, European Investment Bank, FMO of the Netherlands or KfW of Germany are the second most observed type. Only a little less frequent are bilateral loans which are often granted by either a single bank or a company. As the fourth most frequent financing type, sponsor equity ensues, referring to the capital injection by the sponsors of the project. ECA loans involve an export credit agency such as an export import bank and are on the fourth rank in terms of frequency. The four categories ECA Grant, Bridge/Concessional Loan, Public Bond and Government Loan all appear with a frequency of less than 1% in the data.
On the lower part of Graph 16, a scatter plot depicts the different debt and equity injections on the x-axis in relation to the financing amount. The pink mark indicates the average loan size per financing type. Even though, ECA loans are granted more rarely than syndicated loans, their financing amounts vary greatly, thus, on average the amount of ECA loans is highest. Not surprisingly, syndicated loans have the second highest average amount. For each finance provider who funds both through loans as well as through grants, the latter are on average

Graph 16: Financing Types by Frequency and Loan Amounts and Pie Chart with Percentage of Financing Types




The top part of Graph 16 depicts a pie chart which indicates the shares of different financing types. The numbers indicate the respective percentages. Public bonds, bridge/concessional loans and ECA grant appear in less than 1% of all cases. The bottom part of Graph 16 shows a scatter plot of loan type and loan amount including a pink cross indicating the mean loan amount per financing type.

Source: Own Illustration based on SDC Platinum

smaller than the former. This is true for MLAs, ECAs as well as governments. The larger average size of loans makes sense insofar as they are awarded at conditions that reflect the inherent risk and must be repaid (Gatti (2012)). Grants on the other side are often not expected to be repaid and usually would be considered free money. Section 6 will take a closer look at the association between loan type and financing amount.

A summary of the total financing amounts per project in Table 5 exhibits that the minimum loan amount in the data is USD 1 million and the maximum USD 28 billion. The median is

USD 150 million and the mean is USD 440 million. As with the project cost, some extreme values cause the distribution to be heavily right-skewed. When looking at single loans instead of the summarized loans per project, the numbers change slightly. Minimum and maximum are USD 1 million and USD 14.9 billion, the median equals USD 112 million and the mean roughly USD 296 million. The maximum single loan was granted through a syndication process. On average, the highest loans were provided to oil & gas, petrochemical, and transportation assets. As for countries, Mozambique has received the largest financing amounts. Angola and DRC come in second and third.
Moreover, the most frequent debt-equity split is 70% debt and 30% equity, which is standard in project financing deals – it is used in every fifth project where data is available. Higher splits such as 85/15 and 75/25 both appear in over 10% of all cases. Projects where the equity injections are higher than the debt are rare and account for less than 20%. Meanwhile, the debt-heavy structure is a typical feature of project financings.

Table 5: Summary of Single Loan Amount and Loans per Project

| | **Minimum** | **Median** | **Mean** | **Maximum** |
|---|---|---|---|---|
| Single Loan (in USD million) | 1 | 112 | 296 | 14’902 |
| Loans per Project (in USD million) | 1 | 150 | 437 | 28’170 |

Source: Own Illustration based on SDC Platinum

### 5.9.1 Origin & Type of Financing Providers

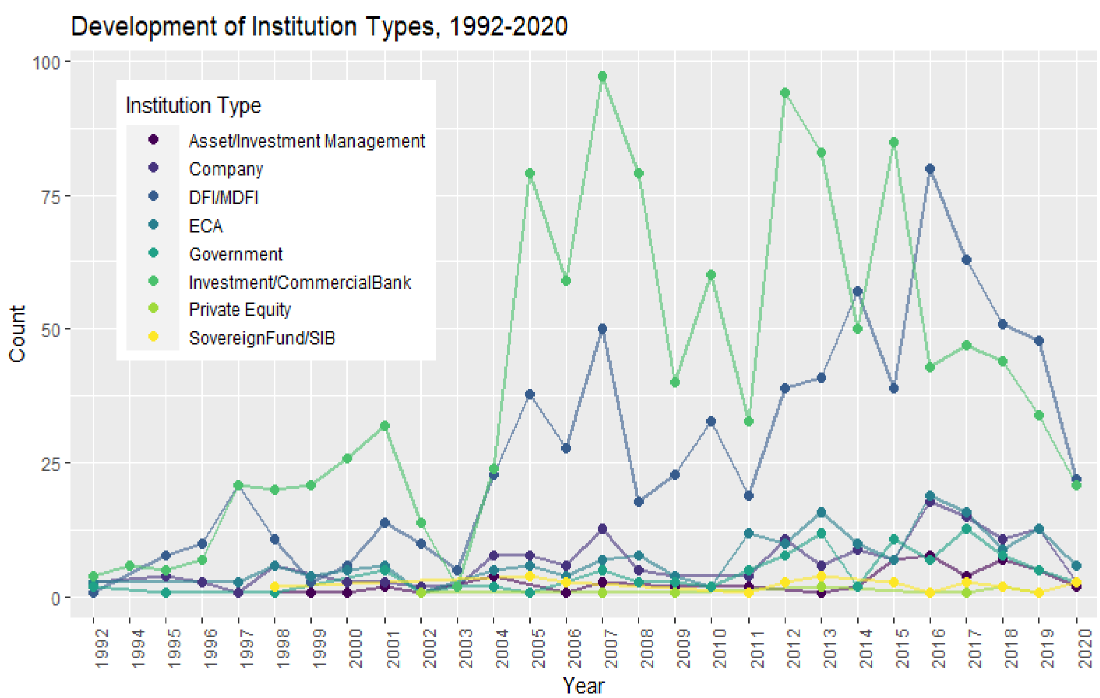
In infrastructure projects, not only is it desirable to have a sponsor from the host country, but it is also helpful to have a local finance provider, as it reassures the foreign lenders and equity providers (Dentons (2018)). Investors from the host country such as local commercial banks or the host government provide financing in 245 out of the 816 projects, which corresponds to 30% of all financings. A single project can have up to 18 financing institutions which are involved in a maximum of four loan types. This high ratio of institutions per loan can be explained by syndications which tend to have a multitude of institutions involved in one single loan. Given the sheer number of institutions in one project, two ways of analyzing will be applied. Firstly, the total of all institutions is examined to evaluate the respective share of each single type. The results of this analysis are depicted in the middle row of Table 6. These numbers add up to 100%, as we look at the totality of all financing providers. Almost half of the institutions in the data are investment/commercial banks, with DFIs making up over 30%. On the right-hand side of Table 6, the involvement on project level is examined. Thus, the numbers indicate the percentage of projects in which a certain institution appears. Since a single project can have more than one debt provider, the total adds to more than 100%. The share of project financings involving a commercial or investment bank is roughly 50%, a little higher than the share involving a DFI or MDFI. ECAs appear in 17% of all projects but have become more frequent in the past decade. According to the World Bank (2016) DFIs and MDFIs are involved in more than a quarter of projects in LIDCs providing guarantees, political risk coverage, syndicated and direct loans, or equity investments. The involvement of a (M)DFI is correlated with a lower default probability which is for one likely caused by a close analysis of projects conducted on the part of (M)DFIs.

Table 6: Share of Different Institution Types (Overall and per Project)

| Institution Type | Share of financial institutions in total | Share of financial institutions per project |
|---|---|---|
| **Investment/Commercial Bank** | 46% | 49% |
| **DFI/MDFI** | 31% | 46% |
| **ECA** | 8% | 17% |
| **Company** | 7% | 15% |
| **Government** | 4% | 11% |
| **Asset/Investment Management** | 2% | 5% |
| **Sovereign Fund / SIB** | 1% | 3% |
| **Private Equity** | 0.4% | 1% |

Source: Own Calculations based on SDC Platinum

Graph 17: Development of Institution Types, 1992 - 2020

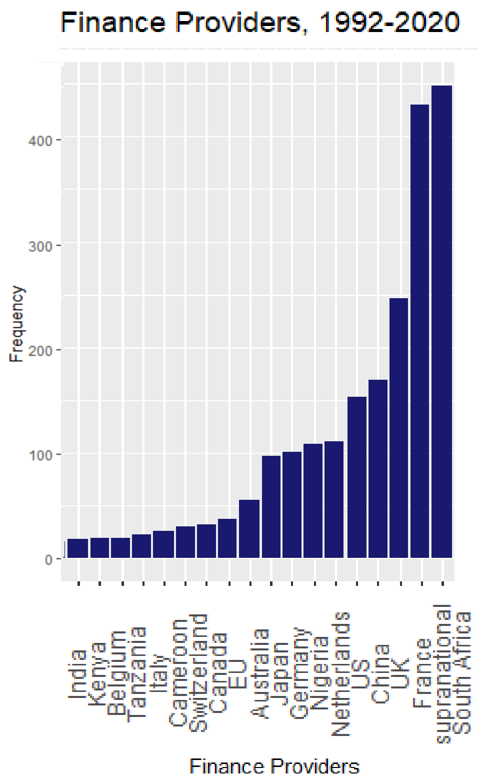



Graph 17 depicts the development of different financing institution types between 1992 and 2020 through a line chart.

Source 4: Own Illustration based on SDC Platinum

On the other side, the presence of a (M)DFI has a positive impact on planning and oversight throughout the construction process. For syndicated loans, a partnership between an ECAs and a MDFIs is common and allows commercial and investment banks to enjoy privileged creditor status (Gatti (2012)). Various authors mention that alliances between ECAs and multilateral agencies like MDFIs could bridge the infrastructure gap thanks to their differing mandates. With the decrease of commercial and investment banks' activity, discovering ways to overcome this gap will gain importance.
Graph 17 illustrates that even though they are main financiers of infrastructure projects, the involvement of investment and commercial banks has not been steady over the period from 1992 to 2020. In recent years, notably since 2016, it has unwaveringly declined and reached its lowest level during the pandemic. However, already after 2008 the activity decreased strongly. As stated in AFME (2015) after the GFC banks started to deleverage their balance sheets. Simultaneously, a new set of policies and regulations (e.g., Basel III) came into force, which led various banks to decrease lending activities in riskier markets such as EMs or DMs. Concurrently, other genres of investors such as sovereign wealth funds, pension funds and insurance companies have increased their lending in infrastructure. For the latter two, infrastructure is a well-suited asset class as its characteristics like the long maturity and high returns match their own liabilities (Kasper (2015)). It can be assumed that pension funds would often be invested through asset and investment managers which have increased their investment activity over the past six years but still appear at a low level. State investment banks (SIBs) and sovereign wealth funds – mainly from Arabic countries – appear in the data for the first time in the late 90s, private equity funds starting from 2002.
Graph 17 shows that with a one-year lag to banks, (M)DFIs have started to decrease their lending activity since 2016, too, and the overall financing has declined since then[25]. Despite the decline of (M)DFIs, supranational lenders are the most important financing providers aside from South Africa as shown in Graph 18. This group comprises international organizations like the World Bank, ICF, multilateral development banks etc. France, the UK, China, and the US are also

Graph 18: 20 most Important Financing Providers




Graph 18 exhibits the 20 finance providers who appear most often over the period of interest.
Source: Own Illustration based on SDC Platinum

[25] In terms of financing institutions as well as in terms of financing amount. A stacked bar chart of the development showcasing the relative share of institutions each year is to be found in Appendix Graph A 8.

among the top five financiers. Plotting total funding amounts per country would provide a clearer picture, however, it is not possible because various institutions and countries are involved in a single loan or equity type.

## 5.10 Network Analysis

To conclude the descriptive part, a network analysis has been conducted visualizing which countries are finance givers in which parts of SSA.

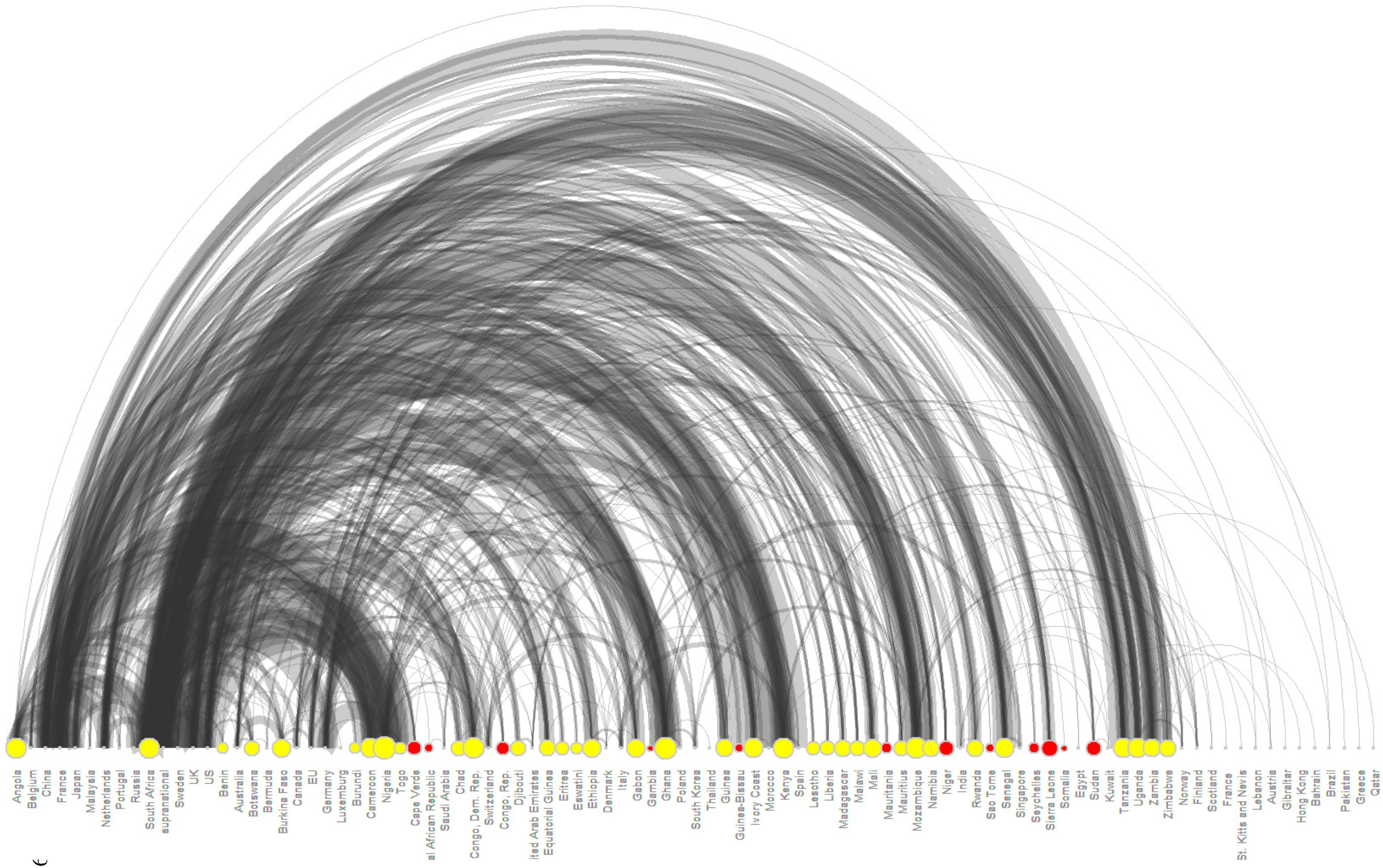
Graph 19 visualizes all financing ties between all countries in the dataset. The color-coding signifies whether a country is a receiver nation indicated by the red colour, a receiver and donor nation which yellow shading signifies, or only a donor nation in case they are grey. It is obvious that solely Sub-Saharan countries can be either red or yellow and all grey countries are from outside SSA. Additionally, the node size increases with inflowing financial funds. Even though there are a lot of connection and clearly establishing links is not possible, the graph does show some trends. For one, only twelve countries are receiver countries, thus 35 nations in SSA are donors as well as receivers. Hence, there is high financing activity within SSA. Even though countries like South Africa and Nigeria, with more developed financial markets, can provide financing across borders[26], the majority of countries is unable to do so and focuses on their home markets. Countries like Ghana, Guinea and Ivory Coast, who are not solely receiver countries, assets financing does sometimes but rather seldomly originate from the home market. Here, the connection between financial market development becomes more visible which will be a topic in Section 6. Moreover, from Graph 19 the main non-SSA donors are recognizable which include China, France, supranational institutions, the UK and the US.

In the Appendix A.2 Graphs A.10 to A.12, the network analysis for sponsors can be found. As there were too many ties redeeming the static networks[27] unreadable, the sponsors have been grouped by certain criteria (BRICs countries, Asian countries, Arabic countries). The graphs go to show how highly interconnected the countries are, nevertheless specific trends are in most cases impossible to recognize and would require more profound analysis witch is beyond the scope of this thesis.

[26] Countries which provide financing to other countries in SSA are Botswana, Burkina Faso, Cameroon, Equatorial Guinea, Gabon, Kenya, Mauritius, Nigeria, South Africa, Togo.

[27] Networks are usually responsive and interactive; however, the static format of the thesis does not allow for such visualizations.

Graph 19: Network Analysis of Finance Donors and Receivers in SSA




Source: Own Illustration based on SDC Platinum

# 6. Quantitative Analysis

In the following, a quantitative analysis of the data will be conducted. This does not constitute the main part of the thesis but solely aims at providing a more profound understanding of certain associations within the data. In consequence, it has no claim to completeness or inferring causal relations but should be viewed as a supplement. Some results from hypothesis testing as well as single and multiple linear regressions will be presented and discussed.

## 6.1 Hypothesis Testing

A set of hypotheses will be stated and tested throughout this section. The use of contingency tables and mosaic plots visualizing them is supplemented with Pearson's Chi-squared tests. Using a Pearson's Chi-square test calculates p-values which allow to either accept or reject the null hypothesis when comparing it to a significance level α. If p≤α, the null hypothesis is rejected and the alternative hypothesis is accepted. If p>α, we accept the null hypothesis of independence. The same procedure applies for the p-value of an Anova test.[28]

### 6.1.1 Project Sector

It is possible that depending on a country's development stage, certain infrastructure areas are prioritized. Richer countries may be more able and willing to build social infrastructure, whereas less developed countries firstly emphasize on the provision of electricity[29]. From this assumption, a null and an alternative hypothesis are stated as follows:

$$H_0: Project\ Sector\ and\ a\ Countries'\ Income\ Group\ Affiliation\ are\ independent$$

$$H_1: Project\ Sector\ and\ a\ Countries'\ Income\ Group\ Affiliation\ are\ not\ independent$$

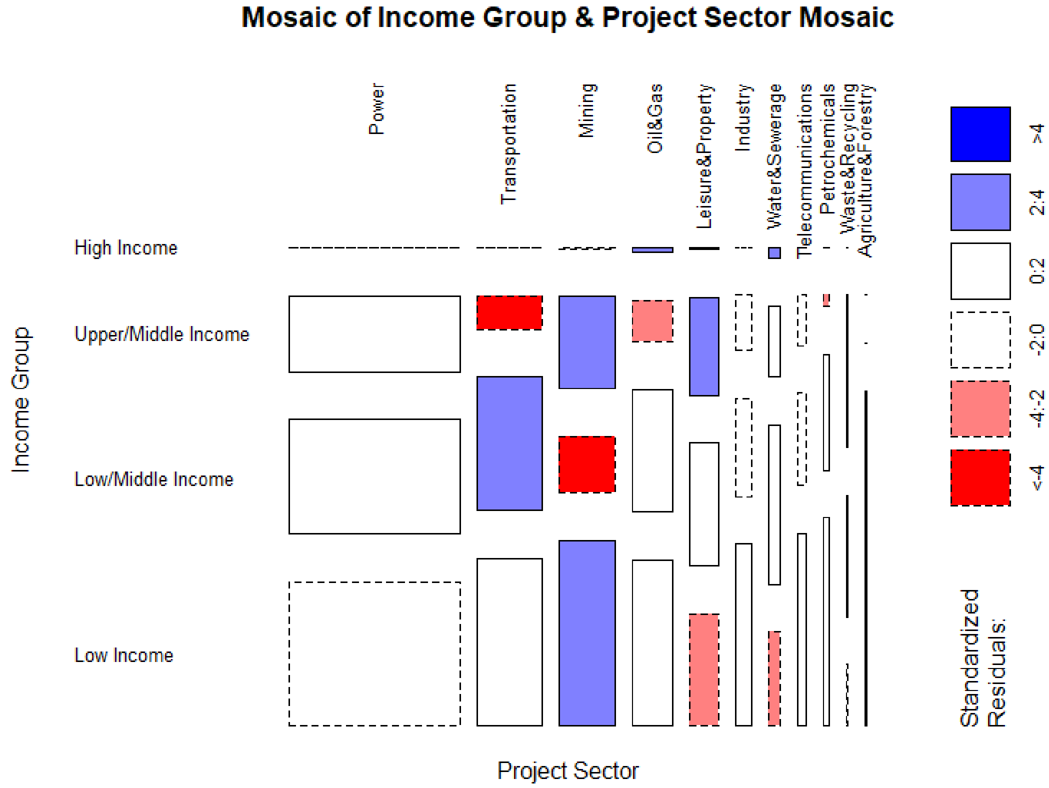
When examining the mosaic plot from Graph 20, there is a strong suspicion that the null hypothesis can be rejected, and the alternative hypothesis can be accepted. As compared to independence between the two variables, low-income countries showcase fewer water & sewerage and leisure & property assets as indicated by the red shading, but higher than expected mining occurrence. Additionally, in the tendency they have a higher share of transportation. The comparative focus on transportation assets is more pronounced for low-middle income countries. On the other hand, high income countries have more water & sewerage projects and upper middle-income countries have more leisure & property and mining projects than expected under independence. To decide whether the null hypothesis can be rejected, Pearson's Chi-squared test of independence is conducted. With a p-value of $1.8e^{-13}$, the null hypothesis can clearly be rejected on every significance level and thus, the alternative hypothesis that income group and project sector are *not* independent is accepted.

Secondly, it is obvious that project nation and project sector are likely dependent, however, testing this statistically will constitute the second tests. The hypothesis is as follows:

[28] For the Chi-Squared test the R-code chisq() was used, and for the Anova test, the R-code Anova().

[29] Refer to the literature review, Section 3.2.

Graph 20: Mosaic Plot of Income Group & Project Sector




The mosaic plot in Graph 20 visualizes the co-occurrence of income group and project sector. The blue colour indicates a higher-than-expected co-occurrence as compared to independence, whereas the red colours indicate a lower-than-expected co-occurrence.

Source: Own Illustration based on SDC Platinum

$$H_0: Project\ Sector\ and\ Project\ Nation\ are\ independent$$
$$H_1: Project\ Sector\ and\ Project\ Nation\ are\ not\ independent$$

The Chi-square test result of $2.2e^{-16}$ leads us to reject this null hypothesis and accept the alternative hypothesis – explicitly project sector and project nation are not independent of each other. Some are positively associated[30] (e.g., DRC, Burkina Faso or Botswana and mining, Nigeria and oil & gas, Zimbabwe and power) and others are negatively associated (DRC, Nigeria and power; Zimbabwe, South Africa and transportation). This is not surprising insofar as a country's resource endowment and factors like being landlocked heavily influence which infrastructure sectors emerge. The mosaic plot is displayed in Appendix A.3.

Thirdly, examining whether the assets have uniformly received financing is interesting and leads to an inference on success rates of different sectors. To that end, an independence test of financing status and project sector is conducted with the following hypotheses stated.

$$H_0: Project\ Sector\ and\ Financing\ Status\ are\ independent$$
$$H_1: Project\ Sector\ and\ Financing\ Status\ are\ not\ independent$$

[30] A positive association implies that a certain variable pairing appears significantly more often than independence would suggest (blue shade in mosaic plot), whereas a negative association implies that a variable pairing appears significantly less often than independence would suggest (red shades in mosaic plot).

Here, too, the null hypothesis of independence can clearly be rejected because the p-value of the Chi-squared test is smaller than the significance level (p-value = $4.5e^{-12} < 0.001 = \alpha$). The data implies that financing is more often received by oil & gas, mining, and telecommunication projects. On the other hand, assets in mining and telecommunication hold less often the very initial financing status (rumor/pipeline) than would be expected. Both the extractive industries as well as telecommunications are lucrative sectors which tend to earn high rents. Telecommunication, in addition, often is heavily taxed and allow for substantial fiscal revenues in developing countries (Matheson and Petit (2017)). Hence, host governments have an interest in those assets being built. Conventional financing is often provided for transportation, leisure & property as well as water & sewerage projects – the sectors where governments are frequently involved as sponsors or co-sponsors. The mosaic plot is displayed in Appendix A.3.

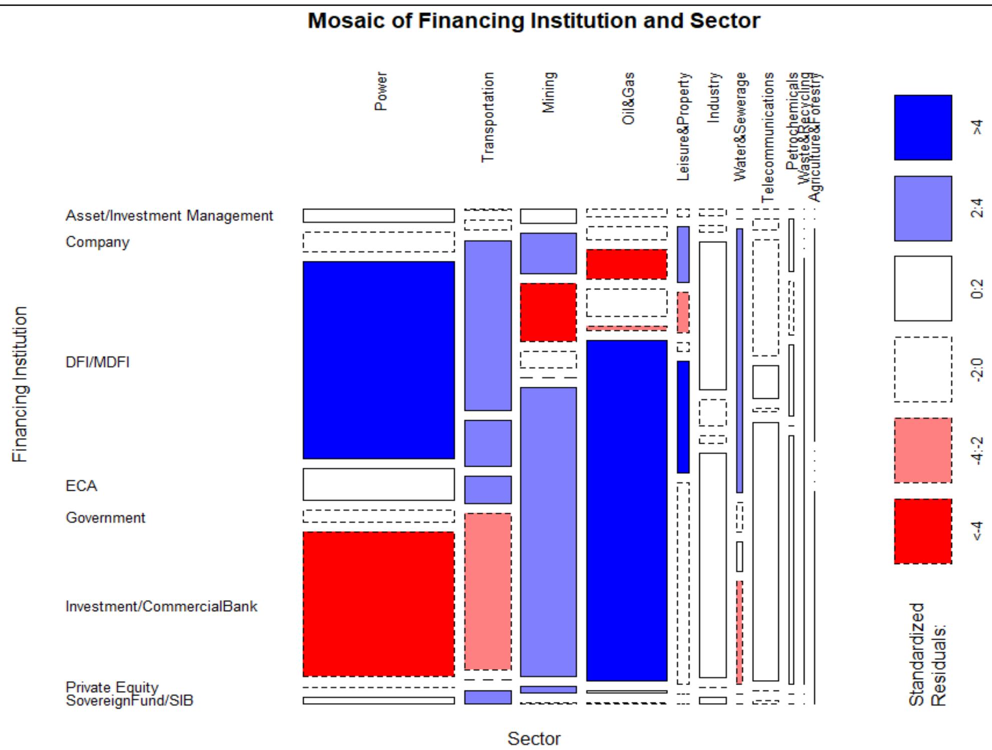
Lastly, the sectoral analysis examines whether there are patterns regarding the financing institution type and the sector. It is probable that projects in the extractive industry would receive less MLA grants, for instance, than urgent projects in the power sector power. The hypothesis is:

$$H_0: Project\ Sector\ and\ Financing\ Institution\ are\ independent$$

$$H_1: Project\ Sector\ and\ Financing\ Institution\ are\ not\ independent$$

Given the Chi-squared test's p-value of $2.2e^{-16}$, the null hypothesis of independence between the two variables can comfortably be rejected and the alternative hypothesis that the two

Graph 21: Mosaic Plot of Financing Institution and Project Sector




The mosaic plot in Graph 21 visualizes the co-occurrence of project sector and financing institution. Blue shadings indicate a higher-than-expected co-occurrence of two variables as compared to independence, whereas red shadings indicate a lower-than-expected co-occurrence. Source: Own Illustration based on SDC Plati

variables are not independent is accepted. The mosaic plot in Graph 21 shows that commercial and investment banks are less frequently than expected involved in power, transportation, or water & sewerage projects, however, more frequently in mining and oil & gas. The exact reverse is true for DFI/MDFIs. Governments are often part of transportation and leisure & property projects which corresponds to these two sectors being most often procured in a PPP.
To conclude, project sectors are not only dependent on the income group affiliation of a country but are also country specific. Besides, the probability of receiving financing as much as the financing institution type varies with the sector. Some sectors are more likely to receive financing than others and those are usually higher profit sectors in the extractive industry.

### 6.1.2 Sponsors

The analysis will now turn to examine two further hypotheses regarding the associations between sponsors and host countries as well as project cost, respectively.

$$H_0\text{: } Sponsor\ Country\ and\ Host\ Country\ are\ independent$$
$$H_1\text{: } Sponsor\ Country\ and\ Host\ Country\ are\ not\ independent$$

When testing for whether sponsor and host nations are random (i.e., independent of each other), again the null hypothesis of independence can comfortably be rejected (p-value of $2.2e^{-16}<0.001$ for confidence level α). Firstly, and as stated earlier in many cases one of the sponsors is from the host country. Besides, as mentioned in Section 5.8, developed countries often focus on a set of developing and emerging countries due to history, language, geopolitical relations and several other factors. For instance, Lusophone countries in SSA often showcase the involvement of Brazil or Portugal and China has been heavily involved with BRI signatories since 2013.
Secondly, it is probable that certain countries that showcase higher development overall or more mature financial markets attract costlier projects than lesser developed nations. Thus, the below hypothesis will be tested:

$$H_0\text{: } Project\ Cost\ does\ not\ depend\ on\ the\ Sponsor\ Countries$$
$$H_1\text{: } Project\ Cost\ does\ depend\ on\ the\ Sponsor\ Countries$$

For this hypothesis, where a categorical variable explains a continuous variable, a dummy coded regression is applied. Note that a regression with only one explanatory dummy coded variable is an analysis of variance (Anova) examining whether the means of the different levels are significantly different from each other (Schmuller (2017)). As depicted in Table 7, the null hypothesis can be rejected as the sponsor country is significantly associated with the project cost on a 99% confidence interval. Some sponsor nations such as China, Japan, South Korea, Oman, and Italy are associated with significantly higher project costs than the reference level which is set to South Africa owed to it being the most frequent sponsor (refer to Appendix Table A 3).
It can be concluded that the relationship between sponsor nations and host nations are not random but depend on a variety of factors which are often complex to pin down. The origin of

a sponsor, further, seems to influence or possibly determine the project cost. For instance, some Asian countries are associated with costlier infrastructure assets.

Table 7: Anova Test Result: Project Sector and Project Cost

| **Anova Table (Type II tests)** | | | | |
|---|---|---|---|---|
| Response: Project Cost | | | | |
| | Sum Sq | Df | F value | Pr(>F) |
| Sponsor Nation | 1.9681e+09 | 109 | 1.3995 | 0.004784 ** |
| Residuals | 2.8642e+10 | 2220 | | |
| | | | | |
| Signif. codes: | 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 | | | |

Source: Own Calculations based on SDC Platinum

### 6.1.3 Financing

Lastly, a variety of associations between financing amount and sector, project nation and loan type are examined. Again, because a categorical variable is used to explain a continuous variable, dummy coded regression models and Anova tests are applied. The three hypotheses are formulated below:

$$H_0: Financing\ Amount\ is\ independent\ of\ Sector\ (/\ Project\ Nation\ /\ Loan\ Type)$$

$$H_1: Financing\ Amount\ is\ not\ independent\ of\ Sector\ (/\ Project\ Nation\ /\ Loan\ Type)$$

As before, for each factor the most frequently occurring level has been chosen as reference level to which the other levels will be compared[31]. The Anova test has been conducted for all variables separately, which can be found in Table 8. It is observable that financing amount is neither independent of project sector, nor loan type, nor project nation. Hence, the null hypothesis is rejected in all three cases and acceptance of the alternative hypotheses results in all cases[32].

A look at the dummy coded regressions in Table 9 enables the identification of the treatment levels which affect the financing amount. For instance, oil & gas as well as power projects have a statistically significant positive association with financing amount, implying that these assets receive higher loans. Furthermore, Angola, Mozambique, Nigeria, and South Africa have a statistically significant positive effect on financing amounts. Hence, these countries receive on average higher funding than other nations. Lastly, depending on the loan type, the financing varies. Multilateral agency loans, sponsor equity and bilateral loans have a negative effect whereas ECA loans effect the amount positively.

[31] i.e., South Africa for project nation, syndicated loan for loan type and power for sector

[32] Note that the F-values of the Anova tests and the dummy-coded linear regression are equal.

Table 8: Anova Test Results for Project Sector, Loan Type and Project Nation

| **Anova Table (Type II tests)** | | | | |
|---|---|---|---|---|
| Response: Financing Amount | | | | |
| | Sum Sq | Df | F value | Pr(>F) |
| Project Sector | 41691221 | 10 | 7.2439 | 3.55e-11 *** |
| Residuals | 664744938 | 1155 | | |
| Signif. codes: | 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 | | | |

| **Anova Table (Type II tests)** | | | | |
|---|---|---|---|---|
| Response: Financing Amount | | | | |
| | Sum Sq | Df | F value | Pr(>F) |
| Loan Type | 21445587 | 11 | 3.2845 | 0.0001888 *** |
| Residuals | 684990572 | 1154 | | |
| Signif. codes: | 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 | | | |

| **Anova Table (Type II tests)** | | | | |
|---|---|---|---|---|
| Response: Financing Amount | | | | |
| | Sum Sq | Df | F value | Pr(>F) |
| Project Nation | 50229883 | 45 | 1.9051 | 0.0003594 *** |
| Residuals | 656206276 | 1120 | | |
| Signif. codes: | 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 | | | |

Source: Own Calculations based on SDC Platinum

Table 9: Results from Dummy Coded Regressions on Financing Amount (only statistically significant covariates included)

**Regression Model 4: Sector & Financing**

| | *Dependent variable:* Financing Amount |
|---|---|
| Transportation | 115.211* |
| | (69.898) |
| Oil & Gas | 557.225*** |
| | (73.993) |
| Petrochemicals | 454.986** |
| | (231.440) |
| Constant | 222.378*** |
| | (35.257) |
| Observations | 1,166 |
| $R^2$ | 0.059 |
| Adjusted $R^2$ | 0.051 |
| Residual Std. Error | 758.641 (df = 1155) |
| F Statistic | 7.244*** (df = 10; 1155) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 Only statistically relevant covariates reported |

**Regression Model 5: Host Country & Financing**

| | *Dependent variable:* Financing Amount |
|---|---|
| Angola | 412.525*** |
| | (143.870) |
| Ethiopia | 238.072* |
| | (142.044) |
| Mozambique | 670.399*** |
| | (115.787) |
| Nigeria | 283.885*** |
| | (88.935) |
| Constant | 249.869*** |
| | (54.261) |
| Observations | 1,166 |
| $R^2$ | 0.071 |
| Adjusted $R^2$ | 0.034 |
| Residual Std. Error | 765.440 (df = 1120) |
| F Statistic | 1.905*** (df = 45; 1120) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 Only statistically relevant covariates reported |

**Regression Model 6: Loan Type & Financing**

| | *Dependent variable:* Financing Amount |
|---|---|
| Bilateral Loan | -229.050*** |
| | (66.862) |
| ECA Loan | 144.447* |
| | (84.187) |
| MLA Loan | -231.024*** |
| | (65.379) |
| Sponsor Equity | -222.989*** |
| | (73.612) |
| Constant | 413.015*** |
| | (38.570) |
| Observations | 1,166 |
| $R^2$ | 0.030 |
| Adjusted $R^2$ | 0.021 |
| Residual Std. Error | 770.441 (df = 1154) |
| F Statistic | 3.284*** (df = 11; 1154) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 Only statistically relevant covariates reported |

Source: Own Calculations based on SDC Platinum

## 6.2 Regressions

This part conducts multiple linear regressions aiming at identifying variables that are associated with the total infrastructure project financing a country attracts.

Through manipulation of the data, a panel data set is obtained with total[33] project cost per year and country. The total project cost is the independent variable in the first three specifications and an explanatory variable in the reversed regression. Given the vast amount of literature looking at the influence of GDP on infrastructure and vice versa, the estimations tries to assess the association between total project cost and GDP per capita/GDP growth in the first regression model. In the second model, the association between average project cost and GDP per capita/GDP growth is assessed. The third estimation imposes a two-year time lag, so that project costs are explained by GDP two years prior[34]. To account for potential omitted variable bias further economic indicators are included as control variable. In particular the following are considered:

- *Financial market development index*: An index summarizing how advanced financial markets are in terms of depth, access and efficiency; from IMF.
- *Export quota*: Exports of goods and services (% of GDP); from World Bank Database.
- *Labor productivity*: Total volume of output (% of GDP) produced per unit of labor (measured in terms of the number of employed persons/hours worked); from ILO database.
- *Index of political stability and absence of violence/terrorism*: Denotes the perceptions of the likelihood of political instability and/or politically motivated violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5; from World Bank Database.
- *Contract enforcement ranking*[35]: A ranking indicating how costly and time-consuming it is to enforce contracts in court; from World Bank Database.
- *Corruption index*: CPIA transparency, accountability, and corruption in the public sector rating (1=low to 6=high) from World Bank Database.

The estimations for the regressions are:

$$\log(C_{it}) = \beta_1 + \beta_2 y_{it} + \beta_3 X_{it} + \gamma_i + \theta_t + \epsilon_{it} \quad (1)$$

$$\log(C_{it+2}) = \beta_1 + \beta_2 y_{it} + \beta_3 X_i + \gamma_i + \theta_t + \epsilon_{it} \quad (2)$$

$C_{it}$ denotes the total project cost of country i in year t. Since the variable is highly skewed, a logarithm serves to allow for an approximately normal distribution. The term $y_{it}$ denotes GDP growth in country i and year t. $X_{it}$ is a vector of country i characteristics as listed above. Of interest is the coefficient $\beta_2$, which indicates the association between total project cost and GDP in a country. Country and year fixed effects, $\gamma_i$ and $\theta_t$, are included. The fixed-effect estimators control for unobserved and time-invariant heterogeneity between the countries, thus for

[33] For certain specifications *average* project cost per year and country was used.

[34] The two-year gap was chosen by the author because infrastructure tends to have lengthy processes during which sponsors form an SPV and plan a project until it can even be announced.

[35] belongs to the *Ease of Doing Business Index*

variables that do not change with time but are different for different countries. Additionally, standard errors are clustered at the country level to account for within-country correlation or heteroscedasticity because observations of a specific country are not independent over time.
In the second estimation, a two-year time lag is introduced. Total project cost of country i in year t+2 will be regressed on GDP growth and the set of economic variables.
Thereafter, a third, reversed regression will be conducted of the form:

$$Y_{it} = \beta_1 + \beta_2 \log(c_{it-2}) + \beta_3 X_{it} + \gamma_i + \theta_t + \epsilon_{it} \quad (3)$$

$Yi_t$ is the explained variable and refers to GDP growth and the logarithm of GDP per capita in country i and year t. For the regression on GDP per capita, a logarithm is used to have an approximately log-normal distribution for the explained variable. The term $c_{it}$ denotes the total project cost country i has attracted in year t-2 which is in logarithm. $X_{it}$ is a vector of covariates of country i characteristics at time t and includes all priorly mentioned variables except for contract enforcement and corruption index. Country and time fixed effects are included, and standard errors are clustered at the country-level.

### 6.2.1 Discussion

Four regression estimations[36] have been conducted with four specifications each. Firstly, the logarithm of total project cost has been regressed on GDP and the set of economic variables (Model 1). Secondly, the logarithm of average project cost has been regressed on GDP and the set of economic variables (Model 2). Thirdly, total project cost has been regressed on both GDP and the set of economic variables two years prior (Model 3). Lastly, in a reversed regression GDP is explained by project costs two years prior and the set of economic indicators (Model 4). In each model, firstly a single regression with the explanatory variable was estimated. Then, in three further regressions control variables were included to see whether and how the associations change. The discussion will focus on Model 1, Model 3, and Model 4. Model 2 and further estimations are to be found in Appendix A.4 but will not be discussed for brevity and because model fits are inferior to the ones presented.
Table 10 exhibits the linear regression output for the first model using the logarithm of total project cost as the dependent variable. It is visible that GDP growth is positive and significant in every specification, hence a positive association between GDP and total project cost is assumed. Another variable that is positive and statistically significant on the 99.5% confidence interval in regressions (2) and (4) is the financial development index. More developed financial markets imply that local commercial banks can provide financing. This may enhance trust from foreign financing sources, hence could be an explanation for the positive association. Because project cost is logarithmic, the coefficients $\beta$ need to be calculated as $e^{\beta}$ for interpretation.

[36] To be exact, eight regression estimations were calculated because for each of the four models, both GDP growth and GDP per capita were used as explained variable. Model 2.1 uses GDP growth and Model 2.2 GDP per capita as explained variable.

Table 10: Regression Model 1: Total Project Cost & GDP Growth

**Regression Model 1: Total Project Cost & GDP Growth**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Total Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP Growth | 0.027** | 0.038** | 0.109** | 0.209*** |
| | (0.013) | (0.017) | (0.047) | (0.038) |
| Financial Development Index | | 0.013** | 0.015 | 0.115** |
| | | (0.006) | (0.012) | (0.055) |
| Labor Productivity | | | 0.00001 | 0.0002*** |
| | | | (0.00001) | (0.0001) |
| Political Stability Index | | | -0.665*** | -0.013 |
| | | | (0.173) | (0.336) |
| Enforcing Contracts Score (Ease of Doing Buisness) | | | | 0.050** |
| | | | | (0.021) |
| Export Quota | | | | -0.045*** |
| | | | | (0.016) |
| Corruption Index | | | | -0.801** |
| | | | | (0.348) |
| Observations | 469 | 457 | 218 | 83 |
| $R^2$ | 0.004 | 0.013 | 0.062 | 0.270 |
| Adjusted $R^2$ | -0.059 | -0.054 | 0.002 | 0.145 |
| F Statistic | 1.839 (df = 1; 440) | 2.891* (df = 2; 427) | 3.358** (df = 4; 204) | 3.707*** (df = 7; 70) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

A one unit increase of the financial development index would increase total project cost by a multiple of $e^{0.115}$=1.122 which translates to a 12.2% increase. Moreover, the score of how effectively contracts can be enforced has a positive influence and so does labor productivity, even though the latter association is very small. Both export quota and corruption index showcase a negative association with total project cost. For the corruption index, this makes sense as corrupt governments are an inhibiting factor for attracting foreign money. However, the negative sign of export quota does not seem logical. Aside from that, some associations are extremely strong, such as GDP growth (23% increase) or corruption index (55% decrease). Therefore, the model specifications are likely not ideal. However, the overall associations seem reasonable for all variables except for the export quota and the R-squared of regression (4) is 27%. According to the adjusted R-squared, the model has an explanatory power of 15% which is fairly low.

In Model 3 reported in Table 11, a two-year time-lag has been imposed on all explanatory variables. In consequence, the logarithm of total project cost in t is regressed on GDP Growth and the set of economic variables in t-2. The output is depicted in Table 11. It is notable that the associations and signs are the same as in Model 1. Again, GDP growth is significant and positively associated with total project cost in every specification. Nonetheless, the financial development index is significant only in the last specification on the 99% level. Concurrently, the negative influence of corruption has increased even more. Despite, the slightly higher explanatory power as compared to Model 1, the fit is not ideal and the model most likely suffers from misspecifications.

Finally, regression Model 4 in Table 12 conducts a reverse regression with a two-year time-lag, so that total project cost of t-2 is used to explain the GDP variable. Here, the logarithm of GDP per capita is the explained variable since the results for GDP growth were not significant[37]. The results from Table 12 show that total infrastructure project cost is positively associated with GDP per capita in regression (3) and (4), but the effect is very small. A 10% increase in total infrastructure project cost two years earlier is associated with a 0.41% or 0.39% increase in GDP per capita in t. Financial development index is again positive and significant on every level and in all regressions. In regression (4), a one-unit increase in the financial development index increases GDP per capita by a multiple of $e^{0.013}$=1.013, hence by 1.3%. Again, labor productivity has a statistically significant but unexpectedly small effect on GDP per capita. In Model 4, export quota is additionally positive and significant, which seems more reasonable.

[37] Please refer to Appendix A.3 and Table A 9 for the results

Table 11: Regression Model 3: Two-Year Time-Lag

**Regression Model 3: Total Project Cost & GDP Growth**
**Imposing a two-year time-lag**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Total Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP Growth *(in t-2)* | $0.036^{**}$ | $0.038^{**}$ | $0.113^{***}$ | $0.196^{***}$ |
| | (0.018) | (0.019) | (0.042) | (0.063) |
| Financial Development Index *(in t-2)* | | 0.009 | 0.007 | $0.071^{*}$ |
| | | (0.007) | (0.015) | (0.043) |
| Labor Productivity *(in t-2)* | | | 0.00000 | $0.0002^{***}$ |
| | | | (0.00001) | (0.0001) |
| Political Stability Index *(in t-2)* | | | $-0.595^{***}$ | -0.031 |
| | | | (0.212) | (0.623) |
| Enforcing Contracts Score *(in t-2)* | | | | $0.053^{**}$ |
| | | | | (0.025) |
| Export Quota *(in t-2)* | | | | $-0.048^{**}$ |
| | | | | (0.022) |
| Corruption Index *(in t-2)* | | | | $-0.875^{***}$ |
| | | | | (0.315) |
| Observations | 492 | 479 | 204 | 97 |
| $R^2$ | 0.007 | 0.009 | 0.048 | 0.276 |
| Adjusted $R^2$ | -0.053 | -0.055 | -0.012 | 0.173 |
| F Statistic | $3.076^{*}$ (df = 1; 463) | 1.994 (df = 2; 449) | $2.403^{*}$ (df = 4; 191) | $4.586^{***}$ (df = 7; 84) |
| *Note:* | | | | $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ |

Source: Own calculations based on SDC Platinum, World Bank, IMF, and ILO, Hlavac (2018)

Table 12: Reverse Regression Model 4

**Regression Model 4: Inverse Regression with a two-year time-lag**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | GDP per Capita *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| Total Infrastructure Project Cost *(in logs, t-2)* | 0.028 | -0.007 | 0.035*** | 0.039*** |
| | (0.027) | (0.021) | (0.012) | (0.013) |
| Financial Development Index | | 0.049*** | 0.011*** | 0.013*** |
| | | (0.001) | (0.003) | (0.003) |
| Labor Productivity | | | 0.00005*** | 0.00004*** |
| | | | (0.00000) | (0.00000) |
| Political Stability Index | | | 0.029 | -0.049 |
| | | | (0.032) | (0.037) |
| Export Quota | | | | 0.012*** |
| | | | | (0.003) |
| Observations | 416 | 406 | 206 | 200 |
| $R^2$ | 0.003 | 0.457 | 0.857 | 0.875 |
| Adjusted $R^2$ | -0.063 | 0.418 | 0.847 | 0.866 |
| F Statistic | 1.284 (df = 1; 389) | 158.896*** (df = 2; 378) | 286.549*** (df = 4; 192) | 259.668*** (df = 5; 185) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

As stated earlier, the regression analysis does not allow for causal inference. Nonetheless, it was shown that a certain positive association between GDP and infrastructure project cost seems to exist. The direction of which, however, is likely to be two-ways. The exact mechanisms of how infrastructure influences GDP and vice versa are not well understood so far and complex to assess. There are most likely both direct and indirect effects as well as simultaneous effects. Delineating them from each other as well as from external effects at play is highly complex. An additional finding of the analysis was a positive association between financial market development and total project cost. If local lenders are able to supply funding for projects, this may enhance foreign investment, too, and as a result, a country may be able to attract more infrastructure project financing. Despite the effect being small, labor productivity is positively associated with GDP and infrastructure project cost in country i at time t.

### 6.2.2 Caveats

Several caveats and flaws inherent to the regressions need mentioning. For one, as stated in Section 3, there is a high probability that the regressions suffer from a simultaneity bias. If infrastructure and GDP exhibit a feedback loop, trying to measure the effect one has on the other without controlling for the simultaneity leads to biased results. If a country has a higher provision of infrastructure, there probably is a positive influence on GDP. Yet at the same time, a higher GDP may lead to an increase in infrastructure provision and possibly attract larger-scale projects. Therefore, measuring a one-way association does not provide robust results. Moreover, the signs for certain variables change from one specification to the next which implies that omitted variable bias, a non-linear relationship between variables or interaction between the explanatory variables distort the coefficients. Other model specifications and different explanatory variables could be used to improve the model fit. Multicollinearity is likely also present. The degree to which contracts can be enforced and the presence of corruption in a country are probably correlated, which would undermine the statistical significance of the explanatory variables. Spillover effects from one country to another may be an additional threat to the internal validity of the results. More research needs to be done in this area to check for the robustness of the results. Lastly, some of the variables were only available for a limited time frame, reducing the number of observations. Longer-term data may allow for a better understanding of the associations between the explanatory and the dependent variable.

# 7. Conclusion

Over the next decade, Sub-Saharan Africa – the world region exhibiting the most dramatic lack of infrastructure – will face an infrastructure financing gap of approximately USD 93 billion. Project finance may be a relevant means to bridge this financing gap. It is an ideal scheme for high-risk and long-term projects as it transfers each risk to the party which is best-suited to manage it. Understanding this method better will allow to identify inhibiting and enabling factors which could facilitate higher success rates of infrastructure assets financed through this method.

The thesis has conducted a comprehensive analysis of the past 30 years of project finance in Sub-Saharan Africa and contributed to the existing literature in various ways. Firstly, it has helped to fill the dearth of quantifiable data as well as the knowledge gap in this area. The descriptive analysis found that the infrastructure project finance activity has increased significantly since the 1990s with the highest project numbers registered right before the Covid-19 pandemic. Over the period of interest, project numbers have moved in unison with the world GDP, indicating that economic shocks and crises affect this financing scheme. After the Global Financial Crisis of 2008 and after the Taper Tantrum respectively during the Euro Debt Crisis, project numbers plummeted. Not only on a macro-level but also on a sectoral basis, demand shocks and price surges have an influence. The analysis showed that development in the oil & gas sector were strongly driven by a price surge after 2004 and a demand shock in 2014. Similar trends are visible for the mining sector, which was affected by both the price surge and the demand shock, too. Country-level contemplation identified that nations such as South Africa, Nigeria, and Kenya exhibit a high project financing activity in infrastructure, whereas this financing scheme is rarely encountered in countries like Somalia, Eritrea, or the Seychelles. Possibly, more mature financial markets allow for higher project numbers.

Moreover, depending on the sector of an infrastructure asset the thesis uncovered vast differences in terms of procurement model, project cost, financing as well as sponsor country. For instance, Australia and Canada are highly focused on mining; the UK and the US are involved in many oil and gas assets; China often appears in transportation and the social infrastructure sector. Certain sectors showcase a much higher propensity to being held by foreign countries than others. Mining, for instance showcases high foreign-only ownership, whereas water and social asset are often held by host countries themselves. Aside from this, the sectoral analysis uncovered trends which point the way to future opportunities. For example, renewable energy has developed to be *the* most frequent subsector exhibiting a quasi-exponential growth. Meanwhile, solar energy which has experienced strong efficiency gains over the past decade constitutes the main renewable energy source. Simultaneously, brown energy projects declined and stood at low levels in 2020.

The enquiry into sponsors furthermore unearthed that in many cases at least one sponsor originates from the host country. This is true for north of 60% of the projects. Aside from this

realization, it is often difficult to pin down which countries appear as sponsors in which host countries and even a sponsor network analysis has failed to provide more clarity.
An inspection of the financing data disclosed that the Great Financial Crisis has shifted the financiers base significantly which is a complicating factor for attracting financing. Investment and commercial banks who are traditionally the main sponsors decreased their involvement, however, DFIs, MDFI and ECAs simultaneously increased their activity. Moreover, private equity and asset/investment managers claimed more territory in the infrastructure financing sphere since 2008, even if it is still a minor stake.
Through hypothesis testing it was additionally found that certain projects sectors are positively associated with certain host countries and more likely to receiving financing. Depending on a host country's income group affiliation, certain sectors are disproportionately more or less frequent. Besides, the loan amounts appear to be associated with both financing nation as well as loan type. For instance, China, South Korea, and Japan were found to be involved in more expensive projects, whereas MLA loans, sponsor equity and bilateral loans are more likely in lower-value financing. These findings are not surprising, however, proving the associations statistically was a valuable contribution to a better understanding of the underlying dynamics.
Lastly, the multiple regression allows to speculate on factors which may enhance or inhibit project financing in a country. The regression results suggest that GDP is positively associated with infrastructure project finance and so are labor productivity and financial development. Meanwhile, higher degrees of corruption are negatively associated with total project value. All of these can logically be defended. This is not the case for export quota which also exhibits a negative association with project value. A reversed regression moreover implied that the relationship between project value and GDP runs in both direction and that there is likely a feedback loop. This finding corresponds to the findings of other authors who suggest a two-way relationship.
In conclusion, the thesis managed to bring forth a multitude of findings and interlinkages in the data. It has provided a comprehensive overview over infrastructure project finance in Sub-Saharan Africa during the period of interest. Nonetheless, certain aspects need to be taken with a grain of salt as data quality was not consistent across all variables and a degree of opaqueness accompanies many infrastructure project financing deals. Further aspects could have been investigated but were left for future research. Longer-term data is the key to a more profound understanding of the dynamics in this topic. A better quality and quantity of data collection as well as defining a set of standards on how to assemble data could aid in gaining further insights. Future research could then focus more thoroughly on the underlying drivers and causal relations of the discovered trends. Greater knowledge of how infrastructure project finance may allow to bridge the financing gap in Sub-Saharan Africa potentially allows to infer policy implications. Ultimately, they could facilitate a higher degree of much needed financing into this region for the provision of critical infrastructure assets. The thesis has done seminal work which hopefully fosters further research in the future.

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# Appendix

## A. 1 Map of Sub-Saharan Africa

Graph A 1: Map of Sub-Saharan Africa


Source: Adjusted Illustration from freeworldmaps.net

## A. 2 Supplementary Descriptive Analysis

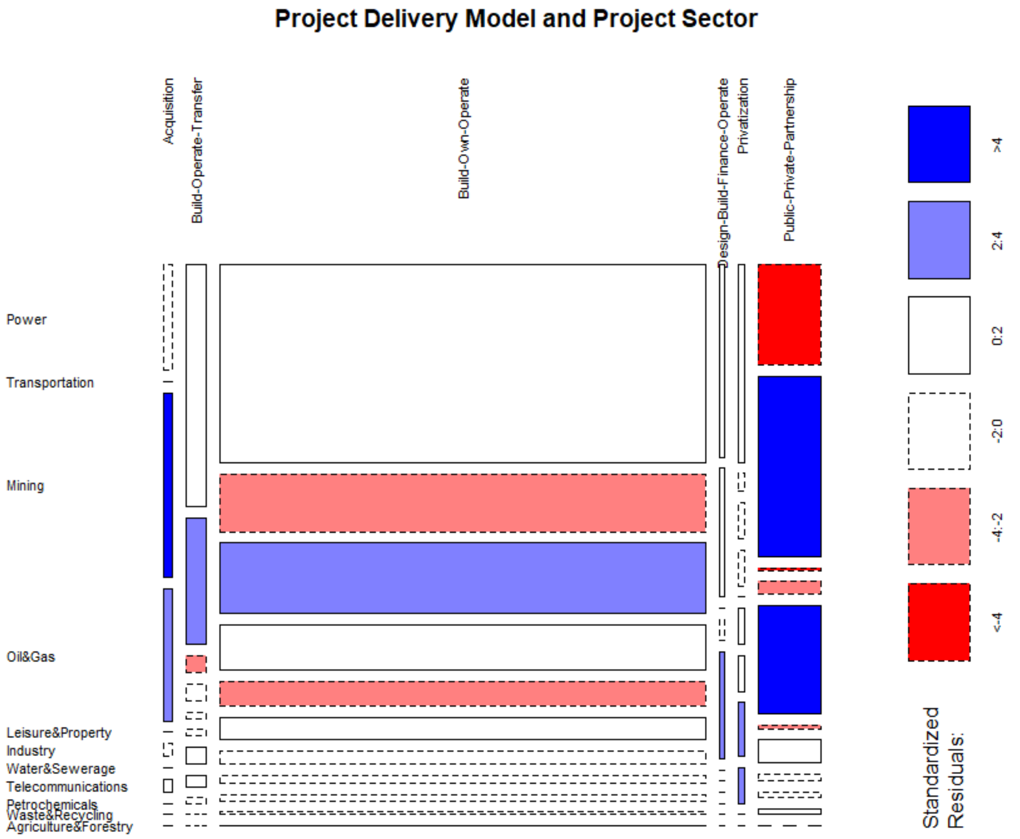
Graph A 2: Project Financings per Country including income group affiliations, 1990-2020


Graph A 2 illustrates the project financing development of each country which registered at least one financing between 1990 and 2020. The colours show the country's income group affiliation according to the World Banks income group database. It is discernible that for some countries, entering a higher income group is associated with more project financings.

Source: Own Illustration based on SDC Platinum and World Bank database on income distribution per country

# Addition to 5.2 Project Model

Graph A 3: Mosaic Plot of Project Delivery Model and Project Sector




Graph A 3 depicts a mosaic plot showcasing the co-occurrence of project delivery model and project sector. As explained in section 4, a mosaic plot visualizes a contingency table and it is possible to recognize here that depending on the project delivery model, certain sectors occur more (blue shading) or less(red shading) than would be expected under independence. The p-value of $2.2e^{-16}$ allows to reject the null hypothesis of independence.

Source: Own Illustration based on SDC Platinum

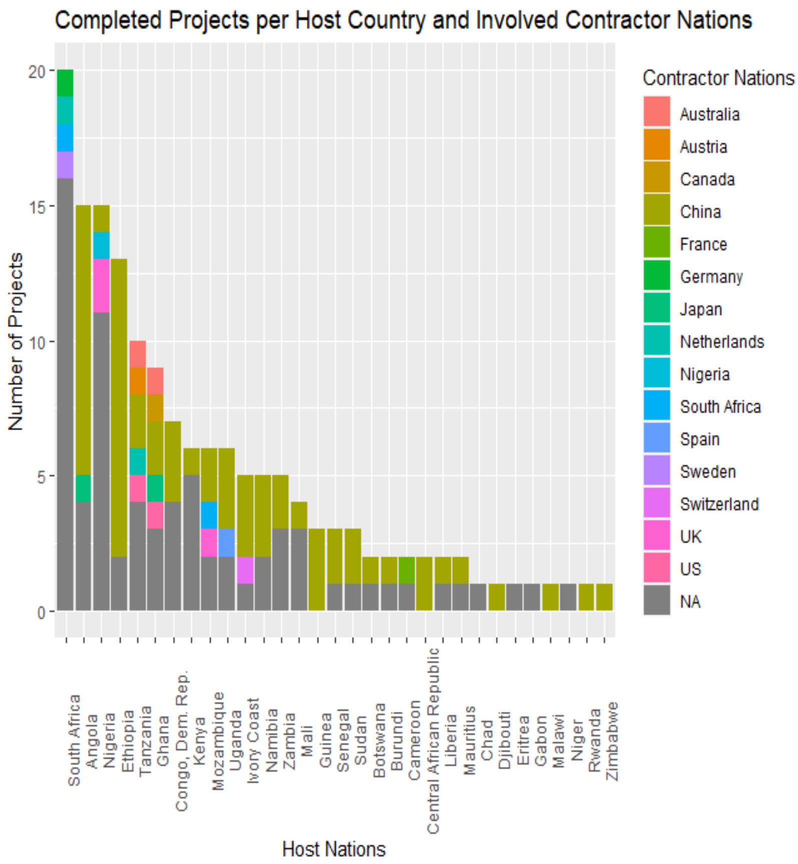
# Addition to 5.3: Project and Financing Status

Table A 1: Table of Project status and percentage of projects with the respective status

| Project Status | Percentage |
|---|---|
| Announced | 53.65 |
| Under Construction | 9.41 |
| Feasibility Study | 6.73 |
| Contract Signed | 6.24 |
| Contract Awarded | 5.32 |
| Completed | 3.96 |
| Operational | 2.24 |
| Government Approved | 1.89 |
| In Tender | 1.58 |
| Preferred Bidder Stage (PBS) | 1.58 |
| Request for Proposal (RFP) | 1.14 |
| Bids Submitted | 0.84 |
| Pre-Qualification Bids | 0.84 |
| Negotiations | 0.66 |
| Awaiting Government Approval | 0.62 |
| Sale Completed | 0.62 |
| Cancelled | 0.57 |
| Inactive | 0.48 |
| Construction Halted | 0.40 |
| Letter of Intent Signed | 0.31 |
| Agreement Signed | 0.18 |
| Relaunched/Renewed | 0.18 |
| Comissioning | 0.13 |
| Planning Permission Applied | 0.13 |
| Public Inquiry | 0.13 |
| Rumoured | 0.09 |
| Planning Permission Granted | 0.04 |
| Re-Tender | 0.04 |

Source: Own Calculations based on SDC Platinum

Graph A 4: Completed Projects per Host Country and Involved Contractor Nations

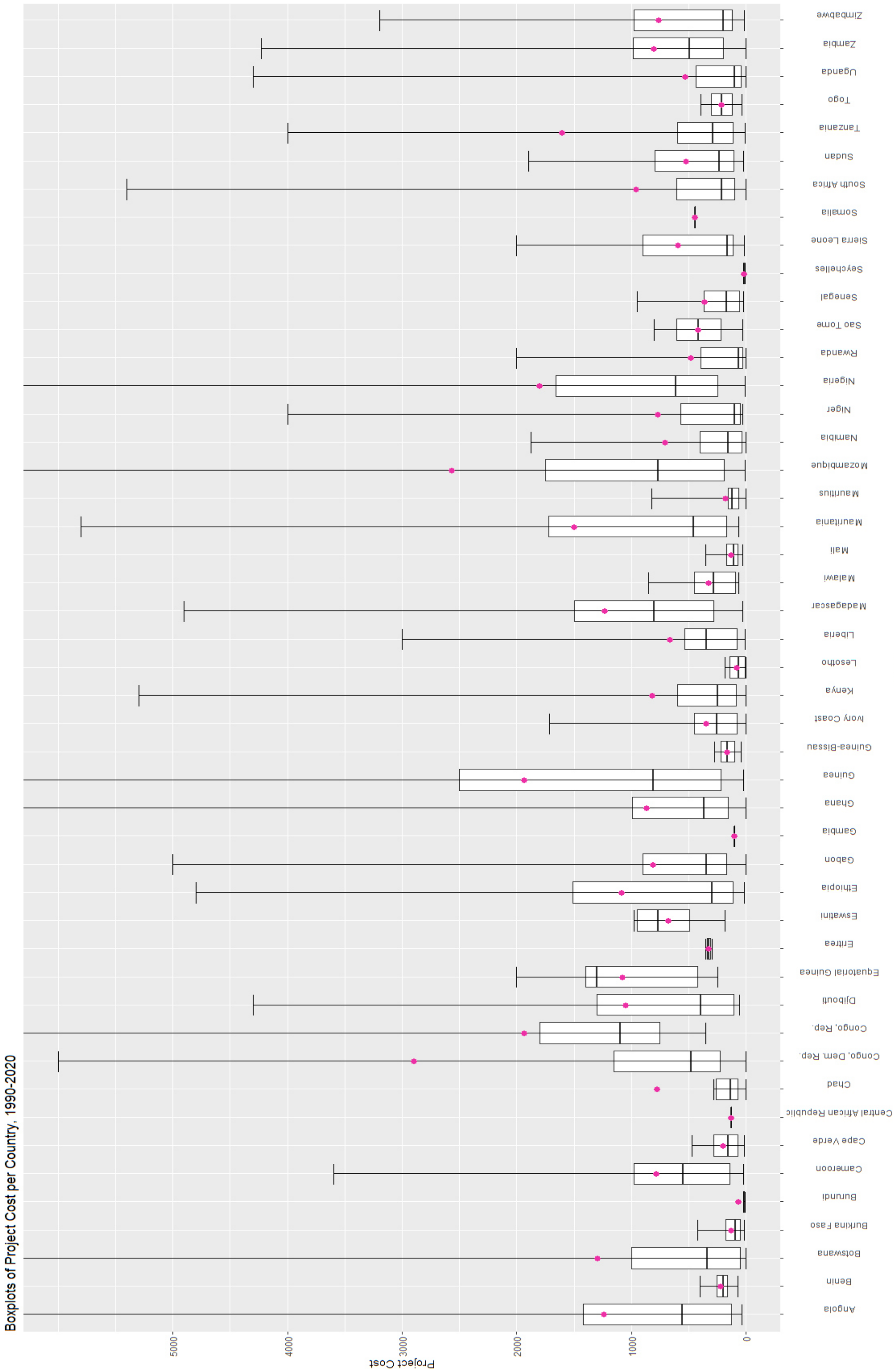



Graph A 4 demonstrates the number of completed and operational projects per corresponding host country. The colour-code of the bars exhibits for certain contracts which country was a contractor in the infrastructure asset. If the colour is grey, no information on contractors is available. It is visible from Graph A 3 that China has been heavily involved as contractor in finalized projects – unlike any other nation.

Source: Own Illustration based on SDC Platinum

## Addition to 5.4 Project Cost

Graph A 5: Boxplots of Project Cost per Country, 1990-2020




Graph A 4 depicts boxplots for the project cost per country excluding outliers. Boxplots exhibit the four statistical values minimum, first quantile, median, third quantile and maximum. The pink dots indicate the mean cost for each sector. For certain countries the maximum is not visible because the scaling was adjusted.

Source: Own Illustration based on SDC Platinum

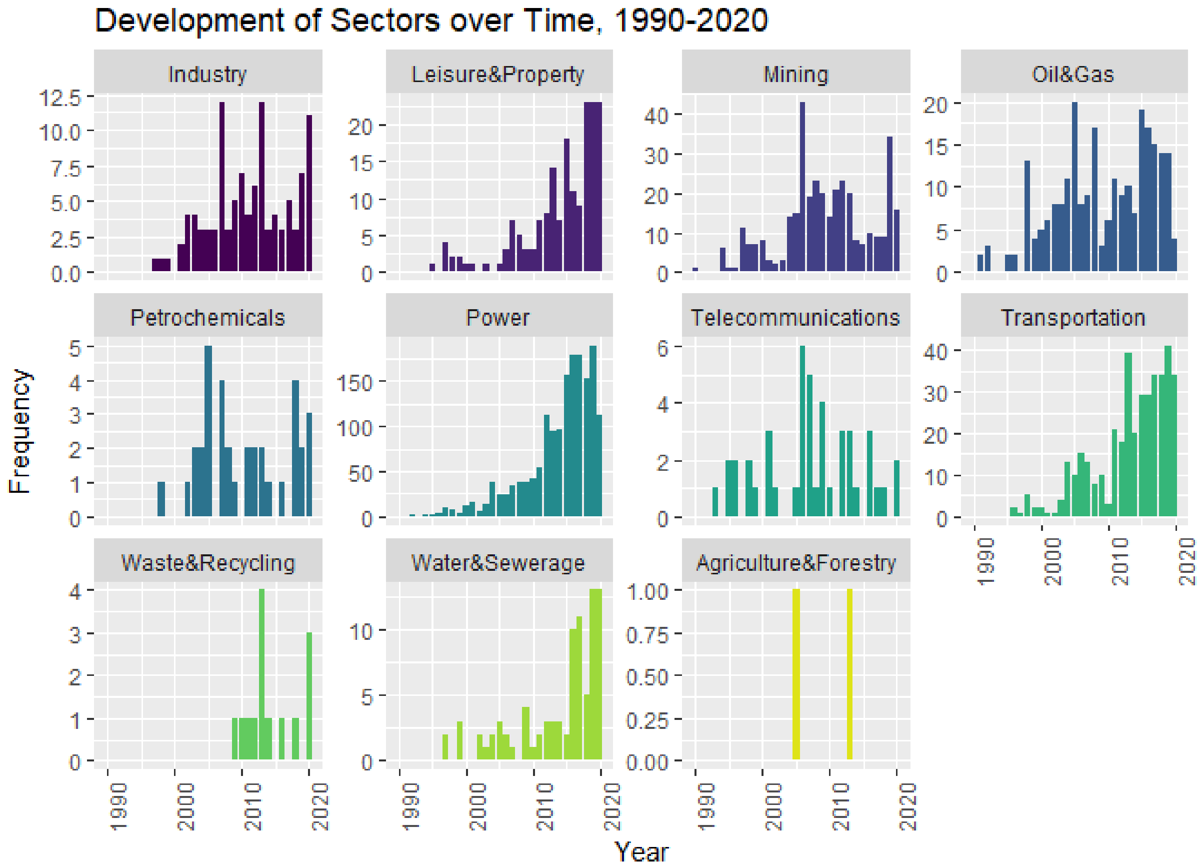
## Addition to 5.5 Sectors and Subsectors

Table A 2: Table of project sectors and subsectors

| Project Main Sector | Project Subsector | Project Main Sector | Project Subsector | Project Main Sector | Project Subsector |
|---|---|---|---|---|---|
| Agriculture&Forestry | Plantation | Mining | Iron/Steel | Power | Hydroelectric |
| Industry | Car Manufacturing | | Lead and Vanadium | | Nuclear |
| | Cement | | Magnesium | | Oil Power |
| | Chemicals and Plastics | | Metals (Other) | | Peat |
| | Fertilisers | | Nickel | | Renewable Energy Source |
| | Food and Grain Mills | | Non-metallic Mining | | Solar |
| | Manufacturing | | Palladium | | Steam |
| | Pulp and Paper | | Platinum | | Tidal/Wave |
| | Smelting Aluminum | | Silver Mining | | Transmission Line |
| Leisure & Property | Defense | | Smelting Aluminum Mine | | Water |
| | Gallery | | Titanium | | Wind |
| | Hospital | | Vanadium | | Wood |
| | Hotel | | Zinc Mining | Telecom-munications | Cable Television |
| | Industrial Estate | Oil&Gas | FPSO | | Land Lines |
| | Information Technology | | Gas | | Personal Communications Network |
| | Office | | Gas Pipeline | | Satellite |
| | Other Commercial | | LNG | | Transmission Line Tele |
| | Other Leisure and Enterta | | LNG Pipeline | Transportation | Airports |
| | Prison | | Oil | | Bridge |
| | Residential Estate | | Oil Pipeline | | Container Terminals |
| | School | Petroche micals | Gas Refinery | | Mass Transit System |
| | Shopping Centre | | Oil Refinery | | Ports |
| | Stadium | | Petrochemical Pipeline | | Roads |
| | Theme Park | Power | Biomass | Waste & Recycling | Waste |
| | Ticketing | | Coal | Water & Sewerage | De-Salination |
| Mining | Coal Mine | | Combined Cycle Gas Turbine | | Water Disposal/Treatment |
| | Cobalt | | Diesel | | Water Pipeline |
| | Copper Mining | | Gas Power | | Water Storage |
| | Gold Mining | | Geothermal | | Water Supply |

Source: Own Illustration based on SDC Platinum

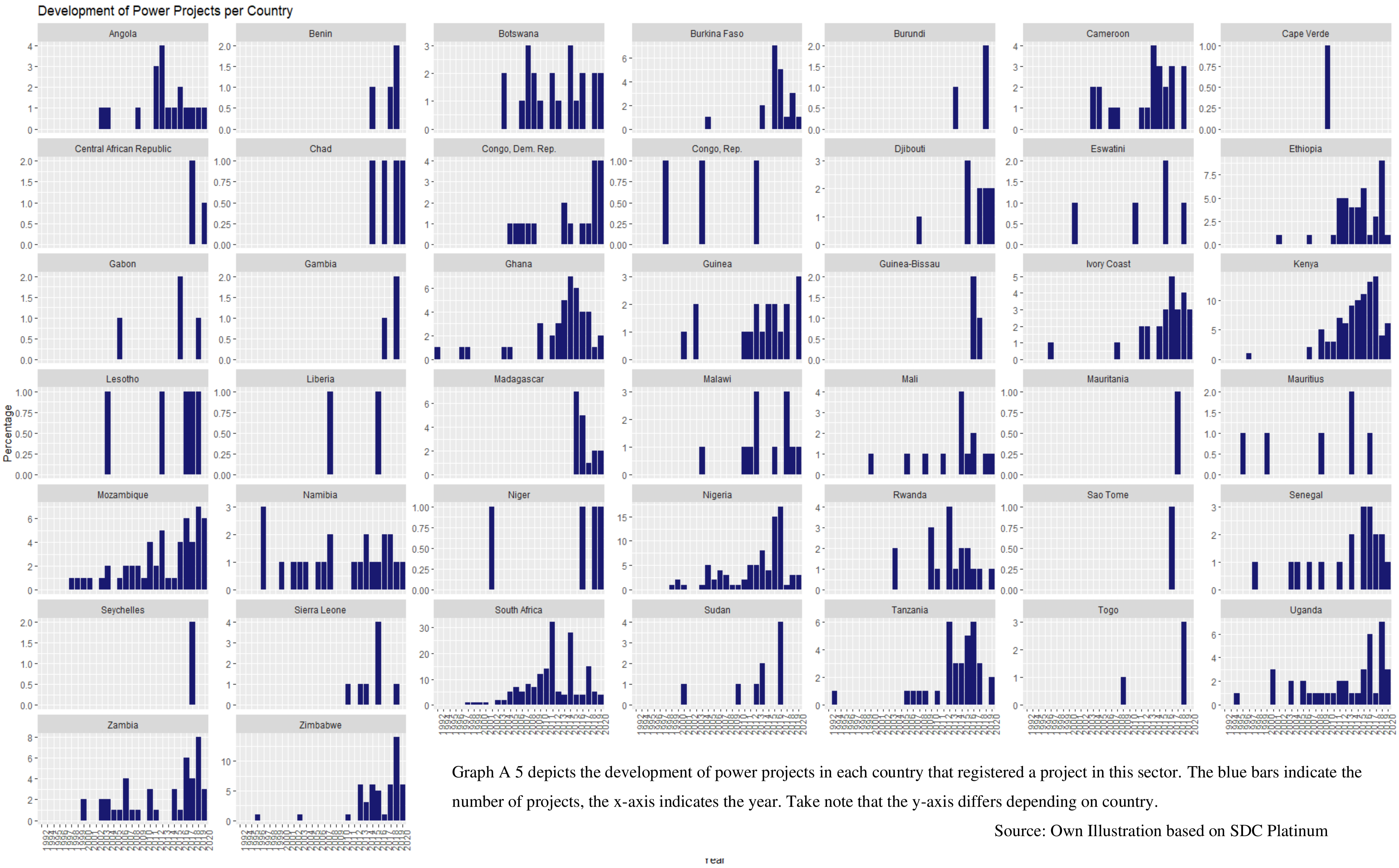
Graph A 6: Development of all Sectors over Time, 1990-2020




Graph A6 shows the development of projects per year for each of the 11 sectors over the examined period. Note that the y-axis differs.

Source: Own Illustration based on SDC Platinum

Graph A 7: Development of Power Projects per Country, 1992-2020

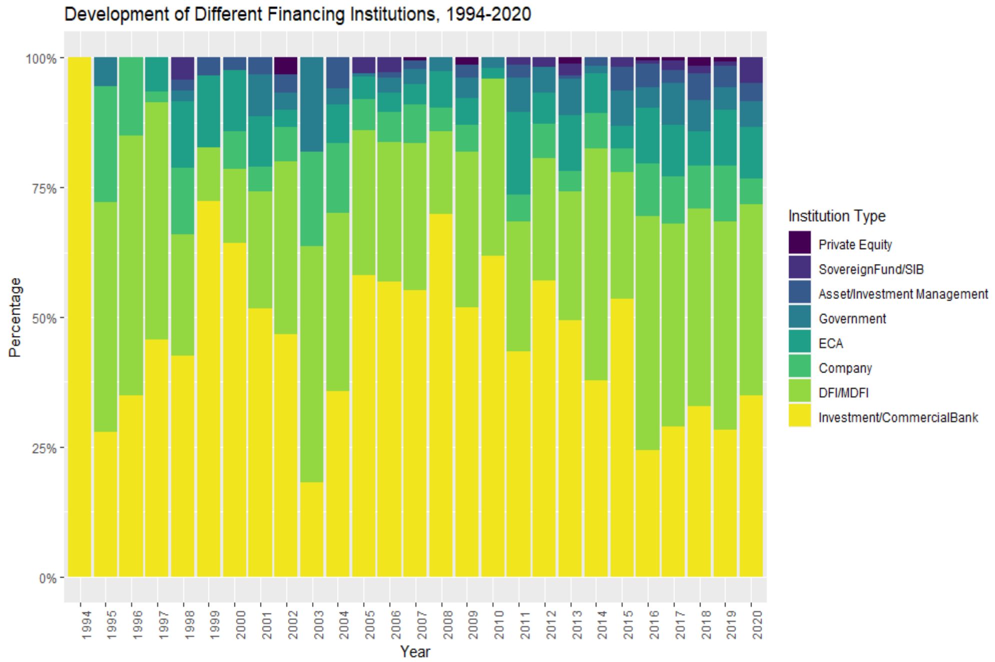



Graph A 5 depicts the development of power projects in each country that registered a project in this sector. The blue bars indicate the number of projects, the x-axis indicates the year. Take note that the y-axis differs depending on country.

Source: Own Illustration based on SDC Platinum

## Addition to 5.9 Financial Analysis

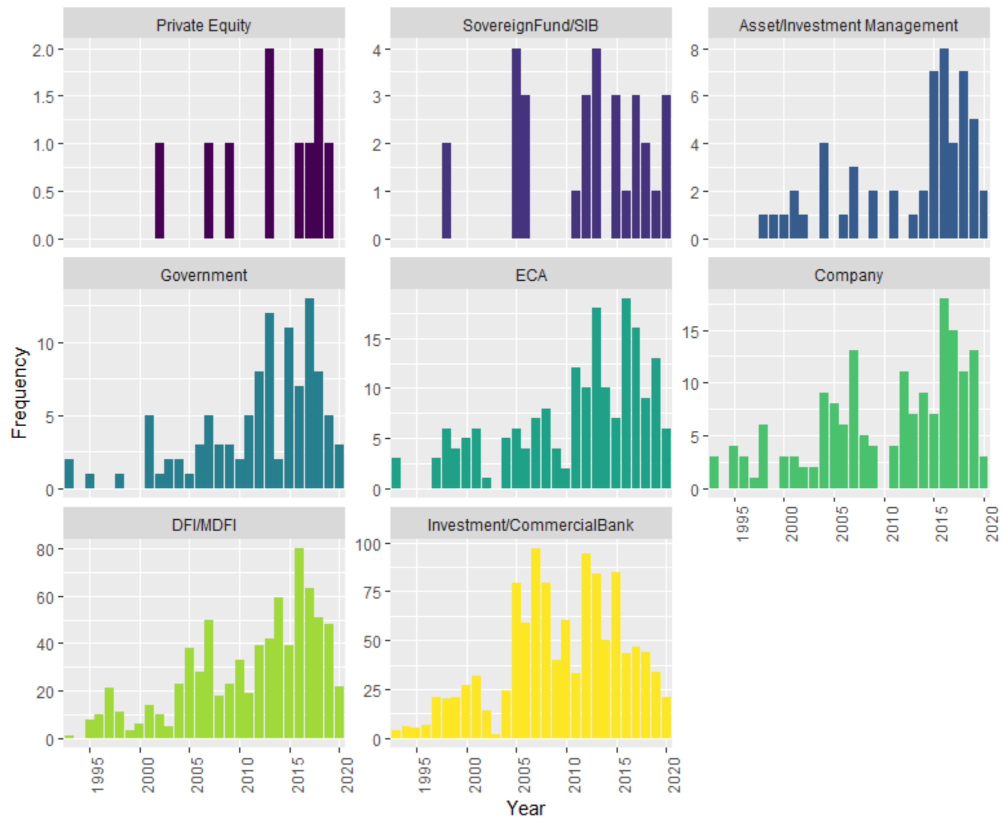
Graph A 8: Stacked Bar Chart of Development of Different Financing Institutions




Graph A 8 shows the development of different financing institutions's shares as percentage of the total per year between 1994 and 2020.

Source: Own Illustration based on SDC Platinum

Graph A 9: Development of Every Financial Institution Type over Time

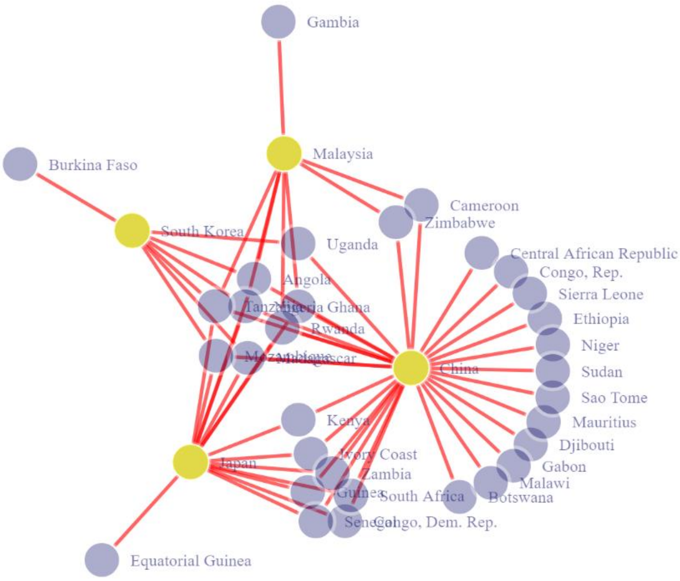



Source: Own Illustration based on SDC Platinum

## Addition to 5.10 Network Analysis

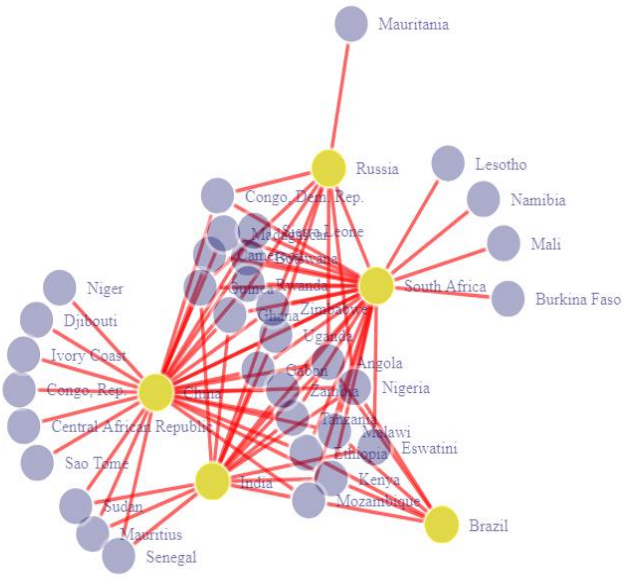
Certain networks of the sponsor network analysis are depicted below, among them the BRICS-sponsor network, the Asian sponsors network as well as the Arabic sponsor network. It is visible that between Arabic sponsors, less overlaps exist than for Asian sponsors. The BRICs countries (Brazil, Russia, China, India, and South Africa) on the other hand are strongly intertwined. These illustrations will not be further discussed but should be seen as a supplement to the descriptive analysis. Future research could look at these connections more thoroughly.

Graph A 11: Asian-Sponsors Network



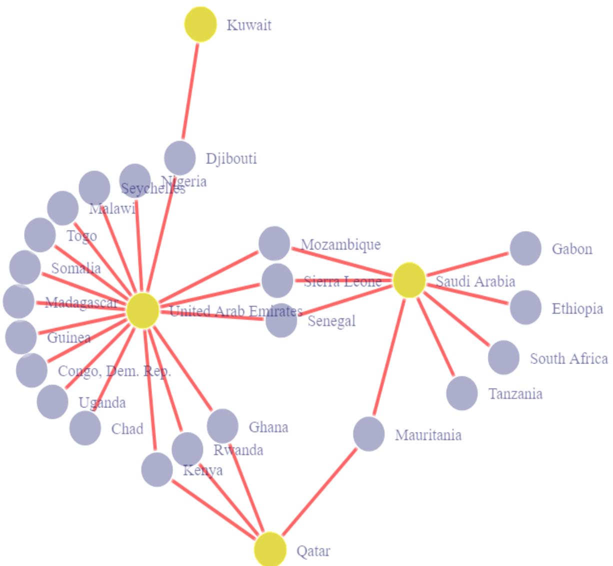

Source: Own Illustration based on SDC Platinum

Graph A 10: BRICS-Sponsors Network




Source: Own Illustration based on SDC Platinum

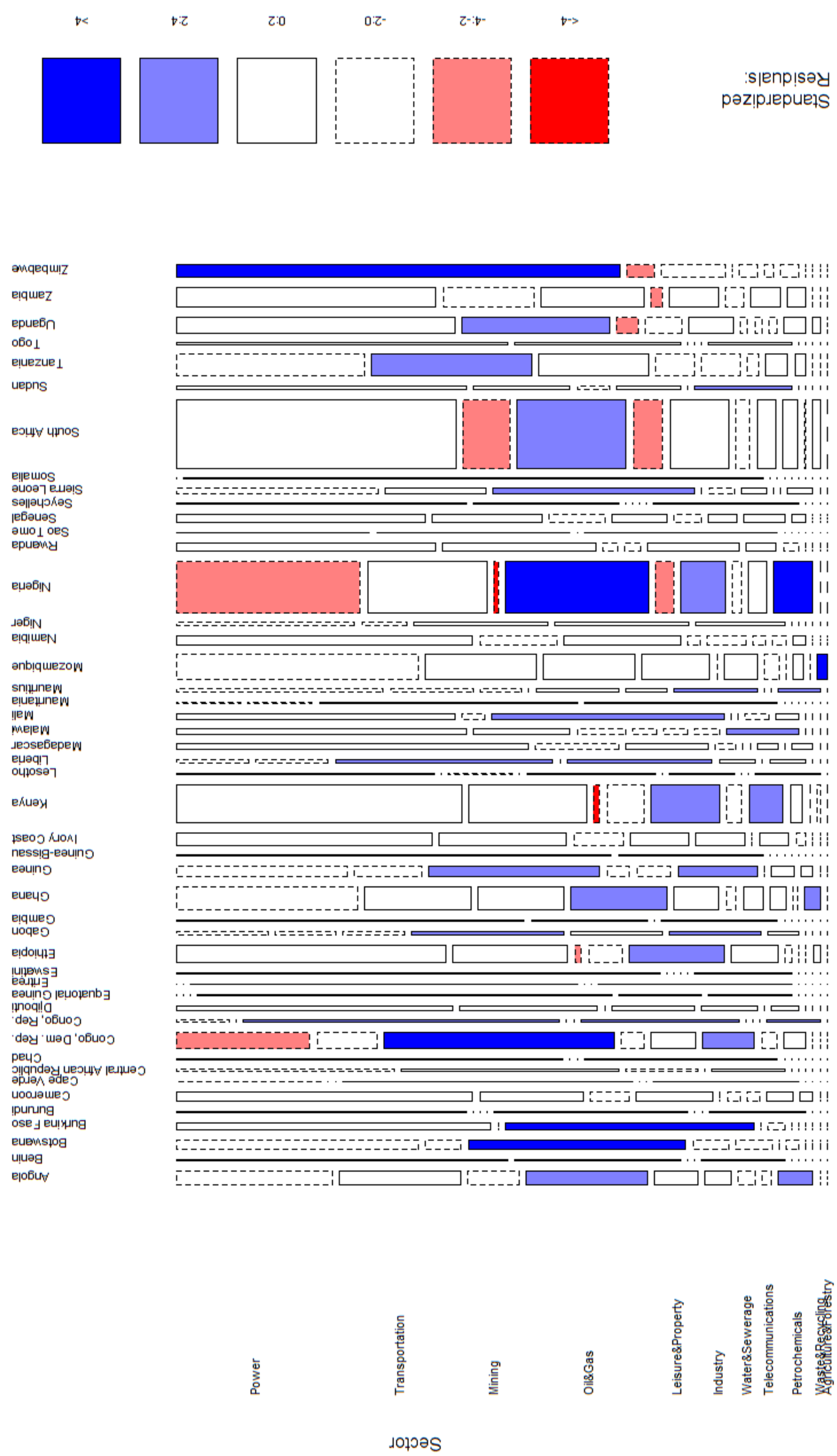
Graph A 12: Arabic-Sponsors Network




Source 5: Own Illustration based on SDC Platinum

## A. 3 Hypothesis Testing and Dummy Coded Regressions

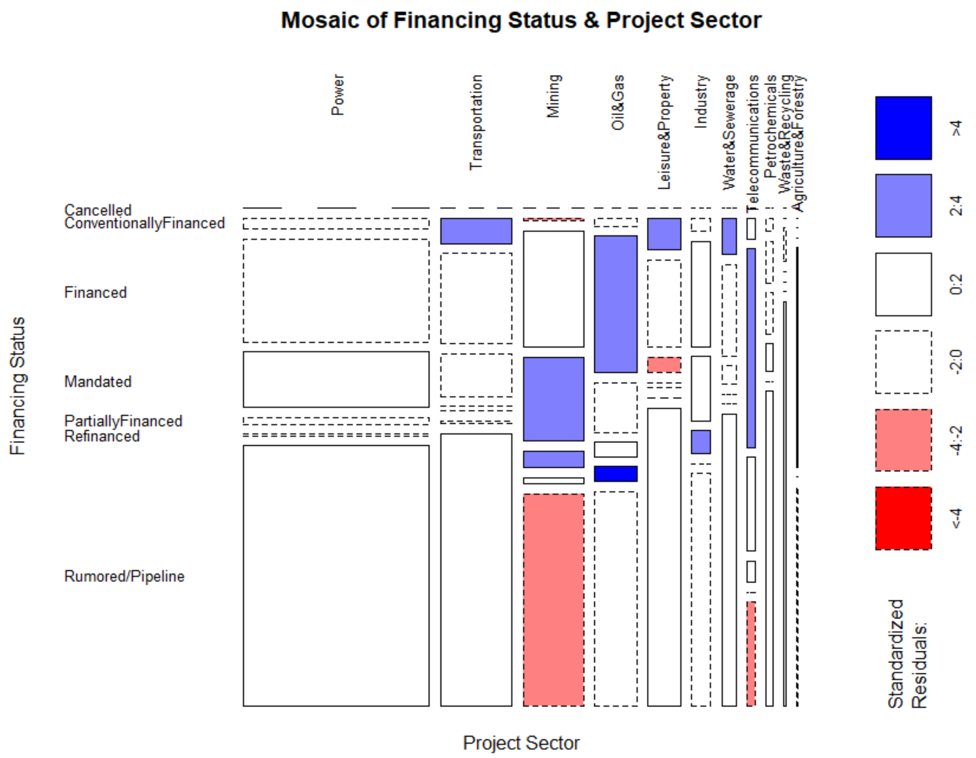
Graph A 13: Mosaic Plot of Project Nation & Project Sectors




Source: Own Illustration based on SDC Platinum

Graph A 13 is a mosaic plot of project nation and project sector. As visible from the blue shading, certain nation-sector-pairings appear more frequently than independence of the two would suggest. On the other hand, the red shading indicates that certain co-occurrences are lower than what independence would suggest.

Graph A 14: Mosaic Plot of Financing Status & Project Sector




Graph A 14 is a mosaic plot of financing status and project sector. As visible from the blue shading, certain sector-financing-pairings appear more frequently than independence of the two variables would suggest. On the other hand, the red shading indicates that certain co-occurrences are lower than what independence would suggest.

Source: Own Illustration based on SDC Platinum

Table A 3: Dummy Coded Regression of Project Cost on Sponsor Nation

**Dummy Coded Regression: Project Cost on Sponsor Nations**

| | *Dependent variable:* |
|---|---|
| | Project Cost |
| China | 1,437.296*** |
| | (387.920) |
| Guinea | 1,684.344* |
| | (983.436) |
| Italy | 2,898.154*** |
| | (613.518) |
| Japan | 2,396.293*** |
| | (551.022) |
| Mozambique | 1,761.799*** |
| | (627.922) |
| Netherlands | 1,422.097** |
| | (576.451) |
| Nigeria | 745.399** |
| | (374.774) |
| Norway | 1,770.867** |
| | (700.342) |
| Oman | 9,057.115*** |
| | (2,548.820) |
| Portugal | 2,952.061*** |
| | (1,103.848) |
| Singapore | 1,821.495* |
| | (951.687) |
| South Korea | 6,803.065*** |
| | (1,287.755) |
| US | 938.440*** |
| | (356.716) |
| Algeria | 6,557.115** |
| | (2,548.820) |
| Constant | 942.885*** |
| | (213.517) |
| Observations | 2,330 |
| $R^2$ | 0.064 |
| Adjusted $R^2$ | 0.018 |
| Residual Std. Error | 3,591.906 (df = 2220) |
| F Statistic | 1.399*** (df = 109; 2220) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 |
| | Only significant covariates included |
| | Reference level set to South Africa |

Source: Own Calculations based on SDC Platinum

Table A.6 provides results from the dummy coded regression.

Table A 4: Results from Dummy Coded Regressions on Financing Amount (only statistically significant covariates included)

**Regression Model 4: Sector & Financing**

| | *Dependent variable:* |
|---|---|
| | Financing Amount |
| Transportation | 115.211* |
| | (69.898) |
| Oil & Gas | 557.225*** |
| | (73.993) |
| Petrochemicals | 454.986** |
| | (231.440) |
| Constant | 222.378*** |
| | (35.257) |
| Observations | 1,166 |
| $R^2$ | 0.059 |
| Adjusted $R^2$ | 0.051 |
| Residual Std. Error | 758.641 (df = 1155) |
| F Statistic | 7.244*** (df = 10; 1155) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 |
| | Only statistically relevant covariates reported |

**Regression Model 5: Host Country & Financing**

| | *Dependent variable:* |
|---|---|
| | Financing Amount |
| Angola | 412.525*** |
| | (143.870) |
| Ethiopia | 238.072* |
| | (142.044) |
| Mozambique | 670.399*** |
| | (115.787) |
| Nigeria | 283.885*** |
| | (88.935) |
| Constant | 249.869*** |
| | (54.261) |
| Observations | 1,166 |
| $R^2$ | 0.071 |
| Adjusted $R^2$ | 0.034 |
| Residual Std. Error | 765.440 (df = 1120) |
| F Statistic | 1.905*** (df = 45; 1120) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 |
| | Only statistically relevant covariates reported |

**Regression Model 6: Loan Type & Financing**

| | *Dependent variable:* |
|---|---|
| | Financing Amount |
| Bilateral Loan | -229.050*** |
| | (66.862) |
| ECA Loan | 144.447* |
| | (84.187) |
| MLA Loan | -231.024*** |
| | (65.379) |
| Sponsor Equity | -222.989*** |
| | (73.612) |
| Constant | 413.015*** |
| | (38.570) |
| Observations | 1,166 |
| $R^2$ | 0.030 |
| Adjusted $R^2$ | 0.021 |
| Residual Std. Error | 770.441 (df = 1154) |
| F Statistic | 3.284*** (df = 11; 1154) |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 |
| | Only statistically relevant covariates reported |

Source: Own Calculations based on SDC Platinum

## A. 4 Multiple Regressions

Tables A 5 to A 9 demonstrate the results of the other regression specifications.

Table A 5: Regression Model of Total Project Cost & GDP per Capita

**Regression Model 1.1: Total Project Cost & GDP per Capita**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Total Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP per Capita | -0.00004 | -0.0001** | -0.00002 | -0.0001 |
| | (0.00004) | (0.0001) | (0.0001) | (0.001) |
| Financial Development Index | | 0.026*** | 0.014 | 0.069 |
| | | (0.008) | (0.012) | (0.055) |
| Labor Productivity | | | 0.00001 | 0.0002 |
| | | | (0.00002) | (0.0001) |
| Political Stability Index | | | -0.614*** | -0.014 |
| | | | (0.175) | (0.374) |
| Enforcing Contracts Score (Ease of Doing Buisness) | | | | 0.055*** |
| | | | | (0.021) |
| Export Quota | | | | -0.038** |
| | | | | (0.019) |
| Corruption Index | | | | -0.532** |
| | | | | (0.261) |
| Observations | 473 | 461 | 218 | 83 |
| $R^2$ | 0.004 | 0.023 | 0.037 | 0.180 |
| Adjusted $R^2$ | -0.059 | -0.043 | -0.024 | 0.040 |
| F Statistic | 1.582 (df = 1; 444) | 5.116*** (df = 2; 431) | 1.968 (df = 4; 204) | 2.202** (df = 7; 70) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

Table A 6: Regression - Average Project Cost & GDP per Capita

**Regression Model 2.1: Average Project Cost & GDP per Capita**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Average Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP per Capita | -0.00004 | -0.00002 | 0.0001 | -0.0001 |
| | (0.00004) | (0.00004) | (0.0001) | (0.0004) |
| Financial Development Index | | -0.006 | -0.010 | 0.041 |
| | | (0.006) | (0.010) | (0.050) |
| Labor Productivity | | | 0.00000 | 0.0001 |
| | | | (0.00002) | (0.0001) |
| Political Stability Index | | | -0.306** | 0.013 |
| | | | (0.149) | (0.353) |
| Enforcing Contracts Score | | | | 0.033** |
| | | | | (0.016) |
| Export Quota | | | | -0.015 |
| | | | | (0.016) |
| Corruption Index | | | | -0.460*** |
| | | | | (0.174) |
| Observations | 473 | 461 | 218 | 83 |
| $R^2$ | 0.005 | 0.007 | 0.022 | 0.104 |
| Adjusted $R^2$ | -0.058 | -0.060 | -0.040 | -0.050 |
| F Statistic | 2.247 (df = 1; 444) | 1.448 (df = 2; 431) | 1.161 (df = 4; 204) | 1.160 (df = 7; 70) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

Table A 7: Regression - Average Project Cost & GDP Growth

**Regression Model 2.2: GDP Growth**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Average Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP Growth | 0.017* | 0.016 | 0.047 | 0.124*** |
| | (0.010) | (0.011) | (0.041) | (0.029) |
| Financial Development Index | | -0.008* | -0.010 | 0.067 |
| | | (0.005) | (0.010) | (0.055) |
| Labor Productivity | | | 0.00002 | 0.0001* |
| | | | (0.00001) | (0.00004) |
| Political Stability Index | | | -0.313** | 0.009 |
| | | | (0.151) | (0.350) |
| Enforcing Contracts Score | | | | 0.030** |
| | | | | (0.015) |
| Export Quota | | | | -0.019 |
| | | | | (0.015) |
| Corruption Index | | | | -0.615*** |
| | | | | (0.212) |
| Observations | 469 | 457 | 218 | 83 |
| $R^2$ | 0.003 | 0.008 | 0.030 | 0.172 |
| Adjusted $R^2$ | -0.061 | -0.059 | -0.032 | 0.030 |
| F Statistic | 1.189 (df = 1; 440) | 1.720 (df = 2; 427) | 1.570 (df = 4; 204) | 2.076* (df = 7; 70) |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

Table A 8: Regression - Total Project Cost & GDP per Capita with Time-Lag

**Regression Model 3: Imposing a two-year time-lag**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Total Project Cost *(in logs)* | | | |
| | (1) | (2) | (3) | (4) |
| GDP per Capita | -0.00004 | -0.0001 | 0.0001 | 0.0001 |
| | (0.00004) | (0.0001) | (0.0002) | (0.0004) |
| Financial Development Index | | $0.018^{**}$ | 0.004 | 0.051 |
| | | (0.009) | (0.015) | (0.047) |
| Labor Productivity | | | -0.00001 | $0.0002^{***}$ |
| | | | (0.00004) | (0.0001) |
| Political Stability Index | | | $-0.575^{**}$ | -0.096 |
| | | | (0.239) | (0.555) |
| Enforcing Contracts Score | | | | $0.059^{***}$ |
| | | | | (0.021) |
| Export Quota | | | | $-0.048^{*}$ |
| | | | | (0.025) |
| Corruption Index | | | | $-0.681^{**}$ |
| | | | | (0.331) |
| Observations | 497 | 484 | 204 | 97 |
| $R^2$ | 0.003 | 0.012 | 0.027 | 0.228 |
| Adjusted $R^2$ | -0.057 | -0.052 | -0.034 | 0.118 |
| F Statistic | 1.318 (df = 1; 468) | $2.653^{*}$ (df = 2; 454) | 1.311 (df = 4; 191) | $3.547^{***}$ (df = 7; 84) |
| *Note:* | | | | $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01 |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)

Table A 9: Reverse Regression - GDP Growth & Total Infrastructure Project

**Reverse Regression Model 4: GDP Growth & Total Infrastructure Project**
**Imposing a two-year time-lag**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | GDP Growth | | | |
| | (1) | (2) | (3) | (4) |
| Total Infrastructure Project Cost *(in logs, t-2)* | $0.206^{**}$ | $0.180^{**}$ | 0.128 | 0.123 |
| | (0.084) | (0.078) | (0.107) | (0.117) |
| Financial Development Index | | $-0.050^{***}$ | -0.033 | -0.034 |
| | | (0.010) | (0.023) | (0.023) |
| Labor Productivity | | | -0.00004 | -0.00003 |
| | | | (0.00002) | (0.00002) |
| Political Stability Index | | | 0.390 | 0.503 |
| | | | (0.493) | (0.498) |
| Export Quota | | | | -0.006 |
| | | | | (0.027) |
| Observations | 413 | 403 | 206 | 200 |
| $R^2$ | 0.011 | 0.039 | 0.067 | 0.068 |
| Adjusted $R^2$ | -0.056 | -0.030 | 0.004 | -0.002 |
| F Statistic | $4.109^{**}$ (df = 1; 386) | $7.610^{***}$ (df = 2; 375) | $3.444^{***}$ (df = 4; 192) | $2.717^{**}$ (df = 5; 185) |
| *Note:* | | | | $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ |

Source: Own calculations based on SDC Platinum, World Bank, IMF and ILO, Hlavac (2018)