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Topic

The effects of FDI and corruption on Tunisian economic growth

Vine Copula approach

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Dedication

I dedicate my parents who have always believed in me, motivated me and supported me.

Ikram

Abstract

This study examines the effects of Foreign Direct Investment and corruption on Tunisia's economic growth. Basing on the bivariate Copula theory, empirical findings suggest that FDI contributes to promote economic advancement. Concurrently, there is a negative relationship between corruption and economic growth. By looking into the transmission channels through which these effects may occur, the multivariate Copula (C-vine and D-vine) have shown that FDI brings positive effect by generating resources of technology transfer, bringing positive impact to domestic firms and improving financial development. On the other hand, corruption causes negatively public finances, discouraging foreign investors and shaking political stability. These results provide policy implications to government and regulatory authorities.

Keywords: Economic Growth, Foreign Direct Investment , corruption, transmission channels, bivariate Copula, C-vine and D-vine Copula.

Résumé

Cette étude examine les effets de l'Investissement Direct Etranger et de la corruption sur la croissance économique de la Tunisie. En se basant sur la théorie de Copula bivariée, les résultats empiriques suggèrent que les IDE contribuent à promouvoir le progrès économique. Parallèlement, il existe une relation négative entre la corruption et la croissance économique. En examinant les canaux de transmission par lesquels ces effets peuvent se produire, les copules multivariées (C-vine et D-vine) ont montré que les IDE ont un effet positif en générant des ressources de transfert de technologie, en ayant un impact positif sur les entreprises nationales et en améliorant le développement financier. D'autre part, la corruption a un impact négatif sur les finances publiques, décourage les investisseurs étrangers et ébranle la stabilité politique. Ces résultats ont des implications politiques pour le gouvernement et les autorités de régulation.

Mots-clés : Croissance économique, Investissement Direct Etranger, corruption, canaux de transmission, copule bivariée, copule C-vine et D-vine.

ACRONYMS

ADF: Augmented Dickey-fuller

CML: Canonical Maximum Likelihood

CPI: Corruption Perception Index

C-vine: Canonical vine

DI: Domestic Investment

D-vine: Drawable vine

ERSAP: Structural Adjustment Program for Economic Recovery

FD: Financial Development

FDI: Foreign Direct Investment

GARCH: Generalized Autoregressive Conditionally Heteroscedastic

GDP: Gross Domestic Product

HC: Human Capital

ICT: Information and Communication Technology

IMF: International Monetary Fund

JB: Jarque-Bera

KS: Kolmogorov-Smirnov

LB: Ljung-Box test

MNE: Multinational Enterprise

OECD: Organisation for Economic Co-operation and Development

R-vine: Regular vine

SAP: Structural Adjustment Program

TR: Tunisian Revolution

UNCTAD: United Nations Conference on Trade and Development

VAT: Value Added Tax

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GENERAL INTRODUCTION

Tunisia experienced sustained economic growth during the 1990s, following the adoption of various structural reforms. The most prominent reform was the structural adjustment program (SAP) of the late 1980s. In addition, Tunisia has ratified and signed several international conventions related to economic activities1 .These ratifications have provided a significant boost to the local economy.

Despite the performance of the Tunisian economy, several problems persist and some have worsened. These economic problems were compounded by the negative effect of the Tunisian revolution which has shaken political and macroeconomic stability. Social agitation, strikes, and protests have hampered production and discouraged foreign investors. Many economic researchers have argued that Foreign Direct Investment (FDI) is an important factor affecting economic success mainly for countries suffering from high level of unemployment and lack of technological advancement such as Tunisia (**Bouchouche and Ali, 2019**). At the same time, corruption has continued to be a contagion, infecting all levels of Tunisian economy and putting further progress at risk. Consequently, Tunisia has gone through a period of profound transformation that has given rise to double challenges, attracting FDI and combating corruption.

The considerable role that have played FDI on economic growth has prompted policymakers and researchers to understand the empirical link between inward FDI in host economy and gross domestic product (GDP) and examine the channels through which FDI promotes economic development. **Borensztein et al., 1998** and **Carkovic and Levine, 2005** suggested that it is through the investments of multinational firms that host developing economies have access to the elements of productivity, modern technologies and management skills that are essential for growth but are otherwise unavailable in the developing countries. **Wang and Blomstrom (1992**) identify three main channels of technological spillovers from foreign to local companies which are: imitation, competition and skills (transfer of knowledge). FDI

1 the General Agreement on Tariffs and Trade (GATT) in 1989, the World Trade Organization (WTO) in 1994, and the multiple agreements with the European Union in 1995 followed later, by the Neighborhood Agreement from 2004 to 2005.

contributes also to enrich human resources through the integration of new technologies in the training of workers, which will help countries to develop in the long term (**Hoi Van et al., 2020)**. Moreover, FDI provides a means of financial development. An increase in FDI would have a significant positive impact on most economic activities in the recipient country, leading to an increase in the funds available in the economy. Consequently, financial intermediation via the available banking system would improve **(Henry, 2000).**

Unfortunately, corruption appears as an important factor that has a distortive effect on investment through rent-seeking activity which would certainly increase cost of doing business. Corruption is a grave concern since it affects not only investments but also the achievement of growth. Therefore, understanding this phenomenon in term of its implications on growth is of a particular interest to Tunisia that was engaged in a strategy of development in the post 2011 revolutionary period, aiming to become an emerging country by the year 2035. In this regard, it is crucial to know how corruption affects economic growth.

Empirically, although many researchers have shown that corruption adversely impacts economic growth, others contest this finding and find that the effect of corruption on growth becomes non significant once some of the determinants of economic growth are controlled. These mixed results seem to favor the idea that if corruption is likely to affect economic growth, its effects will be divided into direct and indirect effects. These formers acted as transmission channels. **(Dridi ,2013).** Indeed, various types of obstacles that corruption may create for the economic progress such as affecting public finance through reducing public revenues and increasing public debt **(Cooray and Schneider,2013; Sonmez and Tülümce, 2018),** and creating political and social instability **(Mo, 2001; Dridi, 2013).** On the other hand , somewhat surprisingly, some studies, have recorded that corruption acts as a motor of economic progress by overcoming the obstacles that an inefficient bureaucracy creates**(Leff, 1964; Swaleheen and Stansel ,2007).**

The fact that corruption can often been seen as an impediment to economic growth and at the same time this former can be boosted by foreign investments, it is crucial to specify the channels via which FDI and corruption should affect economic growth. We are thus trying to provide an answer to this research question: **How corruption and FDI affect economic growth in Tunisia?** To this end, we use the copula theory more precisely the bivariate copula and the vine copula, which model the dependence on average and tail dependence with more

flexibility compared to the standard models. Therefore, to the best of our knowledge, this thesis is the first uses these approaches.

By leading this research, we contribute to the existing literature in three ways. Firstly, we shed the light on the bivariate dependence structure between corruption/ FDI and economic growth by applying different parametric copula functions which enable us to detect tail dependence. Second, we attempt to compare the effect of both of them during the pre-revolution and post-revolution period. Finally, we study the multivariate dependence through the C-vine and D-vine copulas to reveal the channels through which FDI and corruption may affect growth.

This thesis is structured as follows. Chapter 1 provides the theoretical framework. Then in Chapter 2 we survey the extant literature review. Seen that, the copula theory is not a common used approach, we present in chapter 3 its mathematical background. In chapter 4, we describe our database, present our methodology and discuss empirical results .Finally, we drawn conclusion , give some recommendations and suggest future extensions of this thesis

CHAPTER1: GENERALITIES ON ECONOMIC GROWTH, FOREIGN DIRECT INVESTMENT AND CORRUPTION

1 Introduction

The world economy has undergone several waves of globalization over the course of its history. Each wave has led to an increase of interconnection of the world network through foreign trade, cross-border financial flows and migration. One of the most important aspects of globalization in the end of the 20th century was the increase of Foreign Direct Investment (FDI), which is considered as an important source of development as it contributes to bring benefits to the host economy and stimulates the economic growth.(**Batten and Vo ,2009**; **Tiwari and Mutascu, 2011** ; **Omran and Bolbol , 2003).**

At the same time, corruption appears as a component that could be an obstruct to build borderless operations of countries (**Hines, 1995; Wei, 2000; Castro and Nunes, 2013)**or a determining factor in increasing FDI inflows (**Helmy, 2003; Eggera and Winnershow ,2005)**. Nowadays, there is no country, both developing and developed countries, without corruption. It is a phenomenon that affects all aspect of economy around the world and hinders economic development **(Mauro, 1995;Brempong, 2002)**regardless some researchers who suggest that it can act as a motor of economic progress (**Swaleheen & Stansel, 2007; Heckelman and Powell, 2008).**

To better understand what role FDI and corruption play in relation to growth, it is useful as a first step to provide a theoretical background for economic growth, FDI and corruption. This chapter is divided into three parts. The first part will be dedicated to economic growth, the second part is devoted to understand FDI and the last part to corruption. In each part, we will try to give the main concepts, analyze the determinants, and look over economic growth corruption and FDI in Tunisia.

2 Generality on Economic Growth

2.1. Economic growth models

2.1.1.The Harrod-Domar model

The Harrod-Domar model was the precursor of the exogenous growth model and it is Keynesian model of economic growth. It suggests that the growth rate of an economy is a function of the level of savings and capital and there is no inherent cause for an economy to expand at a balanced rate. This model was introduced by Roy F. Harrod in 1939 and Evsey Domar in 1946. They assume that there are three types of growth: natural, real and warranted growth rate. Natural growth is the growth rate required to maintain full employment. Real growth is the real GDP growth rate per year. Warranted growth is the growth rate at which an economy will not continue to expand indefinitely or go into recession.

2.1.2.The Neoclassical model: Solow's approach

Neoclassical growth theory developed by Solow (1956) is an economic theory that describes how a steady rate of economic growth results from the combination of three factors: labor, capital and technology. However, the temporary equilibrium is different from the long-term equilibrium, which does not require any of these driving forces. The model initially considered exogenous population growth to set the growth rate, but in 1957, Solow incorporated technological progress into the model.

2.1.3.The theory of endogenous growth

The endogenous growth theory is a theory of economic growth based on an internal explanation of technical progress. This theory has been developed by Romer in1986 in order to overcome the unsatisfactory features of neoclassical growth model. This theory shows that the interaction of several factors generates positive externalities that lead to growth. These factors can be summarized as follows.

Public capital is often considered an important factor in growth. Among the explanations proposed by some economists (e.g. Gramlich, 1994) for the slowdown in growth in most industrialized countries since the 1970s, the reduction of public investment efforts plays an important role (Veganzones-Varoudakis, 2001). The economic idea is that certain public infrastructure developments generate externalities that would improve the productivity of private factors. As regards the theoretical analysis of the links between public capital and growth, Barro's model (1990) shows that public spending on public infrastructure can play a

driving role in a growth process. Moreover, public action can increase the productivity of the economy, for example by increasing the stock of knowledge through human capital or public infrastructure. For Barro, infrastructure facilitates the movement of goods, people and information.

Technical progress is reintegrated into the growth process and it is seen as a factor that" does not fall from the sky" according to the model developed by Paul Romer. Indeed, he considers that technology is endogenous since it results from economic choices of agents. Innovation is then an activity with increasing returns that increases the stock of knowledge, and the flow of this knowledge can only be beneficial to all, rather than being limited to the innovative firm. Firms are then interdependent and the innovative ambition of each firm benefits all firms, which allows the economy to grow.

Human capital is a broad concept that was developed in the 1960s by several economists . There are many definitions attributed to this concept. The OECD (1998) defines human capital as: "the knowledge, skills, competencies and other attributes embodied in people and relevant to economic activity". According to the endogenous theory, human capital represents a fundamental element in the economic growth process. However, how to measure human capital remains subjective, but it was shown the importance of the education system.

The interdependence of economies is expressed through the integration of different productive areas and represents a fundamental source of growth. The expansion of international trade has therefore played a crucial role in world growth and international specialization.

The evolution of institutions is also an important factor for growth. It is defined by the rules, the norms of behavior, and the way in which the conventions between economic agents are applied. According to Douglass North (1990), it could explain the performance differentials between economies. Otherwise, the stalled growth of some countries is due to poor performance and unsuccessful adaptation of institutions, and therefore an insufficient reduction in production costs relative to an increase in transaction costs. The role of institutions is therefore to reduce the high transaction costs that constitute an obstacle to growth.

Natural resource endowments are also a source of growth, although some countries have been disadvantaged by their low raw material endowments relative to others.

2.2.State of economic growth in Tunisia

2.2.1.Evolution of Economic Policies

Since 1956, when Tunisia gained independence, economic policy has shifted several times. The first phase, which began in 1961, was marked by state dominance of the economy, with many industries nationalized, wage and price controls imposed, and protectionist trade policies implemented. This policy was replaced in 1969 by a strategy that maintained to safeguard domestic producers but also encouraged export growth through fiscal incentives and technical assistance.

In 1972, Tunisia began to provide a variety of incentives to investors in authorized industrial projects, particularly for export production. Consequently, these incentives are seen to contribute to achieve rapid growth rate in GDP and exports, but they proved fiscally unsustainable in the long run.

Large public deficits fostered rapid increase in Tunisia's external debt, which reached an unsustainable level of 65.9% of GDP in 1986. During this period, public borrowing appeared to crowd out domestic investment, which decreased from 34% of GDP in 1982 to 25% in 1986. Therefore, Tunisia was unable to fulfill its international debt or finance its imports by the year 1986.

In 1987, Tunisia began its next policy change with structural adjustment measures. The government sought aid from the World Bank and the International Monetary Fund (IMF) under the Structural Adjustment Program for Economic Recovery (ERSAP), due to foreign insolvency and a domestic political crisis. The program's primary components included lower tariffs and non-tariff barriers to imports, the implementation of a value-added tax (VAT) with offsets in personal income tax, currency depreciation, and the privatization of some firms. In general, the post-ERSAP period has been marked by higher average productivity growth.

In 1997 Tunisia began an ambitious program of reforms outlined in a series of three national development plans that focused sequentially on: integrating Tunisia into the global economy, strengthening the private sector, adapting to the opening of the economy through improving competitiveness, developing infrastructure and reducing regional disparities.

Finally, in 2007, the focus was on maintaining macroeconomic stability, continuing to open the economy gradually, increasing investments in high-value-added sectors, and reforming education.

Following the 2011 Jasmine Revolution, Tunisia has endured the most significant period of political and economic instability in its recent history. Seven heads of government followed one another throughout the political transition, but none of them were able to implement a real economic transition policy.

2.2.2.The evolution of economic growth rate in Tunisia

Growth evolution between 1996 and 2010

- **Between 1996 and 2009,** the economy of Tunisia recorded a positive growth rate with low volatility where the growth rate was higher than the average for MENA and middle-income nations during the period 1997-2001 (World Bank, 2004). **In 2010,** the Tunisian economy entered a recession, with a loss of GDP of over 3%. Indeed, during this period, Tunisia is faced with major events: the signing of a free trade agreement with the European Union and the beginning of protests against unemployment and the fall of the former political regime in 2010.

Growth evolution between 2011 and 2019

- **Since the 2011 revolution** that overthrew the autocracy and established a democratic regime, most economic indicators have weakened and the state has become more indebted. In addition, economic growth has declined from 2.4% in 2010 to -2.9% in 2011.

- **Between 2013 and 2014**, economic growth remained weak, unemployment rates rose, macroeconomic imbalances increased, etc. This poor performance is mainly due to an over-regulated environment that has stifled the functioning of all markets, leading to: Weak competition, rent-seeking activities, low and poor quality of investments and services , heavy bureaucracy, and low firm productivity.

- **Between 2014 and 2015**, the growth rate marked a significant decline mainly due to the successive attacks in 2015. Furthermore, the deterioration in tourism activity and the Libyan crisis could also be the reasons for the modest growth recorded **in 2016**.

- **Between 2017 and 2019** economic growth is improved but risks persist. Business investment benefit from the simplification of procedures inherent in the new investment law, while exports benefit from the recovery in European markets. Inflation increased

in 2017 and the pressure continued in 2018 due to the effects of currency depreciation. Nevertheless, it has eased relatively from 2019.

3 Generality on Foreign Direct Investment

3.1. Main concepts

3.1.1 Foreign Direct Investment

According to OECD definition, Foreign direct investment reflects the objective of obtaining a lasting interest by a resident entity in one economy (direct investor) in an entity resident in an economy other than that of the investor (direct investment enterprise). The term lasting interest means the existence of a long-term relationship between the direct investor and the direct investor enterprise with a significant degree of influence of the investor on the management of the enterprise.

Such investment includes both the initial transaction establishing the relationship between the two entities as well as all subsequent capital transactions between them and between affiliated companies, whether incorporated or not. **(UNCTAD, 2014)**

The OECD and the IMF define this relationship as an ownership of 10% or more of a foreign company's capital. The IMF and the OECD recommend using this percentage to distinguish between direct investment and portfolio investment. Thus, when a non-resident buys from a resident 10% or more of the shares of that enterprise, the price of the acquired holdings must be recorded as a direct investment. Whereas, when a non-resident holds less than 10% of the shares of an enterprise it is considered as a portfolio investment. In addition, the latter is characterized by being short term in nature that does not seek control, contrary to the direct investment.

3.1.2. Foreign direct investor

According to OECD, a foreign direct investor is an individual, an incorporated or unincorporated public or private enterprise, a government, a group of related individuals, or a group of related incorporated and/or unincorporated enterprises which has a direct investment enterprise that is, a subsidiary, associate or branch operating in a country other than the country or countries of residence of the foreign direct investor or investors.

3.1.3. Foreign direct investment enterprise

The OECD defines direct investment enterprise as an incorporated or unincorporated enterprise in which a foreign investor owns 10% or more of the ordinary shares or voting power of an incorporated enterprise or the equivalent of an unincorporated enterprise. Direct investment enterprises may be subsidiaries, associates or branches.

- A subsidiary is an incorporated business entity in which a foreign investor owns more than 50% of the voting power of the shareholders, either directly or indirectly (via another subsidiary) and has the authority to appoint or dismiss a majority of members of the administrative, managerial, or supervisory body.
- An associate company is an incorporated company that is owned by the direct investor between 10% and 50% of the voting shares.
- A branch is a section of the same company that performs the same functions that is completely or partially owned by a foreign investor. It can be a permanent establishment or office of a foreign investor, a joint venture between the foreign direct investor and a third parties, or mobile equipment that operates within a country for at least one year.

3.2. Components of FDI

- **Equity capital:** it is the overseas investor‟s purchase of shares of an enterprise located in a foreign country comprising equity in branches, shares in subsidiaries and associates and other capital contributions.

- **Reinvested earnings:** contain the direct investor‟s share (in proportion to direct equity participation) of earnings not distributed as dividends by affiliates, or earnings not remitted to the direct investor.
- **Intra-company loans or intra-company debt transactions:** refer to short- or longterm borrowing and lending of funds including debt securities and trade credits between direct investors and direct investment enterprises, as well as between two direct investment enterprises that have the same direct investor.

3.3. Types of Foreign Direct Investment

3.3.1. Horizontal FDI

Horizontal FDI is undertaken to produce in the host country the same or similar products as in the home country. It is called horizontal because the company duplicates its activities of its home country in different countries. Such FDI arises because it is too costly to serve the overseas market by exports due to transportation costs or trade barriers. Many reasons have pushed companies to establish this kind of investment. Indeed, by setting up a factory abroad, it's a way to avoid any tariffs barriers by exporting from the home country to the host country. The firm can also improve access to the local market since local companies have obviously better information and facilities. Additionally, the firm can form alliances across production divisions inside the firm by having multiple manufacturing facilities overseas, allowing technological expertise to be easily shared.

3.3.2. Vertical FDI

Vertical FDI is undertaken when a corporation establishes manufacturing facilities in various countries, each producing a distinct input to, or stage of, the company's production process. In this case, the firm fragments stages of production geographically to take advantage of lower input costs and wages. Due to the difference in prices of the inputs, vertical FDI is more attractive and more profitable for the company to split the production chain. It is undertaken also as a way to exploit raw materials or to be nearer to the customers by acquiring distribution outlets.

3.3.3. Conglomerate FDI

A conglomerate FDI is an investment in which a company or individual invests in a business outside its home country that is unrelated to its existing business. Because this type of investment requires entry into a new industry in which the investor has no prior experience, it often takes the form of a joint venture with a foreign company already operating in that industry.

3.4. Determinants of FDI

Foreign direct investment and its determinants are a widely debated topic in the economic literature. The factors that determine FDI are a source of disagreement among researchers. However, **Dunning (1979)** tackled this issue using the Eclectic Paradigm theory. Owning to this theory, researches and firms have succeeded to understand what motivates a company to

pursue a given market and why should that be via FDI and not via exports or licenses. It assumes that firms break into foreign market if the cost of the same actions internally carries a higher price. The eclectic theory known as the OLI model postulates that there are three factors that are essential for FDI which are Ownership, Location and Internalization. These advantages can be summarized in the diagram presented below.

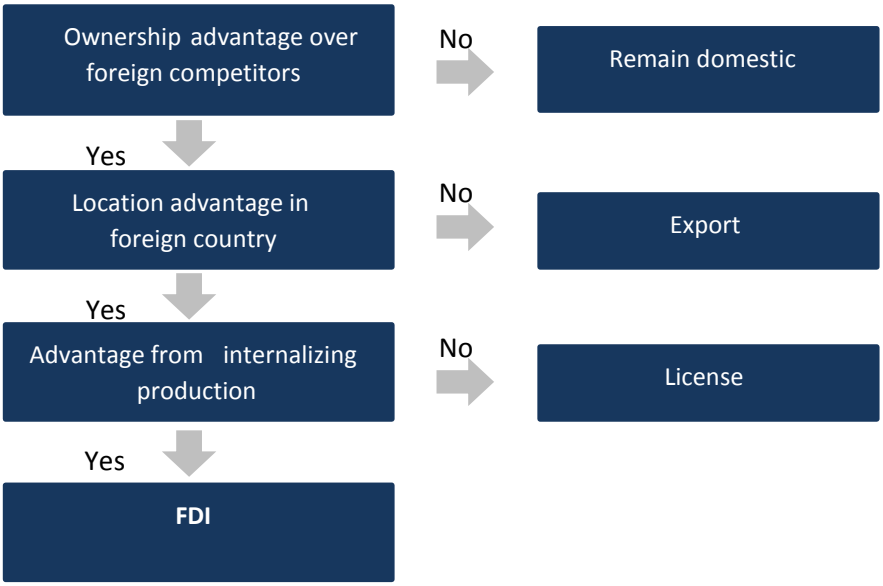


Figure 1: Determinants of FDI

3.4.1. Ownership advantage

The ownership advantage assumes that the firm must own a rare and valuable resource that cannot easily be imitated, which generates a competitive advantage against foreign rivals. Ownership advantages can be classified into two types **(Dunning, 1993);** asset advantages and advantages of common governance .Asset advantages arise from the possession of particular intangible asset such as the possession of superior technology, brands reputation, product differentiation, a patent, a copyright, managerial talent, human capital of the employees. These assets refer to monopolistic benefits and contribute to promote the market power by closing markets to market imperfections. (**Silva Lopes, 2010).** The advantages of common governance arise from the company's ability to coordinate multiple, geographically dispersed value-added activities to gain efficiencies and reduce transaction costs. Both sorts of advantage are the result of two different types of market failure. The first is that firms differ in terms of the resources they own and their exclusive right to exploit them. The second market failure relates to the

possibility that such resources could be better organized through external market transactions. **(Scott-Kennel, 2001).**

Researchers reveal that FDI has immediate effects on the host country due to the transfer of ownership advantages from the parent firm (MNE) to the foreign affiliate. There are direct effects since, besides additional capital, there are also contributions of knowledge and technology. In this sense, the impact of FDI is related to the ownership advantages of the investing MNE. The transfer of assets from the multinational firm to the foreign affiliate allows the latter to overcome all the disadvantages inherent in its home country. Therefore, through FDI, firms may have access to resources such as technology, expertise, knowledge spillovers and management know-how that their local competitors are unable to reproduce in the short term, allowing them to achieve or maintain a dominant position.**(Hooley et al., 1996).**

3.4.2. Location advantage

Location advantages are assets that are specific to a country and available to all companies. Therefore, these advantages generate a competitive advantage for countries rather than for companies. In other words, the multinational firm is drawn to a specific location because it perceives that it will benefit more from exploiting its ownership advantages there due to the set of advantages offered by that location. Firms need to assess whether there is a comparative advantage in performing specific functions in a given country. These considerations relate to the availability and costs of resources when operating in one location compared to another.

The location advantages of the home country also affect the activities of a multinational firm by contributing to the development of ownership advantages. **Porter (1990)** argues that engaging in FDI depends on firm-specific advantages resulting from home country skills.

The location advantage may take the form of economic advantage (market size, infrastructure, economic stability) or political advantage (Trade openness ,policy measures).

- **Market size**

The size of the market of the host country appears to be an important factor for FDI attraction as it provides more opportunities for sales .Larger host markets may be associated with higher foreign direct investment owning to the larger potential demand , lower costs of supplying due to scale economies and lower fixed cost per unit of output which make local sourcing more feasible. For instance, **Scarperlanda and Mauer (1969)** examine the determinants of US direct investments in the European Economic Community (EEC) and find that the size of EEC is the

only significant variable after many simulations. **Nunes et al. (2006)** indicate also that the larger is country's market, the more level of foreign capital will be received in Latin America.

- **Trade openness**

Trade openness denotes to the orientation of a country's economy in the context of international trade. Openness is measured by the actual size of an economy's recorded imports and exports. It is considered by many researchers as a key factor of FDI determinants. A higher degree of openness of an economy ,a higher FDI will be attracted in the long run , which means that a country with fewer restrictions on exports and imports have a higher chance to attract foreign investors by building production sites abroad . **(Makoni ,2018 ; Sahoo ,2006 ; Zaman et al., 2018).**

- **Infrastructure**

A good physical infrastructure, particularly roads, electricity, transportation, and telecommunications, serve as important elements to attract FDI into a country since a good infrastructure has a direct impact on cost of production, as it improves the efficient use of labor and reduces the production costs. **(Wheeler and Mody, 1992). Campos and Kinoshita (2003**) indicate that good infrastructure is prerequisite for foreign investors to operate efficiency. Hence, in developing countries that compete for foreign direct investment, the country that is most prepared to remove infrastructure bottlenecks will absorb more FDI.

- **Macro stability variables**

Inflation rate, current account deficit and fiscal deficit are considered as macroeconomic stability's measures. A country which has a stable macroeconomic environment will attract more FDI inflows than an uncertain economy, as it reflects less investment risk. On the other hand, higher government deficit reduces private investment, thereby crowding out FDI inflows. Similarly, higher current account deficit generates an increase of fiscal deficit and exchange rate fluctuation, thereby decreasing FDI inflows. **(Sahoo et al., 2014).**

- **Policy Measures**

Government policies including fiscal incentives may increase the host country’s locational advantage .Subsidizing FDI reduces production costs for multinational firms, improves incentives to set up patents and increases the attractiveness of location production facilities in the country that offers incentives and raises the economic benefits of FDI relative to exports.

(Sahoo et al., 2014).

3.4.3. Internalization advantage

Under the rubric of the eclectic paradigm, internalization advantages emphasis that a firm's competitive advantage lies not only in its assets ,but also in its ability to integrate these advantages with other resources to generate economies of scale and reduce transaction costs across international markets **(Dunning, 1995).**In other words, an internalization advantage occurs when a firm perceives that valuing its specific advantages would be more beneficial than transferring the right to use them to other firms. Internalization advantages are intended to protect the firm from market failures. The theory suggests that in the event of a market failure or high external transaction costs, the MNE will opt to internalize its benefits **(Hennart, 1989**). Market failures can be structural and transactional failures. Structural imperfections occur when there are barriers to competition and economic rents. In other words, the more ownership advantages a foreign firm has over local firms in a host country, the more imperfect the market is for the transfer of these intangibles assets, and thus the more likely that firms will opt to deploy them in the recipient country through FDI **(Dunning, 1986).** On the other hand, transactional market failures arise when the market is unable to organize transactions in an optimal manner **(Dunning, 1993).**

According to UNCTAD, FDI refers that firms with ownership advantages choose internal expansion abroad at the expense of licensing to local firms **(UNCTAD, 2004).**

3.5. FDI in Tunisia

FDI is perceived as an important part of economic growth and the financial globalization process, not only by attracting additional foreign capital, but also by stimulating technology transfer, improving managerial skills, creating employment opportunities and bringing horizontal and vertical knowledge spillovers via backward or forward linkage with local firms **(Alfaro, 2017**). In this regard, policymakers, especially in developing countries have provided a wide range of investment incentives to attract FDI inflows.

During the last decades, the Tunisian government has always undertaken numerous measures that prioritize foreign direct investment as a key component of its development plan expecting that this will help to promote productivity and stimulate export-led economic growth. Indeed, since 1986, Tunisia has adopted the structural adjustment programs to improve efficiency and

competitiveness of the national economy. It has promoted standard fiscal and monetary reforms, as well as financial sector liberalization. A policy of gradual trade liberalization was pursued, beginning with implementing current account convertibility, followed by entrance to GATT accords, and then by a free trade association with the European Union in 1995, which took effect on January 1, 2008. The objective of the agreement is to remove tariffs and trade barriers on a variety of goods and services, increasing thus the openness of the Tunisian economy and hence FDI inflows.

Unfortunately, since the Tunisian revolution of January 2011, political and economic stability in Tunisia remains fragile. This has impacted Foreign Direct Investment (FDI). According to UNCTAD's World Investment Report 2012, FDI decreased to $ 1143 million in 2011, compared to $ 1513 million in 2010 (-24%). Meanwhile, in order to encourage foreign investment into the country and stimulate economic development ,Tunisia provided a wide range of FDI incentives such as tax relief , exemption from VAT , duty exemption on raw materials, , semi-finished goods, and services necessary for operation, duty-free import of capital goods with no local equivalents, tax exemptions on profits and reinvested revenues.

Although these motivations, FDI continues to decrease, reaching the threshold of $ 845 million in 2019.

Actually, the majority of FDI was allocated to industry, followed by energy and services and the main foreign investors are the UAE, France, Qatar, Italy and Germany.

(UNCTAD'sWorld Investment Report 2020).

4 Generality on corruption

4.1. Concept of corruption

Corruption is a worldwide issue that exists in almost all societies with varying degrees. It is perceived as a persistent feature that has serious implications in both developing and developed countries. The concept of corruption is not only complicated but also difficult to define, and it has generated considerable controversy among scholars. Hence, many of them, such as **Jain (2001)** start their studies by attempting to define corruption because how it is defined actually ends up determining what gets modeled and measured **(Jain, 2001)**. According to **Leff (1964),** corruption is "an extra-legal institution used by individuals or groups to gain influence over the actions of the bureaucracy". **Leff (1964)** points out that corruption is a neutral concept, so to assess whether it is good or bad, it is necessary to take into account what

corruption is used to achieve. For example some public officials need to bypass certain bureaucratic procedures to make decisions faster that would have taken a long time, so corruption is used for a good purpose in this case. **Nye (1967)** asserts that corruption is an activity that deviates from official duties to gain personal advantage. Examples of this type of behavior are bribery, misappropriation and nepotism. For **Shleifer and Vishny**

(1993), corruption is "the sale by government officials of government property for personal gain." Although it is difficult to find a precise definition, most researchers consider corruption as an activity in which the power of a public office is used for personal gain. In this regard, World Bank defines corruption as: "the abuse of public office for private gain." Transparency International regards corruption as "the misuse of entrusted power for private gain". **FrazierMoleketi (2007)** on the other hand,gives a border definition of corruption. He considers that corruption is not only related to the public sector, but also to the private sector.

4.2. Categories of Corruption

Corruption can be classified in different ways. The most common types of corruption are grand versus petty corruption, supply versus demand corruption, public versus private corruption , and conventional versus unconventional corruption.

4.2.1. Grand versus petty corruption

Grand corruption is an abuse of power involving high-ranking officials who exploit the opportunities offered by government work. It often stems from bribes associated with largescale government projects mainly, infrastructure and construction projects. Political corruption has also been seen as grand corruption because of its prevalence and severity. On the other side, petty corruption is the everyday abuse involving low-level public officials. It often occurs when citizens pay bribes to public administration officials to access to public services such as education, health, security, and customs, which under normal circumstances should cost less.

4.2.2. Public versus private corruption

The type of corruption can also be distinguished by whether it is "public" or "private". The distinction lies in the sectors in which the participants in the illegal act operate. In the case of public corruption, a public official is involved in the corrupt act, while private corruption involves only persons from the private sector.

4.2.3. Supply versus demand corruption

Supply corruption describes the act of offering an unlawful payment, whereas demand corruption describes the acceptance of such payment. Active and passive corruptions are terms that have been used interchangeably with supply and demand corruptions.

4.2.4. Conventional versus unconventional corruption

Conventional corruption occurs when government officials, whether higher or lower ranking, illegally receive undue personal gain disregarding public interest. In this case, there is an element of reciprocity; both active and passive bribery are forms of conventional corruption. However, unconventional corruption is not perceived as an illegal act seen that there is no element of reciprocity as there is no clear transaction between the two parties.

4.3. Determinants of corruption

4.3.1. Economic Determinants

Economic factors cover a wide range of economic variables that could potentially affect the benefits or costs of paying or receiving bribes.

It has been argued that the wage rate of public servants relative to the private sector creates incentives for corruption **(Van Rijckeghem and Weder 1997; Tanzi 1998; Lindbeck 1998**). Given that public sector pay is relatively low, the benefit of a particular bribe will be perceived greater, while the cost of losing a government job if the bribe is discovered will be perceived less. As stated by **Paldam (2002)**, ”A skew income distribution may increase the temptation to make illicit gains”. Based on the Gini coefficient, he suggests that income inequality fosters corruption.

Various researchers have suggested that corruption is influenced by the level or stage of economic growth (**Knack and Azfar 2003; Lederman, Loayza, and Soares 2005; Serra 2006).** A wealthier country will devote more resources to detect and prevent corruption. Furthermore, with the increase of education and literacy that development provides, the likelihood that an act of corruption will be discovered and punished increases.

Knack and Azfar (2003) have suggested that higher levels of economic freedom reduce levels of corruption. **Broadman and Recanatini (2000, 2002)** find evidence that the greater the barriers to entry and exit faced by firms, the more widespread corruption is.

Various authors have suggested that socio-demographic factors are relevant in explaining corruption. These include human capital, population, and labor force. According to **Van Rijckeghem and Weder (1997),**and, **Ali and Isse (2003)**the level of corruption increases in economies with high human capital. **Knack and Azfar (2003)** show that corruption increases with population growth, while **Tavares (2003)** finds that population harms corruption. Another appealing demographic variable is the percentage of the female population in the labor force. **Swamy et al (2001)** find a significant decrease in corruption when women's participation in the workforce increases. They provide four explanations for this result. First, "women may be brought up to be more honest or more risk averse than men, or even feel there is a greater probability of being caught .Second "women, who are typically more involved in raising children, may find they have to practice honesty in order to teach their children the appropriate values." Third, "women may feel more than menthe physically stronger sex that laws exist to protect them and therefore be more willing to follow rules." Finally, "girls may be brought up to have higher levels of self-control than boys which affect their propensity to indulge in criminal behavior".

4.3.2. Political Determinants

The political causes of corruption can be divided into two categories namely political liberty and decentralization or federalism. **Kunicova and Rose-Ackerman (2005)** argue that political liberty tends to reduce corruption. The main reason is that political freedom imposes transparency and provides checks within the political system. Political participation and constraints increase the public's ability to monitor and prevent politicians from engaging in corrupt behavior. Moreover, democratic systems are often found to be more politically stable. In this regard, authors such as **Lederman et al. (2005) and Park (2003)** find that corruption is widespread in unstable polities.

It has also been suggested that decentralization is important in the fight against corruption, but the empirical evidence is mixed. For instance, by using transfers from the central government to different levels of the national government as a measure of decentralization, **Lederman et al. (2005)** conclude that decentralization significantly reduces corruption. The same result was reported by **Ali and Isse (2003)**.On the other hand, **Damania et al. (2004)** find that a federal system is more conducive to corruption.

4.3.3. Bureaucratic and Regulatory Determinants

Corruption has been influenced by the judicial system and the quality of the bureaucracy. As **Van Rijckeghem and Weder (1997)** argue, public sector salaries are strongly correlated with measures of rule of law and quality of bureaucracy, and can therefore affect corruption. In developing countries, bureaucrats are paid so low that they provide incentives for corruption. In addition, low income economies suffer from a lack of organizations to detect corruption. The effect of wage on corruption has been also highlighted by several researchers such as **Rauch and Evans (2000), Herzfeld and Weiss (2003) and, Alt and Lassen (2003).** However, **Gurgur and Shah (2005), and Treisman (2000)** show that this relationship is not always statistically significant.

According to **Van Rijckeghem and Weder (1997), and ,Gurgur and Shah (2005),** the higher the quality of the bureaucracy, the lower the probability of corruption. It is also worth noting that in the bureaucracy, the lack of promotion and the lack of professional training are linked to the high levels of corruption **(Rauch and Evans, 1997).**

Finally, the rule of law is another factor that has been suggested by various authors to be associated with corruption. Basing on different rule of law indexes, they assert that the strong rule of law reduces the likelihood that corruption will occur. For instance, **Damania et al (2004)** employ the rule of law index that takes into account various indicators to measure the extent to which economic agents respect the rules of society. **Herzfeld and Weiss (2003) , Brunetti and Weder (2004)** use an index that measures the extent to which countries have strong political institutions and courts.

4.4. Corruption in Tunisia

Corruption is a phenomenon that has hit Tunisia over the past decade, affecting all sectors of the economy. According to the Transparency International, the level of corruption in Tunisia has worsened during the last years. Indeed, the corruption index fell to 38 in 2011 against 53 in 2001, dropping the country from the rank 31rd in 2001 to 73rd in 2011 and 74rd in 2019 among 180 countries. The police sector is the most corrupt sector in Tunisia, with a rate of 51 percent, followed by parliamentarians and national government employees with a rate of 32 percent. Despite the worsening of corruption, Tunisia remains among the countries with a moderate level of corruption.

Currently, corruption plagues every aspect of Tunisia's economic and hinders economic development. The most obvious effect of corruption is on economic growth. According to a World Bank study, Tunisia lost on average around 2% of its GDP each year due to corruption in the ten years leading up to the revolution. Furthermore, high levels of corruption discourage investment by eroding the confidence of international and domestic investors and introducing additional risks. Corruption is consistently ranked as one of the main obstacles to doing business in Tunisia. Both the level of foreign direct investment and the origin country are affected by corruption. Countries with higher levels of corruption tend to attract less FDI from those who have signed anti-corruption agreements, while countries with lower levels of corruption attract more FDI. This is an issue for Tunisia, as it seeks more investment from Europe and the United States, both seen as less corrupt countries.**(Sarah Yerkes,2017)2.** Politically, corruption affects negatively the country's international image. But, more importantly, it erodes the confidence between citizens and their government. **(Sarah Yerkes, 2017).** Most dangerous of all, corruption provides opportunities for drug and arms traffickers and can aid terrorists and make money laundering easier. Indeed, many who engage in the informal economy that accounts about half of the Tunisian economy according to INS, take advantage of porous borders and corrupt customs to smuggle drugs and weapons. Furthermore, a corrupt system may allow terrorists to exploit the anger and frustration that comes along with corruption.

Since the revolution, Tunisian government has undertaken numerous measures to fight against corruption. For instance, in 2011, a National Anti-Corruption agency was created. A new public procurement decree was adopted in 2014 to improve transparency, governance and complaint mechanisms. In 2017, a whistleblower protection law was adopted.

5 Conclusion

Corruption is an activity in which the power of a public office is used for personal gain. Paying or receiving bribes is affected by different economic factors such as the wage rate, the level of economic growth, economic freedom and socio-demographic factors. Political, bureaucratic and regulatory determinants are also relevant in explaining corruption. In recent

2 https://carnegieendowment.org/2017/10/25/tunisia-s-corruption-contagion-transition-at-risk-pub-73522

years, especially after the revolution, there is a wide spread of corruption in Tunisia affecting all sectors of the economy.

In the second part of this chapter, we provide an overview of FDI. It is perceived as an important part of economic growth. Given its benefits, Tunisia has provided a wide range of FDI incentives in order to attract FDI and stimulate economic development. The eclectic theory known as the OLI model suggests that there are three determinants of FDI which are Ownership, Location and Internalization. The location advantage may take the form of economic advantage or political advantage.

CHAPTER 2: LITERATURE REVIEW

1 Introduction

The relationship between corruption, FDI and economic growth is not a new concept in the field of economics. Many researchers have tried to explore the causes and the consequences of corruption and FDI on growth using empirical and theoretical analyses. Heterogeneity in estimation methods, data sources, time periods and countries covered have made it difficult to obtain comparable, reliable, and verifiable conclusions about the effect of corruption and FDI on economic growth. There is hardly any consensus among them on the nature of the link.

The aim of this chapter is to present a review of the empirical literature with regards to the impact of corruption and FDI on economic growth. In the first part, we will provide the relevant of literature on how FDI affects growth. The empirical evidence of the nexus between corruption and growth will be discussed in the second part.

2 Empirical studies on FDI and economic growth

The nexus between FDI and economic growth has received considerable attention from researchers and governments of developing countries around the world .This relationship has been intensively studied using data from a single country or a sample of many countries, empirical methods and different time periods. Unfortunately, no consensus on the empirical finding has been achieved among researchers. While there are various studies that found a positive relationship, others supported the view that FDI has a detrimental impact on economic growth or does not exhibit any relationship with growth.

Basu et al. (2003) explore the two-way linkage between FDI and economic growth for 23 developing countries. Empirical results showed that FDI and economic growth move together in the long-run or they are cointegrated after allowing for heterogeneous country effects. **Iamsiraroj (2016)** examines the relationship between FDI and economic growth. Basing on panel data for 124 countries, he found that FDI contributes to economic growth and growth attracts FDI which in turn stimulates growth further.. **Omran and Bolbol (2003**) find a high correlation and significant causality between FDI and economic growth for Arab countries over the period 1975–1999. They also considerd that local economic and political conditions, as well as policies aimed at attracting FDI, were important determinants in influencing FDI.

Soltani and Ochi (2012) use recent techniques of time series analysis to investigate the FDI-growth relationship in the Tunisia context. They suggested that FDI could improve the process of long-term economic growth over the period 1975-2009. Similarly, empirical findings of **Bouchoucha and Ali (2019)** based on ARDL model, indicate that FDI has a positive effect on economic growth in Tunisia in both the short and the long term over the period 1980-2015. However, **Belloumi (2014)** assumes that there is no causal relationship between FDI and GDP near from FDI to GDP nor from GDP to FDI during the period 1980-2008.

Dimelis (2015) investigates the role of technological advancement on productivity growth that can be generated by FDI. By using 2589 manufacturing firms operating in Greece, he supported the view that FDI spillovers have a positive and significant impact on economic growth when the technological gap between foreign and domestic firms is small. Basing on cointegration tests, **Lee (2013)** argued that FDI plays an important role in boosting economic growth for the G20 through introducing new technologies and developing renewable energy resources. On the other hand, there are studies which have found that technology transfer can create negative effects. In this regard, **Moura and Forte (2009**) show that modern technology can negatively affect the growth of the host country depending on the technologies generated by foreign firms. **Vissak and Roolaht (2005)** state that the host country may become dependent on the innovations brought by multinationals and developed countries.

Furthermore, FDI can promote economic growth through domestic investment. For **Pessoa (2007),** the entry of foreign firms increases the supply on the local economy. Therefore, domestic firms, in order to maintain their market share, they have to response to this competition, which leads to improve the productivity and more efficient use of resources. **Ngouhouo (2008)** argues that there is a more beneficial long term effect on domestic investments that sake advantages from FDI spillovers. Nevertheless, the establishment of foreign firms can have a negative impact on local firms by leveraging power in terms of technological advantage, branded products and crowding out domestic investment **(kumar and Pradhan ,2002).**

Results of **Fauzel (2016)** based on the PVAR model suggest that FDI presence contributes to economic growth in the small island developing states (SIDS) by strengthening financial development. Indeed attracting FDI is important for the well-functioning of the banking system.

In African context, **Beck et al. (2009)** argue that there a bidirectional causality between FDI and financial development, additionally FDI impacts positively growth. Given that financial market is less developed in the African continent, FDI can be seen as a motivation for developing financial market and can also serve as a tool to improve liquidity. On the other hand, there are studies that fail to confirm that financial development is always beneficial for economic growth. For instance ,by using a dynamic panel threshold method with GMM estimator for the period 1987-2016, **J.Osei and Kim (2020)** show that there exists a potential maximum financial development threshold, beyond which , the effect of FDI on economic growth becomes negligible.

Many studies have emphasized the impact of FDI on economic growth through the improvement of human resources. For instance, **Romer (1990)** assumes that human capital is seen as a central element in the growth process. **Busse and Groizard, (2008**) show that FDI is viewed as an important source of capital inflow and the improvement of human capital development in the host country. Moreover, **Zhang (2001**) argues that FDI is a source of economic growth and they bring together highly skilled workers. In contrast, human capital generated by FDI can adversely affect economic growth. According to **OECD (2002),** given that multinational firms use advanced technology, the number of workers compared to those used by local companies is reduced consequently there is an increase in the unemployment rate, which threatens economic growth.

Konings (2001) find no positive relationship between FDI and Poland growth. Furthermore, ,the author stated that FDI hampered Romanian and Bulgarian economy, as these countries were subject to trade imbalances, monopolies or reverse transfers of knowledge and technology. **Lyroudi et al. (2004**) investigate the nature of the impact of FDI on growth in the US and the western European countries. Bayesian analysis showed that there is no relationship between FDI and economic growth for the transition economies even after dividing the sample into nations with low and high growth rates. **Pacheco-López (2005)** assume that the increase in FDI can create difficulties for the Mexican economy. Results illustrate that, on average, GDP growth in the pre-FDI is higher than post –FDI. Additionally, it contributes in damaging local industries, stifled domestic industrialization, and contributed to the Mexican economy's "polarization." According to **Jyun-Yi and Chih-Chiang (2008)**, FDI plays an ambiguous role in accelerating economic growth. they didn't find a positive relationship between FDI and economic growth for 62 countries covering the period 1975–2000. Results of **Curwin and**

Mahutga (2014) suggest that if FDI penetration happens too quickly, it may affect negatively economic growth in transition countries in the short and long term, thus less FDI penetration is better than more.

3 Empirical studies on corruption and economic growth

In recent years, the link between corruption and economic growth is widely discussed. While many scholars support the "sand the wheels" hypothesis that predicts corruption decreases economic growth, some support the "grease the wheels" hypothesis that predicts corruption increases growth.

The first comprehensive econometric research is by **Mauro (1995)** who found a negative association between growth rate and corruption index in 70 countries. Results indicate that a decrease of the corruption by one standard deviation leads to a significant increase in the annual growth rate of GDP per capita by 0.8 percent. However after controlling for political stability, investment and GDP per capita, the effect becomes insignificant.

In a cross-country study based on a regression analysis, **Tanzi and Davoodi (1998)** explore five channels through with corruption can reduce growth over the period 1980-1995. A higher level of corruption is associated with lower government revenues, lower government spending, lower quality of infrastructure and higher public investment.

Monte and Papagni (2001) state that corruption plunders Italy‟s economic growth by decreasing the efficiency of public expenditure. According to them, public services constitute inputs financed through taxes to be used in private productive activities .When bureaucratic corruption purchase these inputs from the private sector with some degree of discretion, the efficiency of expenditure on public investment decreases.

Mo (2001) find that corruption has a negative impact on economic growth. This effect is transmitted through several channels including investment, human capital and political instability which accounts for about 50% of the overall effect. According to **Mo (2001),** corruption leads to economic and social inequality by favoring one particular class over another, usually the relatively wealthy over the poor. As a result, instability arises as the poor, often disgruntled, seek other means of survival. Instability, which can take the form of frequent

changes in government or higher crime rates, produces uncertainty, which scares off investors and reduces productivity, thus decreasing economic growth. Another school of thought argues that increasing economic and income inequality does not always slow down the growth of the economy. For instance, **Petersen and schoof (2015)** argue that economic inequality in Germany can promote growth in the 1950s and the 1960s by accumulating savings that can be invested by the higher income classes in society. By adopting the same method as Mo (2001), **Pellegrini and Gerlagh (2004)** attributed the negative effect to investment and trade openness.

Brempong (2002) investigates the impact of corruption on economic growth in African countries during the 1990s. It was found that a unit increase in corruption decreases the growth rate of GDP and per capita income by between 0.75% and 0.9% and 0.39% and 0.41% per year respectively by decreasing the productivity and reducing investment. **Gyimah-** While it was found that the largest impact of corruption on income distribution was in Latin America, African countries recorded the largest impact of corruption on growth. **Ugur and Dasgupta (2011)** look over 115 studies in a meta-analysis of earlier studies on the effect of corruption on economic growth in developing nations. It was stated that corruption has a negative impact on growth through direct and indirect means. They confirm that investment, public expenditures and human capital are transmission channels through which the indirect effects of corruption occur.

The analysis of **Hakimi and and Hamdi (2015)** indicate that even when strong indicators of governance such as political stability, regulatory quality, rule of law, and corruption control are present, corruption may negatively affect economic growth in 15 Middle East and North African (MENA) countries over the period 1985-2013.
Malanski and Póvoa (2021) highlight the effect of corruption on growth for different levels of economic freedom for the period 2000-2017. Results indicate that corruption damages growth in Asian countries with less economic freedom. However, in Latin America, there is a negative relationship between corruption and growth in countries with high level of economic freedom.

Empirical results of **Al Qudah et al. (2020)** show that corruption has a negative effect on economic growth in Tunisia. They found that if corruption increase by 1%, GDP per capita should be decreasing by 1%. This effect is transmitted directly and indirectly through investment in physical capital. **Zouaoui et al (2018)** suggest that there is a gap between the real and the predicted GDP per capita in Tunisia, which represents the cost of corruption. For

Akrout (2020), corruption adversely affects Tunisia's economic growth through channels mainly the private capital stock, total public expenditure, and human capital. Basing on a system of simultaneous equations, **Dridi (2013)** considered that human capital and political instability are the two important transmission channels via which corruption is likely to decrease the economic growth of Tunisia from 1980 to 2002.

There are studies that look into the effect of corruption on public finances. For instance, **Gonzales-Fernadez and Gonzalez-Velasco (2014)** find that corruption has a direct and significant positive impact on public debt in Spain. Similarly, **Cooray et al. (2013**) argue that an increase of the level of corruption leads to an increase in the stock of public debt in developing and developed countries. Results of **Pattillo et al. (2004)** find that for countries were the level of debt is high, the negative effect of debt on growth is stronger in countries with bad quality of policies. Through the dynamic panel Gaussian mixture models (GMM), results of **kim et al. (2017)** during the period 1990-2014 showed that the impact of public debt on economic growth is a function of corruption . Adding to that, they found that in transparent countries, public debt promotes economic growth and vice versa. By applying the same method and during the period 1996–2012, **Cooray et al. (2017)** argue that corruption could increase public debt, however in countries with high level of corruption, the negative effect of public debt on economic growth became stronger. Basing on the GMM method, **Thuy Van et al. (2020)** show that public debt and budget deficit have negative effect on sustainable economic development. However, controlling corruption may limit this effect and pushing economic growth. In other words, countries with low level of corruption, an increase of public debt or budget deficit will lead to higher economic growth than countries with high level of corruption.

Studies of corruption and its relationship to foreign direct investment (FDI) have produced mixed results. Some have found that corruption can be a stimulus for FDI, some have found the opposite and the others have found no relationship between the two variables. For example, **Freckleton et al (2012)** show that low corruption boost the impact of FDI on economic growth. According to **Cies´lik and Goczekv (2018),** the effect of corruption on growth is especially shown in countries with low investment rates because international investors hesitate to invest in an economy where there is a high level of corruption. The main raison is that, the uncertainty generated by corruption serves as a tax on entrepreneurship, decreasing thus the investment return. The analysis of **Gründler and Potrafke (2019)** suggest that FDI is the most important variable through which corruption is likely to influence negatively economic growth. Empirical

findings of **Okada and Samreth (2014)** show that the negative and positive effect of FDI and growth is separated by a threshold level of corruption. Indeed, when corruption is below (above) a certain level, FDI has a positive (negative) impact on growth. **Egger and Winner (2005)** find a positive relationship between FDI and corruption for a sample of 73 developed and less developed countries. For **Helmy (2013),** FDI varies positively with corruption in MENA countries from 2003 to 2009.

On the other hand certain studies, have recorded a positive relationship between economic growth and corruption. Theoretical work of **Leff (1964)** identifies an intriguing link between corruption and economic growth: corruption acts as a motor of economic progress when the government's bureaucratic delays and rigid restrictions allow private agents to purchase their way out of politically imposed inefficiencies. Thus, corruption improves an economy's efficiency and affects positively growth.. Similarly, in cross-sectional analysis in a panel of 60 nations **Swaleheen and Stansel (2007)** conclude that when economic agents have a wide variety of economic choices, corruption helps to improve growth by allowing them to escape government controls. Therefore, corruption contributes to enhance growth in countries with high levels of economic freedom. Contrary to these findings, **Heckelman and Powell (2008)** find that corruption has the potential to boost growth in countries that have low levels of freedom and the benefits of corruption for growth decrease as economic freedom increases. **Malanski and Póvoa (2021)** assume also that for the case of Latin America, corruption promotes economic growth in countries with less level of economic freedom. Results of **Podobnik et al. (2008)** show that corruption affects positively economic growth it was reported that on average a one-unit increase in the Corruption Perceptions Index correlates to a 1.7 percent increase in the annual GDP per capita growth rate. For **Delgado et al (2014**), corruption has a positive effect on growth rates in about 30% of the countries in the sample, a negative effect in 11% and no effect in the other 59 %. **Trabelsi and Trabelsi (2020)** argue that corruption can be beneficial to economic growth under a certain optimal threshold. This level which is assumed to be between 2.5 and 3, represents the point at which the marginal advantages and the marginal costs of corruption are equal.

5. Conclusion

Author(s)	Main variables	Countries	Transmission channel(s)	Main findings
Basu et al. (2003)	FDI-growth	23 developing countries	-	FDI and economic growth move together in the long-run
Iamsiraroj (2016	FDI-growth	124 countries	-	FDI contributes to growth and growth attracts FDI.
Omran and Bolbol (2003)	FDI-growth	Arab countries	-	High correlation between FDI and economic
Soltani and Ochi (2012)	FDI-growth	Tunisia	-	FDI improve the process of long-term economic growth
Bouchoucha and Ali (2019)	FDI-growth	Tunisia	-	FDI has a positive effect on growth in the short and the long term
Belloumi (2014)	FDI-growth	Tunisia	-	No causal relationship between FDI and GDP near from FDI to GDP nor from GDP to FDI
Dimelis (2015)	FDI-growth	Greece	Technological advancement	FDI spillovers have a positive impact on growth when the technological gap between foreign and domestic firms is small.
Lee (2013)	FDI-growth	G20	Technological advancement	FDI plays an important role in boosting economic growth
Moura and Forte (2009)	FDI-growth	Several countries	Technological advancement	Modern technology can negatively affect the growth of the host country

Vissak and Roolaht (2005)	FDI-growth	Estonian economy	Technological advancement	Host country may become dependent on the innovations brought by multinationals and developed countries.
Pessoa (2007)	FDI-growth	Several Countries	Domestic investment	FDI promote economic growth through domestic investment
Ngouhouo (2008)	FDI-growth	Central Africa	Domestic investment	There is a more beneficial long term effect on domestic firms that sake advantages from FDI
kumar and Pradhan (2002)	FDI-growth	6. Developing countries	Domestic investment	FDI can crowd out domestic investment
Fauzel (2016)	FDI-growth	Small island developing states	Financial development	FDI strengths financial development
Beck et al. (2009)	FDI-growth	African continent	Financial development	Positive bidirectional causality between FDI and financial development
J.Osei and Kim (2020)	FDI-growth	62 countries	Financial development	There is a potential maximum financial development threshold, beyond which , the effect of FDI on growth becomes negligible
Busse and Groizard (2008)	FDI-growth	Several countries	Human resources	FDI is viewed as an important source the improvement of human capital development in the host country
Zhang (2001)	FDI-growth	11 economies in East Asia and Latin America	Human resources	FDI is a source of economic growth and they bring together highly skilled workers
Konings (2001)	FDI-growth	Poland	-	No positive relationship between FDI and growth.

Lyroudi et al. (2004)	FDI-growth	US and the western European countries	-	No relationship between FDI and economic growth
Pacheco-López (2005)	FDI-growth	Mexico	-	The increase in FDI can create difficulties for the Mexican economy
Jyun-Yi and Chih-Chiang (2008),	FDI-growth	62 countries	-	FDI plays an ambiguous role in accelerating economic growth
Curwin and Mahutga (2014)	FDI-growth	Transition countries	-	FDI affects negatively economic growth in the short and long term
Mauro (1995)	Corruption-Growth	70 countries	Political instability, investment	Negative association between growth and corruption
Tanzi and Davoodi (1998)	Corruption-Growth	OECD countries	Government spending, Public investment.	A higher level of corruption damages growth
Monte and Papagni (2001)	Corruption-Growth	Italy	Public expenditure	Corruption plunders economic growth
Mo (2001)	Corruption-Growth	20 regions	Investment, human capital and political instability	Corruption has a negative impact on economic growth
Brempong (2002)	Corruption-Growth	African countries	Productivity and investment	A unit increase in corruption decreases per capita income by between 0.39% and 0.41% per year .
Gyimah-Brempong and Camacho (2006)	Corruption-Growth	61 countries from Asia, Africa and Latin America	Income distribution	Negative relationship between corruption and

Ugur and Dasgupta (2011)	Corruption-Growth	Developing countries	Investment, Public Expenditures and Human Capital	Corruption has a negative impact on growth
Hakimi and and Hamdi (2015)	Corruption-Growth	MENA countries	-	Corruption may negatively affect economic growth
Malanski and Póvoa (2021)	Corruption-Growth	Asian countries	Economic freedom	Corruption damages growth
Zouaoui et al (2018)	Corruption-Growth	Tunisia	-	There is a gap between the real and the predicted GDP per capita which represents the cost of corruption
Al Qudah et al. (2020)	Corruption-Growth	Tunisia	Investment in physical capital	If corruption increase by 1%, GDP per capita should be decreasing by 1%.
Akrout (2020)	Corruption-Growth	Tunisia	Private capital stock, Public Expenditure and Human Capital.	Corruption adversely affects economic growth
Dridi (2013)	Corruption-Growth	Tunisia	Human Capital and Political Instability	Corruption decreases the economic growth
Gonzales-Fernadez and Gonzalez-Velasco (2014)	Corruption-Growth	Spain	Public debt	Corruption has a significant positive impact on public debt.
Cooray et al. (2013)	Corruption-Growth	Developing and developed countries	Public debt	Corruption leads to an increase in the stock of public debt
kim et al. (2017)	Corruption-Growth	77 countries	Public debt	The impact of public debt on economic growth is a function of corruption

Cooray et al. (2017)	Corruption-Growth	126 countries	Public debt	Corruption increase public debt, however in countries with high level of corruption, the negative effect of public debt on economic growth became stronger.
Thuy Van et al. (2020)	Corruption-Growth	59 developing countries	Public debt and budget deficit	An increase of public debt or budget deficit will lead to higher economic growth than countries with high level of corruption.
Freckleton et al (2012)	Corruption-Growth	Developed and developing countries	FDI	Corruption boost the impact of FDI on economic growth.
Cies´lik and Goczekv (2018),	Corruption-Growth	142 countries	FDI	The effect of corruption on growth is especially shown in countries with low investment rates
Gründler and Potrafke (2019)	Corruption-Growth	175 countries	FDI	Corruption influences negatively economic growth.
Okada and Samreth (2014)	Corruption-Growth	130 countries	FDI	When corruption is below (above) a certain level, FDI has a positive (negative) impact on growth.
Egger and Winner (2005)	Corruption-Growth	73 developed and less developed countries	FDI	Positive relationship between FDI and corruption
Leff (1964)	Corruption-Growth	-	-	Corruption acts as a motor of economic progress
Swaleheen and Stansel (2007)	Corruption-Growth	60 nations	-	Corruption contributes to enhance growth in countries with high levels of economic freedom.
Heckelman and Powell (2008)	Corruption-Growth	Panel data	-	Corruption has the potential to boost growth in countries that have low levels of freedom

Malanski and Póvoa (2021)	Corruption-Growth	Latin america	-	Corruption promotes economic growth in countries with less level of economic freedom
Podobnik et al. (2008)	Corruption-Growth	Different countries in the world	-	Corruption Perceptions Index correlates to a 1.7 percent increase in the annual GDP per capita growth rate.
Delgado et al (2014)	Corruption-Growth	Developing countries	-	Corruption has a positive effect on growth rates in about 30% of the countries in the sample.
Trabelsi and Trabelsi (2020)	Corruption-Growth	88 countries	-	Corruption can be beneficial to economic growth under a certain optimal

CHAPTER 3: THE COPULA THEORY BACKGROUND

1 Introduction

The powerful notion of copula function has been introduced into the field of finance by Embrechts, McNeil, and Straumann [1999,2000]. Since then, the use of copulas has strongly spread various domains. This popularity and usefulness of copulas in modeling dependence is due to numerous advantages relative to traditional empirical methods. (1) Copula function is a robust technique as it is able to separate the dependence structure from the univariate marginal. (2) Give the flexibility to capture nonlinear distribution. (3) There was no requirement that the marginals should be normal distributed. (4) Another important advantage of copula over the other models resides in its ability to analyze upper, lower, symmetric and asymmetric tail dependencies which is not feasible with dependency methods applied in the literature. This chapter is dedicated to give the main characteristics of the copulas applied in our thesis which are the bivariate and the multivariate copulas as well as to provide the procedure used to analyze the dependence structure. As this approach is not commonly used, we will try to be more detailed.

2 Modeling the marginal distributions

As we said, the major advantage of using copula is the capacity to separate the margins and the dependence structure. As a first step, it appears the importance of fitting an appropriate and adequate distribution to each marginal. This step is fundamental, because using a misspecified model for the margins, leads to a misspecified copula. This is due to the possibility that the probability integral transform will not be uniform. That's why choosing the right distribution for margins can be considered even more important than calibrating of copula.

Throughout previous studies, according to many authors,time series have been successfully modeled by ARMA model with GARCH type model:

$$R_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i R_{t-i} + \sum_{i=1}^{n} \beta_i \varepsilon_{t-i} + \varepsilon_t \qquad (1)$$

We assume that the ε_t follows one of the GARCH type models which are defined below.

2.1. GARCH (p,q) process

The GARCH process is given by:

$$\varepsilon_t = Z_t \sqrt{h_t} \qquad (2)$$

The variance equation: $\square_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j}^2$ (3)

WhereZ_t is a sequence of identically and independently distributed normal random variables with zero mean and unit variance,$h_t$represents the conditional variance of the processwhich is function of a constant term ω , an ARCH term $\varepsilon_{t-i}^2$and a GARCH term h_{t-j}^2.

To ensure a positive conditional variance and a stationary unconditional variance, two conditions are imposed respectively: $\omega > 0, \alpha_i \geq 0, \beta_j \geq 0$and $\sum_{i=1}^{q} \alpha_i + \sum_{j=1}^{p} \beta_j < 1$.

Unfortunately, the symmetric model of ARCH-GARCH model assuming the symmetric effect of the positive and negative error terms on the volatility, are inappropriate and usually violated. To the end of solving this issue, and to take into account this fact, many extensions of the GARCH model were introduced. Two important classes dealing with the asymmetry are the GJR-GARCH model and the E-GARCH model.

2.2. EGARCH(p,q) process

The EGARCH model is given by:

$$\varepsilon_{t=\sigma_t z_t} \qquad (4)$$

$$ln\sigma_t = w + \sum_{i=1}^{q} (\alpha_i \, g(z_{t-i}) + \sum_{j=1}^{p} \gamma_i \, ln \, h_{t-j} \qquad (5)$$

A mean adjusted process follow a GJR model is written as follows

$$\varepsilon_{t=\sigma_t z_t} \qquad (6)$$

$$\sigma_t^2 = w + \sum_{i=1}^{q} (\alpha_i + \gamma_i I_{t-i}) \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \qquad (7)$$

where: $w, \alpha_i, \gamma_i \text{and} \beta_j > 0 \sum_{i=1}^{q} \alpha_i + \mu \sum_{j=1}^{q} \beta_j + \sum_{i=1}^{p} \beta_i < 1$

μ is a constant that depends on the distribution of ε_t. β is the conditional variance term and γ is the asymmetric effect coefficient.

The indicator variable I_{t-i} is as follows:

$$I_{t-i} = \begin{cases} 1 \; if \; \varepsilon_{t-i} < 0 \\ 0 \; if \; \varepsilon_{t-i} \geq 0 \end{cases} \qquad (8)$$

3 The Copula theory background

3.1. Definition

The Copula expresses the joint distributions of two or more random variables. With a copula we can separate the joint distribution into two contributions: the marginal distributions of each variable, and the copula that combines these marginal into a joint distribution.

A copula C is the joint distribution of random vector $U=(U_1,U_2,.....,U_n)$ in $\mathbb{R}^n$ with the marginals $U_1,U_2,....,U_n$ are uniform U:[0,1]

$C(u_1,u_2,...u_n)=\mathbb{P}(U_1\leq u_1,U_2\leq u_2.....U_n\leq u_n)$ (9)

Two-dimensional copula

A 2-copula is a multivariate joint distribution, of a random vector in $\mathbb{R}^2$, defined on the 2 dimensional unit cube $[0,1]^2$.

Then, the copula is any function C $[0,1]^2\rightarrow [0,1]$ $\forall i$ u_i and v_i in [0,1] .

The 2-copula function is: $C(u_1,u_2)=\mathbb{P}(U_1\leq u_1,U_2\leq u_2)$ (10)

, and must satisfy these properties:

- $C(0,u)=0=C(0,v)$ which means , $\mathbb{P}(U_1\leq u,U_2\leq 0)= \mathbb{P}(U_1\leq 0,U_2\leq u)=0$ (11)
- $C(u,1)=1$ and $C(1,v)=1$ which means, $\mathbb{P}(U_1\leq u_1,U_2\leq 1)= \mathbb{P}(U_1\leq 1,U_2\leq u)=1$ (12)

These two properties make sure that the marginals are uniform

- C is 2-increasing which means $C(u_1 ,v_1)-C(u_1 ,v_2)-C(u_2 ,v_1)+C(u_2 ,v_2)\geq 0$ (13)

This last property leads to the continuous theorem: let $u_1\leq u_2$ and $v_1 \leq v_2$ then

$|C(u_2,v_2)-C(u_1,v_1)|\leq|u_2-u_1|+|v_2-v_1|$ (14)

These properties can be extended to the n-dimensional

3.2. Basic properties of copula

3.2.1. Sklar's theorem

The Sklar's theorem is the basis of the foundation of copulas. Sklar's theorem states that:

Theorem 1 Let F be a joint distribution function with margins F_1 and F_2. Then there exists a copula C such that for all (x,y) in $\mathbb{R}^2$;

$$F(x,y) = C(F_1(x),F_2(y)) \quad (15)$$

and if F_1 and F_2 are continuous then C is unique.

This definition, then, provides the manner that copula appends the marginals to remit the joint distribution.

Corollary 1: Let F be a joint distribution function with continuous margins F_1 and F_2. $F_1^{-1}$and F_2^{-1} are the inverse of F_1 and F_2, (u,v) in [0,1]

$$C(u,v) = C(F_1(x),F_2(y)) \quad (16)$$
$$=F(F_1^{-1}(u), F_2^{-1}(v))$$

This theorem is the foundation of copula theory and its application in statistics.

3.2.2. Properties

In the previous sections we highlighted the utility, advantages and the structure of copulas. So, it's obvious, there is a need to describe and learn about the properties that make copulas popular and useful. One of the strengths of copula, in the case of strictly monotonous transformations, is its capacity to be invariant or to change in predictable way.

Theorem: Let X and Y be continuous random variables with copula $C_{X,Y}$ .If α and β are strictly increasing functions, then:

$$C_{\alpha(X),\beta(Y)} = C_{X,Y} \quad (17)$$

Copula also is a powerful method to capture a complete information of dependence between random variables. It's largely used as dependence function

- **Freshet bounds**

$C^- < C(u) < C^+$ (18)

With $C^- = \max(u_1+u_2-1,0)$, C^- is the inferior bound of Freshet

$C^+ = \min(u_2,u_1)$ $\forall u$ in [0,1], C^+ is the superior bound of Freshet.

and the independence can be captured and defined as $C^{\perp} = u_1 u_2$

C^- is a copula only in the bivariate case. But the independence and the superior bound of Freshet are copula for all dimensions.

The concordance ordering can be defined as follows

$C^- \prec C \prec C^{\perp}$: negative ordering dependence (19)

$C^{\perp} \prec C \prec C^+$: positive ordering dependence (20)

with: $\prec$ represents the concordance order (partial order relation)

3.3. Measures of dependence and concordance

3.3.1. Rank correlation

A. Definition of concordance

Definition 3 (Concordance and discordance).For any pair of observations (X_i, Y_i) and(X_j, Y_j):

-If both $X_i > X_j$ and $Y_i > Y_j$and if both $X_i < X_j$ and$Y_i < Y_j$, then we say observations (X_i, Y_i) and$(X_j, Y_j)$are concordant$\leftrightarrow (X_i - X_j)(Y_i - Y_j) > 0$

-If both $X_i > X_j$ and $Y_i < Y_j$and if both $X_i < X_j$ and$Y_i > Y_j$, then we say observations (X_i, Y_i) and$(X_j, Y_j)$are discordant$\leftrightarrow (X_i - X_j)(Y_i - Y_j) < 0$

B. Kendall's tau

Kendall's tau measures the dependence as the difference between probability of concordance and probability of discordance.

Definition 4(Kendall's tau).Let $(X_1, Y_1)$and(X_2, Y_2)be independent and identically distributed random vectors with distribution function F, Kendall's tau is defined as follows:

$$r_k(X,Y) = \Pr(concordance) - Pr(discordance)$$

$$= \Pr[(X_1 - X_2)(Y_1 - Y_2) > 0] - \Pr[(X_1 - X_2)(Y_1 - Y_2) < 0] \quad (21)$$

Furthermore, the Kendall's tau can be written as a function of the copula as follow:

$$r_k(X,Y) = 4\int_0^1\int_0^1 \boldsymbol{C}(u,v)\, d(u,v) \quad (22)$$

$$= 4E[C(U,V)] - 1$$

WhereU, V ~ U (0, 1) with joint distribution function $\boldsymbol{C}$

Proprieties:

The most important properties of r_k are:

-Symmetric: $r_k(X,Y) = r_k(Y,X)$

-Normalized to the interval [-1, 1]: -1< $r_k(X,Y)$<1

If $r_k(X,Y) = 1$ ↔conomotic dependence between X and Y.

If $r_k(X,Y) = -1$ ↔ anticonomotic dependence between X and Y.

If $r_k(X,Y) = 0$ ↔X and Y are independent

-Invariant under non-linear transformations: $r_k(T_1(X), T_2(Y)) = r_k(X,Y)$, if $T_1$and T_2 are two increasing continuous functions.

C. Spearman's rho

It's a similar measure to the Pearson measurement of dependence without requiring a linear relation of the increase .The idea is to measure the relation between ranked variables.This measure was developed by Charles Pearson (1904).

Definition5 (Spearman's rho)**.**Let $(X_1,Y_1),(X_2,Y_2)$and$(X_3,Y_3)$are three independent identically distributed random vectors, Spearman's rho is defined as follow:

$$\rho s(X,Y) = 3(\mathbb{P}[(X_1 - X_2)(Y_1 - Y_3) > 0] - \mathbb{P}[(X_1 - X_2)(Y_1 - Y_3) < 0]) \quad (23)$$

The Spearman's rho can be written as a function of Pearson's coefficient ρ as follow:

$$\rho s(X,Y) = \rho(F_X(X), F_Y(Y)) \quad (24)$$

Where F_X and F_Y are the cumulative distribution functions, respectively, of X and Y

Furthermore, the Spearman's rho can be computed using copula function as follow:

$$\rho s(X,Y) = 12\int_0^1\int_0^1 uv\, d\boldsymbol{C}(u,v) - 3 \quad (25)$$

$$= 2\int_0^1\int_0^1 \boldsymbol{C}(u,v)\, du\, dv - 3$$

WhereU, V ~ U (0, 1) with joint distribution function $\boldsymbol{C}$

Proprieties:

The most important properties of ρs are:

-1<$\rho s(X,Y)$<1

If $\rho s(X,Y)$=1 ↔ comonotone dependence between X and Y.

If $\rho s(X,Y) = -1 \leftrightarrow$ antimonotone dependence between X and Y

If $\rho s(X,Y) = 0 \leftrightarrow$ X and Y independent.

- Invariant under non-linear transformation.

In general, the main advantage of rank correlations is that they are invariant under monotonic transformations and sensible in handling of perfect dependence. That's why, these two measures, Spearman rho and Kendall tau, of concordance between random variables can be measured in copulas level (Nelson (2006) showed they are properties of copulas).

3.3.2. Tail dependence

The tail dependence coefficient is the probability that a random variable exceeds a certain threshold conditional on the fact that another random variable has already exceeded that thresholdIn other words, the tail dependence coefficient aims to measure the dependence in the upper (right) - tail or lower-(left) -tail of a bivariate distribution.

Definition 4.9(Upper Tail Dependence)**:**Let X and Y be random variables with distribution functions, respectively F_X and F_Y, the coefficient of upper tail dependence is defined as:

$\lambda_U = \lim_{u \to 1} \Pr[Y > F_Y^{-1}(u) \mid X > F_X^{-1}(u)]$ (21)

Furthermore, the upper-tail coefficient may be written in terms of copulas as follow:

$$\lambda_U = \lim_{u \to 1} \frac{1-2u+\boldsymbol{C}(u,u)}{1-u} \qquad (26)$$

If $\lambda_u \in (0,1]$then X and Y are asymptotically dependent in upper tail.

If $\lambda_u = 0$ thenX and Y are asymptotically independent in upper tail.

Definition 4.10 (Lower Tail Dependence)**:** Analogously, the coefficient of lower - tail dependence is defined as:

$\lambda_L = \lim_{u \to 0} \Pr[Y \leq F_Y^{-1}(u) \mid X \leq F_X^{-1}(u)]$(23)Furthermore, analogously the lower-tail coefficient may be written in terms of copulas as follow:

$$\lambda_L = \lim_{u \to 0} \frac{\boldsymbol{C}(u,u)}{u} \qquad (27)$$

If $\lambda_L \in (0,1]$thenX and Y are asymptotically dependent in lower tail.

If $\lambda_u = 0$ thenX and Y are asymptotically independent in lower tail.

3.4. Bivariate Copulas families.

3.4.1. Elliptical Copulas

A. Gaussian Copula

Dependence proprieties:

In the case of Gaussian copula, the Kendall's tau and Spearman Rho are, respectively $\rho\tau_{i,j}=\frac{2}{\pi}\arcsin\rho_{i,j}$ / $\rho s_{i,j}=\frac{6}{\pi}\arcsin\frac{\rho}{2}_{i,j}$

The Gaussian Copula is symmetric without tail dependence hence it exhibit a poor representation of extreme events.

B. Student-t Copula

Similar to the normal copula, t-copula is symmetric but it presents a tail dependence. The bivariate tail dependence is given by: $\lambda = 2T_{v+1}\left(\frac{\sqrt{v+1}\sqrt{1-\rho}}{\sqrt{1+\rho}}\right)$ (28)

whereT_{v+1}denotes the distribution function of a univariate Student's t-distribution with ν + 1 degrees of freedom.

Notice: the parameter v, degree of freedom, is the responsible for generating the fat tail.

3.4.2. Archimedean copulas

Nelsen (2006) gives a detailed discussion on how Archimedean copulas are advantageous. The popularity of the Archimedean copulas is due to the fact that they can be constructed easily and also this class of copulas presents a large variety of families of copulas. Adding to that, it represents many properties, such as symmetry and associativity.

Dependence properties:

One of the specifications of the Archimedean copula is the facility to calculate the expression of the Kendall's tau with no need to calculate the double integration.

It's possible to compute it directly from the generator

A. Gumbel copula

Dependence proprieties:

The Gumbel copula detects asymmetric tail dependency. Indeed, it generates a strong upper tail dependence and weak lower tail dependence. Hence, it is adapted to model the increasing movements. In addition, it accounts only for positive dependency.

kendall's tau: $\tau_K = 1 - \frac{1}{\theta}$

Tail dependence coefficients: $\lambda_U = 2 - 2^{1/\theta}$, $\lambda_L = 0$

B. Clayton Copula

Dependence proprieties:

kendall's tau: $\tau_K = \frac{\theta}{\theta+2}$

Taildependence coefficients :$\lambda_U = 0$, $\lambda_L = 2^{1/\theta}$

C. Frank copula

Dependence proprieties:

The Kendall's tau: $\tau_K = 1 - \frac{4}{\theta}\left(1 - D_1{}^{(\theta)}\right)$

The Spearman's rho: $\rho s = 1 - \frac{12}{\theta}\left(D^{1(\theta)} - D^{2(\theta)}\right)$

The tail dependence coefficients: $\lambda_U = \lambda_L = 0$

With $D_k(\theta)$ is the Debye function :$D_k(\theta) = \frac{k}{\theta^k}\int_0^\theta \frac{t^k}{e^t - 1} dt$, $k = 1,2$

3.5. Vine Copula

A vine is a graphical representation based on Pair Copula Construction (PCC), introduced by Bedford and Cooke (2001, 2002). The idea is to construct multivariate distributions using bivariate and conditional bivariate copulas as building blocks. They called the structure as Regular vine (R- vine) since it is based on graphical trees. Aas et al. (2009) focused on the canonical vine (C-vine) and drawable vine (D-vine) copulas which are two special cases of the R- vine. In our thesis, we consider the C-vine and the D-vine copulas with different hierarchical tree structures.

3.5.1. Definition of Vine copula

Definition 9 (Vine) $V = (T_1, \dots, T_{d-1})$is a vine on *d* elements if:

- $T_1$is a tree with nodes $N_1 = \{1, \dots, d\}$and a set of edges E_1.

- For *i=2,…,d-1*, T_i is a tree with nodes $N_i = E_{i-1}$ and a set of edges E_i

V is called a **regular vine** on *d* elements if we add a third condition to the two previous ones:

- For *i=2,…,d-1*, if $a = \{a_1, a_2\}$ and $b = \{b_1, b_2\}$ are nodes of T_i linked by an edge, then exactly one of the$a_i$equals one of theb_i .

Depending on the types of trees, different vine copulas can be constructed and two special cases of R-vine may exist, C-vine and D-vine copulas.

A. C-Vine copula

A C-vine copula is an R-vine copula for which each tree has a unique node which connects with all the other nodes.

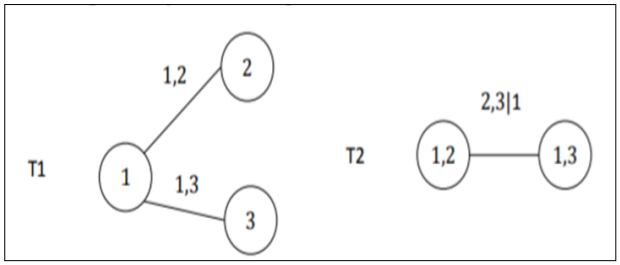


Figure 2: 3-dimensional C-vine structure with 2 trees and 3 edges

B. D-Vine copula

A D-vine copula is an R-vine copula for which each tree has a path structure means node are connects in a symmetric way.

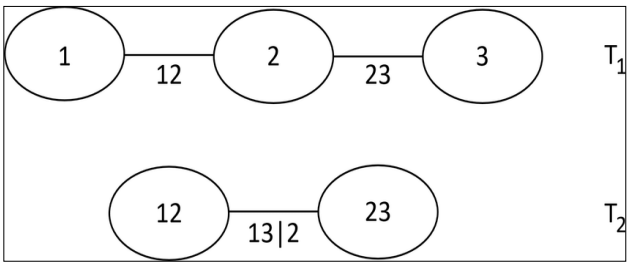


Figure 3: 3-dimensional D-vine structure with 2 trees and 3 edges

3.5.2. Estimation procedure

In their paper, Czado et al (2012) propose a sequential estimation procedure for vine copulas that we summaries as follow: Firstly, the parameters of the unconditional pair-copulas, in the first tree, are estimated and then are used to estimate the parameters of the conditional pair-copulas of the second tree, which are as well used to estimate the pair-copulas with two conditional variables in the third tree. This procedure is repeated until all parameters of pair-copulas are estimated.For example, for a *4*-dimensional C- vine and D-vine copulas the estimation procedure ends when the pair-copula with two conditional variables is estimated. As

a final step, these sequential estimates are used as starting values in order to compute the maximum likelihood estimation (MLE) of the vine copula.

3.6. Statistical Inference of Copulas

There is a wide range of methods to estimate parameters of copula such as method of moments, the parametric estimation (Maximum likelihood estimation (MLE),Inference Function for Margin (IFM)) and the semi-parametric estimation (CML). In this thesis we use the later method.

The Canonical Maximum Likelihood Method (CML)

The CML method is proposed by Bouye et al (2000), which is close to the IFM method but consists on estimating the parameter vector of the copula without specifying the marginals.
Indeed, it is about a two stage method. First, we transform the dataset into uniform variates using an empirical distribution function. Then, we estimate the copula parameters

3.7. Model selection

It is important to determine how well the model fits the data and which model is the best. Therefore, there are different ways to select the adequate copula that gives the best dependence structure.

3.7.1. Graphical criterion

This Scatter plot allows for a graphical overview about the adequacy quality of an estimated parametric copula and the empirical copula.
Although it provides a view of the dependence structure, this graphical method can be used solely in the bivariate case.

3.7.2. Information criteria

We select the model that minimizes the amount of Kullback-Leibler'sinforamation.Among the many criterions that have been proposed in literature, the most commonly used are: the BIC and the AIC criterions.

4 Conclusion

In this chapter, we introduced the main properties of copulas used in our thesis which are the bivariate copula (Elliptical and Archimedean copula) and the multivariate copula (C-vine and D-vine copulas). Our methodology for the bivariate copula, consists as a first step to construct marginal distributions. Then, we estimate copula parameters using CML method. Finally, we select the adequate copula that gives the best dependence structure using graphical and

information criterions to analyze the dependence on average (Kendall's tau or Spearman's rho) and the dependence in times of extreme movements (tail dependence coefficients). For the Vine copula, we apply the sequential procedure Following Czedo et al. (2012).

CHAPTER4: EMPIRICAL RESULTS

1 Introduction

This chapter is dedicated to present our findings. Indeed, we are seeking to assess the effects of corruption and FDI on economic growth. For this purpose, we focus on the copula theory. The use of this approach requires as a first step to fit an appropriate and adequate distribution to each marginal. This step is fundamental, because using a misspecified model for the margins, leads to a misspecified copula. That's why, we present in the first part of this chapter the statistical analysis of our variables under study. Then, we study the bivariate dependence between corruption, FDI and economic growth by using Elliptical and Archimedean copula. Finally, by including other variables as transmissions channels, we analyze the multivariate dependence between each channel, corruption and economic growth on one hand, and each channel, FDI and economic growth on the other hand. We are trying in each part to present the procedure of estimation.

2 statistical analysis

2.1. Data description

Firstly, we examine the bivariate dependence structure between economic growth, corruption and FDI using data related to the Tunisian economy. Our database is recorded annually[3] for all variables on the period that spans from 1996 to 2019. The data is collected from several sources. The first source, which is used to obtain the growth rate as measured by the growth rate of real per capita GDP is (https://www.theglobaleeconom.com/). Then, the data about corruption which is measured by Corruption Perception Index (CPI) is derived from International Transparency (IT) database. Concerning FDI, the data is provided from the World Bank's website.

Then, we explore the channels through which economic growth is affected. To this end, we include domestic investment measured by the gross fixed capital formation (% of GDP) obtained from IFS. We use also public debt (% of GDP), budget deficit (% of GDP), political instability, tertiary gross enrolment rate as a proxy for human capital, domestic credit to private

[3] To give better results, Copula theory is more appropriate for a larger database. Therefore, we transform our annual data to quarterly data basing on the formula explored by many researchers such as Mansouri (2003), Mansouri, Brahim and El Baz, Ayad (2018)

sector by banks divided by GDP as a measure of financial development. Our dataset contain also High-tech imports (% total goods imports) used to represent the variable

technology transfer, which includes computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods. These variables are collected from the World Bank's website.

At the beginning, in order to summarize and describe the main characteristics of the sample, we determine the descriptive statistics of the databases[4] cited above.

Table 1: Descriptive statistics

	FDI	CPI	GDP	HC	DI	ICT	FD	PI	DEBT	DEFICIT
Mean	0.0291	4.5050	3.702e+03	0.2914	0.2343	0.04876	0.5481	1.1963	0.5690	0.0372
Standard deviation	0,09457	0,012005	0,019357	0,02969	0,01773	0,032636	0,0169	0,02791	0,01841	0,067091
Maximum	0.0958	5.3000	4.471e+03	0.3589	0.3084	0,066579	0.7112	2.1413	0.8408	0.0696
Minimum	0.0095	3.7593	2.627e+03	0.1356	0.1835	0,032056	0.4577	0.6755	0.3904	0.0101
Kurtosis	8.6283	1.6827	1.7549	2.5683	4.3661	-0,993283	1.8605	1.6781	2.1388	2.3708
Skewness	2.2300	0.1147	-0.4274	1.0146	-0.4399	-0,066572	0.5817	0.6436	0.3196	0.3888

Source: MATLAB Software

As it is shown in **table 1** the standard deviation is small for all the variables where FDI is the most volatile. The kurtosis coefficient is above 3 for FDI and DI, hence these series are leptokurtic suggesting that the probability to obtain extreme values are higher than the normal distribution. For the rest of the series, the distribution produces thinner tails compared to the normal distribution. The Skewness coefficient is positive for all the series except for the GDP, DI and ICT. These positive values imply that the extreme values are located on the right side of the mean. In contrast, for the others, the left tail is longer and the mass of the distribution is concentrated on the right of the mean. Thus, the results of the skewness and the kurtosis coefficients reinforce the rejection of normality.

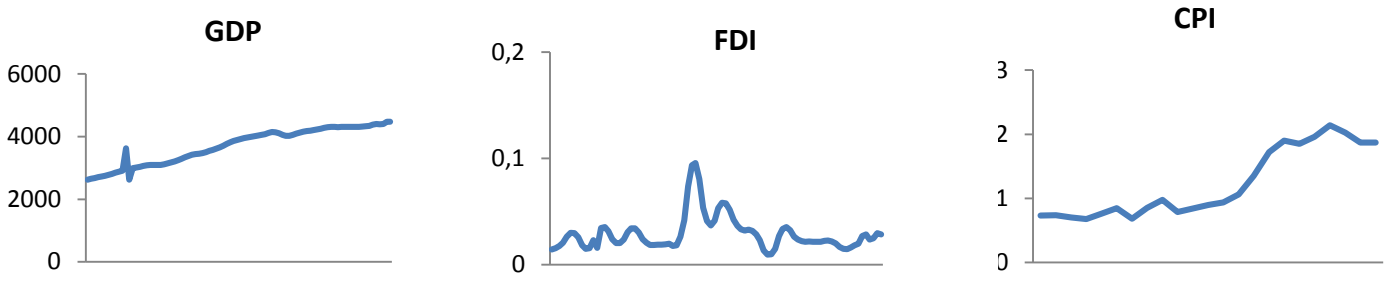
2.2. Margin distribution

In order to specify the marginal distribution, some statistical tools will be used such as tests of stationarity , normality ,autocorrelation and ARCH effect tests as well as some graphical tools.

[4] Corruption (CPI) , Human capital (HC), domestic investment (DI), technology transfer (ICT), financial development (FD), political instability (PI), public debt (DEBT), budget deficit (DEFICIT).

2.2.1. Stationarity testing

A. Graphical approach



Source: EXCEL

Figure 4: Evolution of GDP, FDI and CPI

As it is apparent in **figure 4**, series of GDP, FDI and CPI as well as all the other variables studied display upward and downward movements that do not vary around the mean, and with different amplitudes. These observations indicate that the two statistical properties (the mean and the variance) change over time, thus the stationaitry condition is violated.

By taking the difference in the logarithm of the two successive values, we show in the **figure 5** that return series are stationary .

Source: EXCEL

Figure 5: Evolution of GDP, FDI and CPI returns

In addition to the graphical intention, the stationarity can be verified by statistical tests. We use the most widely used, which is the (ADF) test.

B. Augmented Dickey-Fuller (ADF) test

We test the null hypothesis of non-stationary time series against the alternative one the stationary series5.

Table 2: ADF test (5%)

	FDI	CPI	GDP	HC	DI	ICT	FD	PI	DEBT	DEFICIT
H	1	1	1	1	1	1	1	1	1	1
Test statistic	-5.8442	-9.2195	-18.3971	-17.1746	-9.2195	-15.4561	-15.5308	-9.2195	-8.1490	-4.1226
P-value	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}

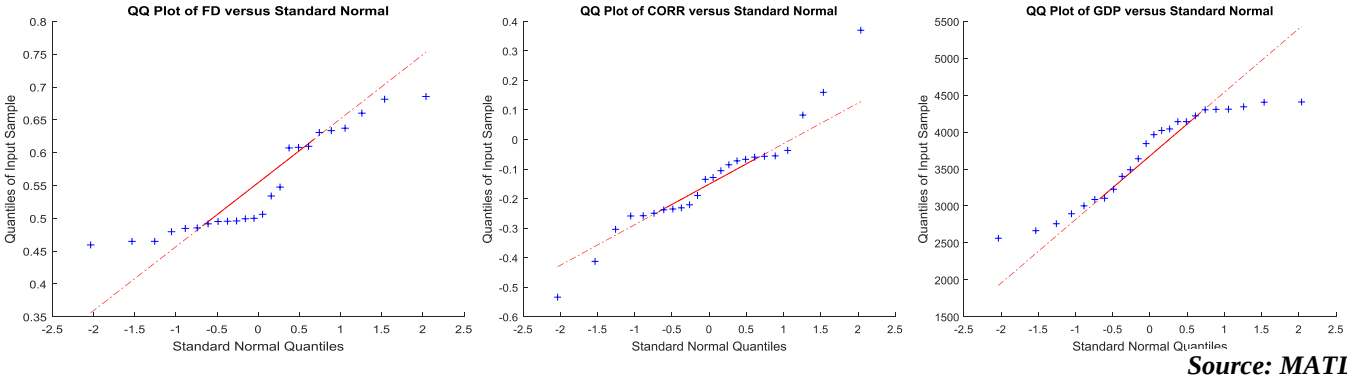
Source: MATLAB Software

Table 2 reports the results for the ADF test. According to these results, the P-value for all variables is lower than 0.05 which prove that all series are stationary.

2.2.2. Normality testing

It is rare that time series exhibit normal distribution. Thus, it is important to know that not everything could be modelled under the normal distribution. It is then crucial, for every researcher to verify if the used data is normal or other distribution are indeed more convenient. For this purpose , we use the most common graphical tool which the QQ-plot against the Gaussian distribution as well as the JB test to give more precise results and verify our intention.

A. Graphical approach



Source: MATLAB Software

Figure6: QQ plots of GDP, FDI and CPI versus the normal distribution

5H=0: indicates rejection of the unit root in favor of the alternative model
H=1: indicates failure to reject the unit root null.

According to QQ plots6 (**figure 6**) , there is a deviation from the straight line in the tails, proving that the distribution is more heavy-tailed than the normal distribution.

B. Jarque-Bera (JB) test

This test is based on the skewness and the kurtosis to construct the JB test statistic. Under the null hypothesis , the data is normally distributed , while the alternative is the non normality. This test confirms results obtained above (p-value<0.05). Therefore, our distributions are beyond being normal.

Table 3: JB test (5%)

	FDI	CPI	GDP	HC	DI	INFR	FD	PI	DEBT	DEFICIT
H	1	1	1	1	1	1	1	1	1	1
Test statistic	19.9800	335.9711	5488.3	3865.5	3865.5	2559.6	2565.2	1737.3	336.221	53.0175
P-value	0.0035	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}

Source: MATLAB Software

2.2.3. Kolmogorov-Smirnov test

Referring to the descriptive statistics, there is an excess of Kurtosis and non-null Skewness values for all the variables, accordingly, we expect to have a heavy tailed distributions. For this reason, we fit the marginal distributions of our return series to the t-distribution, which is characterized by its fat tails compared to the normal distribution. Basing on KS tes[7]8, we test whether our series are Student's t-distributed.

Table 4: Kolmogorov-Smirnov (KS) test

	Normal			Student			
	H	**P**	**KSstat**	**H**	**P**	ϑ	**KSstat**
GDP	1	0	0.4753	0	0.5816	3.13762	0.0133
FDI	1	0	0.4741	0	0.1080	3.06749	0.0208
CPI	1	0	0.4780	0	0.6866	2.896	0.0123
HC	1	0	0.4750	0	0.2700	3.12469	0.0172
DI	1	0	0.4764	0	0.2068	4.06104	0.0183
ICT	1	0	0.4797	0	0.2929	3.60029	0.0168

[7] The null hypothesis is that the distribution of the return series comes from the specific distribution object of test and under the alternative hypothesis, the distribution of returns is different from the distribution object of test.

FD	1	0	0.4687	0	0.3504	3.61616	0.0160
PI	1	0	0.4769	0	0.1579	3.46661	0.0194
DEBT	1	0	0.4528	0	0.2543	2.51456	0.0424
DEFICIT	1	0	0.4478	0	0.1895	2.45879	0.0351

Source: MATLAB Software

As reported in **table 4**, the null hypothesis is accepted for all the variables. Indeed, the Student's t-distribution is more appropriate to describe our time series.

2.2.4. Autocorrelation testing

We use the Ljung-Box test (LB test) to examine the existence of the autocorrelation. Under the null hypothesis , the data does not exhibit autocorrelation versus the alternative of the presence of autocorrelation.

Table 5: LB test (5%)

	FDI	**CPI**	**GDP**	**HC**	**DI**	**ICT**	**FD**	**PI**	**DEBT**	**DEFICIT**
H	1	1	1	1	0	0	0	0	0	1
Test Statistic	112.1950	38.7260	37.8351	35.0878	12.2527	24.8332	25.1701	15.3584	17.4093	133.9006
P-Value	7.7716e-15	0.0072	0.0093	0.0196	0.9071	0.2079	0.1950	0.7555	0.6263	0

Source: MATLAB Software

The results from **Table 5** show that FDI, CPI, GDP, HC and DEFICIT are autocorrelated with the absence of autocorrelation for the other residual of returns.

2.2.5. ARCH effects testing

ARCH effect can be tested by several methods and the conventional one is the ARCH Langrange Multiplier (ARCH-LM) test. In this test, the null hypothesis is the absence of ARCH effect, while under the alternative there is an ARCH effect.

Table 6: ARCH test (5%)

	FDI	**CPI**	**GDP**	**HC**	**DI**	**ICT**	**FD**	**PI**	**DEBT**	**DEFICIT**
H	1	0	1	1	1	1	1	0	1	1
Test Statistic	6.0675	0.7156	18.018	23.826	20.732	21.015	28.054	0.153	8.480	12.382
P-Value	0.0138	0.3976	2.187e-05	1.054e-06	5.280e-06	4.556e-06	1.179e-07	0.695	0.003	4.3347-04

Source: MATLAB Software

The results of the LM test reported in **Table 6**, show the rejection of the null hypothesis for all variables (P-value < 0.05) except for CPI and PI, which confirm the existing of volatility clustering phenomenon.

2.2.6. GARCH Filter

As it is shown in our results, our time series present autocorrelation and ARCH effect. Thus, it is crucial to fit our returns series to deal with the autocorrelation and conditional heteroskedasticity to model our interdependence between different series with copula .To this end, we must choose as a first step the most appropriate model to correct and model the conditional heteroskedasticity and filter the log negative returns and get i.i.d residuals. A basic AR (1)-GARCH (1,1), AR (1)-EGARCH (1,1) and AR (1)-GJR-GARCH (1,1) models with Student-t error terms, are employed in our study as they are the most common used to describe time series through literature. For each variable, we compare the information criteria of these models and select the one that present the minimum AIC and BIC values.

Table 7: information criteria for GARCH models

	GARCH		**EGARCH**		**GJR-GARCH**	
	BIC	**AIC**	**BIC**	**AIC**	**BIC**	**AIC**
GDP	-376.9487	-381.8805	**-416.7140**	**-426.5776**	-374.3140	-381.7118
FDI	-28.5783	-35.9760	**-30.3032**	**-40.1668**	-25.7495	-35.6132
HC	-394.1368	-399.0686	-415.3712	-425.2348	**-419.0808**	**-428.9444**
DI	-329.5259	-334.4577	**-327.0238**	**-336.8874**	-328.0947	-335.4924
ICT	-350.2099	-357.6076	**-372.8405**	**-382.7042**	-363.8975	-373.7611
FD	-378.3399	-384.0860	-362.8436	-372.7073	**-379.1541**	**-388.2035**
DEBT	-300.9665	-308.3643	**-342.8834**	**-352.7470**	-301.8473	-311.7109
DEFICIT	-135.9096	-143.3074	**-137.4013**	**-147.2649**	-135.0914	-144.9550

Source: MATLAB Software

According to this table, all the variables are described by EGARCH process except for HC and FD which are described by GJR-GARCH model.

Table 8: GARCH Estimation

	C*(10^{-4})	**AR(1)**	**K**	α	β	v
GDP	8.78645	0.850684**	-7.9098	1*	0.17991	-0.597383
FDI	64.322	0.701618*	-1.13732	1*	0.728542	-0.0367568
CPI	0.0006e-04	2.28346e-10*	-	-	-	-
HC	11.0587	0.817653*	1.33081e-05	0.7854123*	0.00264477	-0.00528994
DI	-3.9685	0.702297*	-4.15572	1*	0.45776	-0.093855
ICT	-0.5513	0.946263*	-2.80299	1	0.637167	0.374748

FD	11.9707	0.901474*	6.36085e-06	0.71014*	0.0102323	-0.0204649
PI	0.002951	2.37935e-07*	-	-	-	-
DEBT	5.05907	0.982543*	-1.8342	1*	0.794006	-0.393732
DEFICIT	-5.6854	0.815717*	-1.12298	1	0.799232	0.0242359

Source: MATLAB Software

The **Table 8** reports results for the GARCH estimation for all variables under study. As it is shown, AR(1) coefficients are statistically significant for all the series. The α coefficients which measure the adjustment to past shocks are significant for all series except for ICT. Moreover, the β coefficient which measure the volatility persistence of the process are approximately high and significant for all series which indicates that the conditional volatility is persistent over time and past-dependent. The insignificant estimate of δ (leverage effect) suggests that good news and bad news do not exert different effects on GDP, FDI , DI, ICT, HC , FD and DEFICIT volatilities. For DEBT, this coefficient is negative and statistically significant indicating that negative shocks generate higher volatility than positive shocks of the same magnitude. For HC and FD which are modeled by GJR-GARCH, the stationarity condition is guaranteed since the sum of the α and β of each variable is less than one.

3 The effect of Corruption and FDI on economic growth

In this part, our main purpose is to measure the degree of interdependence among economic growth, corruption and FDI in the Tunisian context. To this end, we use a flexible technique which is the copula framework. Indeed, the use of this theory is useful since it let us to study the dependence on average and the dependence in distress period. The dependence on average can be obtained by Kendall's tau or Spearman's rho which are calculated from copula parameters, while the dependence in extreme movements is given by the tail dependence coefficient of the copula. To this aim, we fit various copulas to the standardized residuals and we choose the most suitable one. Once we have chosen the appropriate copula we analyse in the first the dependence in normal periods and then the dependence in extreme periods.

Our database cover the Tunisian Revolution of 2011, so we should better disaggregate the data into full sample and sub-periods in order to provide more in-depth analysis of the inter-linkage between these variables during the pre-revolution[9] and the post-revolution[10] period.

We note that the Corruption Perception Index (CPI) ranges from 0 to 10, where 0 indicates high level of corruption and 10 indicates less level of corruption into the country. Indeed, a positive dependence between CPI and GDP means that economic growth increases as the level of corruption decreases, thus corruption hurts economic growth[11].

3.1. Bivariate dependence on average

In this part, we are seeking to analyse the dependence structure between economic growth, corruption and FDI using bivariate joint distribution. To this end, we use the dependence on average provided by the copula. Having a general idea of the dependence structure is important. This general view is given by establishing a graphical tool that is the scatter plot between each pair.

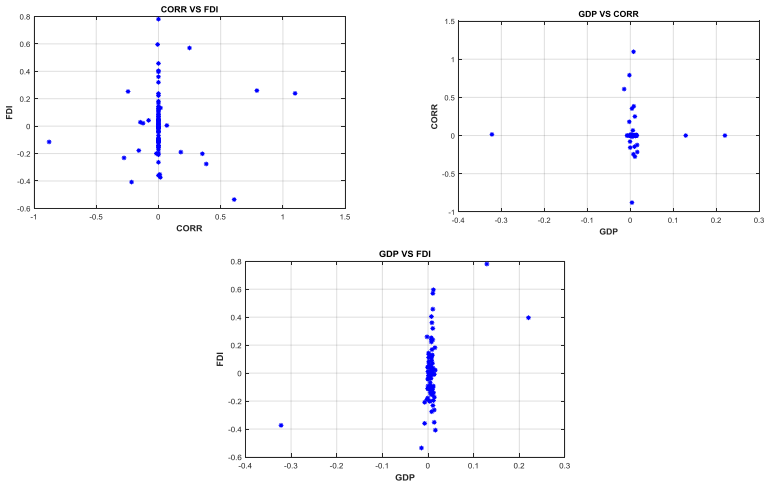


Figure 6: Scatter plots of CPI-FDI, GDP-CPI and FDI-GDP

Source: MATLAB Software

The **Figure 7** shows that the dependence structure between the pairs is ambiguous and not very clear. However, since the dots are roughly plotted in the middle on the chart, we can say that the dependence between these pairs is small

[9] From 1996 to 2010
[10] From 2011 to 2019
[11] Similarly for FDI.

3.1.1. Dependence measures

A. Pearson correlation

Table 9: Pearson correlation matrix

	Overall period			Pre-revolution			Post-revolution		
	GDP	**FDI**	**CPI**	**GDP**	**FDI**	**CPI**	**GDP**	**FDI**	**CPI**
GDP	1	0.3883	-0.0926	1	0.4342	-0.1733	1	0.7220	0.1390
FDI		1	0.1649		1	-0.0735		1	0.2385
CPI			1			1			1

Source: MATLAB Software

Table 9 displays the Pearson correlation matrix for GDP, FDI and CPI. During all the periods, the correlation coefficient between GDP and FDI point out that there exists a significant co-movement between these two variables. However, CPI and GDP present a negative relationship during the full sample and the pre-revolution and positive relationship after the revolution. Furthermore, we find that FDI varies positively with CPI especially after the revolution and negatively before the revolution.

However, the linear correlation is not an authentic measure. For this reason, we need to use more flexible tools such as the Spearman and Kendall correlations. flexible tools such as the Spearman and Kendall correlations.

B. Rank correlation

Table 10: Rank correlation

	Overall period		Pre-revolution		Post-revolution	
	Kendall	Spearman	Kendall	Spearman	Kendall	Spearman
GDP-FDI	0.1516	0.1959	0.0290	0.0270	0.4452	0.5665
GDP-CPI	0.0641	0.0741	0.0495	0.0581	0.0686	0.0748
CPI-FDI	0.0257	0.0285	-0.0129	-0.0293	-0.0108	-0.0064

Source: MATLAB Software

According to this table, Kendall and Spearman coefficients diverge in some cases with Pearson correlation. The reason is that the linear correlation requires linearity of the movement whereas the rank correlation overcomes this restriction. As we can see, for the overall period, both of Kendall and Spearman coefficients explore a positive correlation between GDP and FDI. These

findings are confirmed by those for the pre-revolution and post-revolution. The co-movement is however higher during the second sub period. On the other hand, we find that CPI is positively associated with GDP during all the periods. Somewhat surprisingly, we find a negative relationship between CPI and FDI during the two sub-periods. Unfortunately, these results are insufficient until we identify the appropriate fitting copulas to our data.

3.1.2. Fitting copula

Given the availability of the estimates of GARCH models, we turn to estimate copula functions for each pair and for all the periods using a Canonical Maximum Likelihood (CML) method. Indeed, as it is shown previously, our return data are exposed to autocorrelations and ARCH effects. For that, we consider the vector of standardized residuals from EGARCH and GJR-GARCH models (instead of the returns) and transform it into the vector of uniform variates using the ECDF.

Overall period						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.3348	0.2807	197.1489	1.7118	0.5553	1.2777
GDP-CPI	0.1457	0.1055	197.1535	0.5693	0.2053	1.1027
CPI-FDI	0.0176	0.0778	197.1535	0.3112	0.0227	1.0113
Pre-revolution						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.0201	0.1195	197.1527	0.1966	0.0259	1.0130
GDP-CPI	0.1826	0.0484	197.1529	0.6979	0.0992	1.0496
CPI-FDI	0.0377	0.0395	197.1527	0.3327	0.0492	1.0246
Post-revolution						
	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.7761	0.7367	2.4480	6.7533	2.6040	2.3020
GDP-CPI	-0.0742	0.0673	197.153	0.1109	0.2648	1.1324
CPI-FDI	-0.2847	0.0549	197.153	0.4852	0.4503	1.2252

Table 11: CML estimation of copulas parameters

Source: MATLAB Software

Table 11 reports the results for the parametric copula models described previously. As it is shown, almost the values of the copulas parameters during the second sub period are higher than those during the first sub period. By examining the Elliptical copulas during the all periods, the dependence parameter in the Gaussian copula is positive for all the considered pairs except for CPI-FDI and GDP-CPI during the second sub-period, where copula dependence coefficients are negative. For the Student-t Copula, the dependence parameter is positive between all the pairs and during all the periods. We notice the highest degree of freedom for the t-copula which indicates the fat tail for the distributions and confirms that the period chosen exhibit a high volatility and extreme movement. By considering asymmetric tail dependence given by the Archimedean copulas, the parameter estimates for the Clayton and Gumbel copulas reflect positive dependence between all the considered pairs. Similarly to the Elliptical copulas, the dependence parameters for the Frank copula give the same result.

3.1.3. Copula choice

Given that the studied copulas provide different interpretations, a question of high importance arises: Which copula to choose?. The decision rule is to choose the copula which maximises the log likelihood and minimises the AIC and BIC criterion.

Table 12: Results of the LL, AIC and BIC criterions (full sample)[12]

	Elliptical copulas					
	Gaussian			**Student-t**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	-7.6805	-13.3610	-10.8951	**+∞**	**−∞**	**−∞**
GDP-CPI	-0.1488	1.7024	4.1683	**+∞**	**−∞**	**−∞**
CPI-FDI	- 1.3548	-0.7096	1.7563	**+∞**	**−∞**	**−∞**

	Archimedean copulas								
	Gumbel			**Clayton**			**Frank**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	- 1.1671	-0.3342	2.1317	-3.0729	-4.1457	-1.6798	-3.1810	-4.3619	-1.8960
GDP-CPI	- 7.6153	-13.2306	-10.7647	-0.1258	1.7483	4.2142	-0.1112	1.7775	4.2434
CPI-FDI	- 2.5261	-3.0522	-0.5863	-1.4116	-0.8231	1.6428	-0.5083	0.9834	3.4493

Source: MATLAB Software

[12] Results of the LL, AIC and BIC criterions for the two sub-periods are contained in Appendix A. Table 23

In light of these results, the most appropriate copula for all pairs is the Student-t copula except for the pair GDP-FDI during the second sub period where the Gumbel copula is the most adequate to model the dependence structure. The use of these copulas enables us to detect the extreme movements which are well present in most series.

3.2. Bivariate dependence in extreme movements

Now, we assess the dependence structure in full sample and in Tunisia Revolution period. In the full sample, we analyse the dependence in times of extreme market movements obtained from tail dependence coefficients of the selected student-t copula. In the Tunisia Revolution sample, we re-estimate the different copulas models and then based on the tail dependences of the selected copulas we discuss the dependence structure of each pair.

3.2.1. Tail dependence of the Student-t copula

Table 13: Tail dependence (full sample)

	λ_L	λ_U
GDP-FDI	0	0
GDP-CPI	0	0
CPI-FDI	0	0

Source: MATLAB Software

Table 13 reports the values of the tail dependence coefficients of the Student-t copula. As we can see, the dependence structure between all pairs is symmetric in bear and bull markets since lower and upper tail dependence coefficients are exactly equal.

As we can see, the values of tail coefficients are equal to 0, suggesting that there is no tail dependence between our pairs, consequently, there is no co-movement neither during tranquil nor turbulent periods.

These findings seem to be illogical and contradictory with the evidence in the literature. Hence, we will further refine our results by taking into account an extraordinary sub period which is the Tunisian revolution (TR) that dates from 2011 to 2014.

3.2.2. The Tunisian revolution analysis

Now, we proceed with a less statistical and more arbitrary approach to deal with the dependence in extreme conditions. Thus we will identify and focus on periods of crises and high incertitude.We reproduce the same procedure explored previously. Results of CML estimation and information criterions presented below, are reported in tables 14 and 15 respectively.

Table 14: CML estimation of copulas parameters (TR)

	Gaussian	Student-t		Frank	Clayton	Gumbel
	ρ	ρ	ϑ	θ	θ	θ
GDP-FDI	0.7124	0.6384	0.7411	5.3837	2.0385	2.0192
GDP-CPI	0.1185	0.0959	197.1535	-0.0338	0.1635	1.0818
CPI-FDI	0.3855	0.1263	197.1535	1.7523	0.6737	1.3369

Source: MATLAB Software

Table 15: Results of the LL, AIC criterions (TR)

Elliptical copulas						
	Gaussian			**Student-t**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	32.0838	-62.1676	-61.4596	**40.3494**	**-78.6988**	**-77.9907**
GDP-CPI	0.5855	0.8289	1.5370	$+\infty$	$-\infty$	$-\infty$
CPI-FDI	0.3158	1.3685	2.0765	$+\infty$	$-\infty$	$-\infty$

Archimedean copulas									
	Gumbel			**Clayton**			**Frank**		
	LL	**AIC**	**BIC**	**LL**	**AIC**	**BIC**	**LL**	**AIC**	**BIC**
GDP-FDI	38.9039	-75.8078	-75.0997	3.5278	-5.0557	-4.3476	4.1359	-6.2719	-5.5638
GDP-CPI	6.1262	-10.2525	-9.5444	0.0519	1.8962	2.6043	3.3798e-04	1.9993	2.7074
CPI-FDI	10.8100	-19.6201	-18.9120	0.0845	1.8311	2.5391	0.0869	1.8262	2.5342

According to AIC and BIC criterions, the dependence structure are described by Student-t copula for all the pairs. Basing on this result, we compute the tail dependence of each pair.

Table 16: Tail dependence (TR)

	λ_L	λ_U
GDP-FDI	0.6066	0.6066
GDP-CPI	0	0
CPI-FDI	0	0

Source: MATLAB Software

Table 16 shows evidence that there is no co-movement between GDP-CPI and CPI-FDI during the post-revolution period if any shock happens. However, there is a meaningful impact of FDI on GDP. Indeed, a negative or positive shock leads the FDI to cause the economic growth of Tunisia. This finding is thus consistent with the view that high (low) level of FDI into a country leads to increase (reduce) the extreme dependence level of its economic growth.

3.3. Nonlinear Granger causality test

As it's shown, there is dependence between the variables under consideration. In order to further analyze the cause-effect relation, we use the nonlinear Granger causality test. Actually, this test has popularly been employed in the research fields of economic data **(e.g Chiou-Wei et al., 2008,Ye Lim and Mun Ho,2013, Munir and Ameer,2019).**

As we know, the linear Granger causality test is a measure of directional causation between two time series that assumes the linearity. To deal with this issue, it's more informative to use the nonlinear Granger causality test to explore the causal relationship. The BDS test proposed by **Broock et al. (1996)** was employed on the residuals to justify the existence of the non-linearity of the variables. Results of this test was provided in **table 17**.

Table 17: BDS test results

	Dimension				
	2	**3**	**4**	**5**	**6**
GDP	6.0064*	5.4775*	5.0175*	4.6367*	4.3497*
FDI	5.1723*	5.1474*	5.7298*	6.2829*	6.5065*
CPI	2.3062*	3.3756*	3.4197*	2.0858*	1.399

*Indicates the rejection of the BDS null hypothesis at the 5% level of significance.

Source: R Software

In light of these results, the null hypothesis of i.i.d. is rejected at 5% level of significance across various dimensions. Indeed, the phenomenon of nonlinearity exists in the residuals and therefore using the linear Granger causality test may lead to misspecification.

We proceed then to the nonlinear test by modeling each variable via AR (1)-EGARCH (1,1) and AR (1)-GJR-GARCH(1,1)in which standardized residuals follow Student's t-distribution. Obtained values of F-test are presented in table below. As it is observed, the relationship between FDI and GDP is bidirectional which suggests that FDI plays a considerable role in boosting economic growth of Tunisia confirming the FDI-led growth hypothesis. Moreover,

results support also the Growth-driven FDI hypothesis, thus economic growth contributes to attract foreign investors. On the other hand, we find a unidirectional causality from CPI to economic growth which implies that an increase of the level of corruption leads to a decrease of the GDP per capita. However, GDP does not granger cause corruption which is in contrast with results reported by **Queshi et al. (2020)**. On the other hand, a unidirectional causality was perceived from CPI to FDI. In other words, an increase of the level of corruption in Tunisia may discourage foreign investments. This is because international investors hesitate to invest in an economy where there is a high level of corruption. The findings are in line with the study by **Anwar and Sun (2011), and Queshi et al. (2020).**

Table 18: Nonlinear Granger causality test results

	Direction					
	GDP⇨FDI	**FDI⇨GDP**	**GDP⇨CPI**	**CPI⇨GDP**	**CPI⇨FDI**	**FDI⇨CPI**
F-statistic*	9.09808	2.02265	0.530202	11.1893	3.58014	1.61017
P-value	2.77712 e-09	0.04434	0.862827	5.90491e-11	0.00076197	0.122734

*The critical value at 5% of risk: 1.975

Source: R Software

3.4. Discussion

Empirical findings show evidence that FDI acts as a stimulus for growth. Thus, when FDI rises, GDP per capita should be seen growing. Furthermore, through the granger causality test, we find that economic growth is recognized as a determinant for attracting multinational firms. A growing market can be attractive to foreign investors because it leads to an increase in the aggregate demand and offers the opportunity to benefit from economies of scale **(Zhang, 2001).** So, policymakers should take several measures in order to prioritize foreign direct investment as a key component of its development plan. Attracting FDI will generate benefits to the Tunisian economy and leads consequently to attract FDI further. This positive impact can be transmitted indirectly by different channels which will be discussed afterward.

The relationship between FDI and economic growth is higher during the post-revolutionary period compared to the pre-revolutionary period. This result is explained by the deterioration of the economic situation and the climate of insecurity and instability that characterized Tunisia during the post-revolutionary period which affected significantly the GDP as well as the FDI

especially in 2011. Indeed, in this year, the GDP per capita growth rate reached -2.89%, the FDI decreased by -68.8% and more than 80 foreign firms left the country. Furthermore, on average the GDP growth rate is estimated at 3.5% before the revolution compared to 0.7% after the revolution. Also, the FDI growth rate is on average 32.7% before the revolution compared to 18.84% after the revolution.

The obtained results reveal also that corruption is directly and negatively associated with economic growth especially after the revolution compared to the pre-revolution period. As a consequence, Tunisian government has tools at hand to promote economic growth. Indeed, they should undertake numerous measures to fight against corruption. This negative impact could be translated indirectly via transmission channels. Therefore, to better understand this effect, we investigate and identify in the next part the main mechanisms through which corruption affects negatively economic growth.

Somewhat surprisingly, we find a negative relationship between CPI and FDI during the two sub-periods. Such discovery is similar to **Eggera and Winnershow (2005), Castro and Nunes (2013**) and **Helmy (2013)**. In this regard, different explications of this unexpected result. First, GDP per capita prove to be positively correlated with FDI in Tunisia. This finding implies that income or wealth is an important factor that instigates FDI in Tunisia as elsewhere and has a greater impact than corruption. Therefore, an increase of the GDP or another determinant of FDI, increases FDI even if corruption rises. Another explication supported by **Helmy (2013)** is that, given that corruption can be viewed as a means of economic expansion by overcoming restrictive laws, so that the benefits generated by FDI exceeds the costs supported by corruption.

Apart from dependence on average, we have turned to assess the dependence structure in times of extreme market conditions. Results indicate that there is no tail dependence neither during bearish nor during bullish periods. Such illogical result inspired us to focus on the period of high incertitude which is the post-Tunisian revolution period dated from 2011 to 2014. Our findings reveal that there is a significant impact of FDI on GDP. Indeed, a negative shock affects the economic growth of Tunisia. This finding is thus consistent with the view that low level of FDI into a country decreases the extreme dependence level of its economic growth.

4 Indirect effects of Corruption and FDI: transmission channels

In this part, we investigate the channels through which corruption and FDI affect economic growth. To this aim, we use the vine copula (C-vine and D-vine) approach that describes with

more flexibly the multivariate dependence structure between each channel (PI, FDI, DEFICIT, DEBT), corruption and economic growth on one hand and between each channel (DI, HC, FD, ICT), FDI and economic growth on the other hand. Following **Dissmann et al. (2013)**, we apply the sequential procedure to firstly specify the appropriate vine structure (the order of the variables) for our data which can be done using the empirical Kendall's tau. Then, for a given C-vine and D-vine structure, we select the adequate pair-copulas from a range of different copula specifications considering the lowest Akaike information criteria (AIC) and, in the next step, copulas are estimated sequentially using the maximum likelihood estimation (MLE) to obtain the initial value for the vine copula that will be finally taken into account to estimate the final parameters of the pair copulas. Finally, we select the appropriate vine model (C-vine or D-vine) for each channel to analyse whether it serves as a source of indirect effect of corruption/FDI on economic growth.

4.1. Constructing Vine copulas

4.1.1. Structure selection

In order to specify the order of the variables, we calculate the empirical Kendall's tau for all the considered pairs and select the variable which has the sum of the absolute value of all Kendall's tau maximized. **Table 19** provides the empirical Kendall's tau matrix and the sum of their absolute values. The orders should be the following: for DEBT: DEBT (order 1), GDP (order 2), CPI (order 3). For PI: CPI (order1), GDP (order2), PI (order3). For DEFICIT: DEFICIT (order1), CPI (order2), GDP (order3). For FDI: GDP (order 1), FDI (order 2), CPI (order 3). For DI: DI (order 1), GDP (order 2), FDI (order 3). For FD and HC: GDP (order 1), transmission channel (order 2), FDI (order 3). For ICT: GDP (order 1), FDI (order 2), ICT (order 3).

Table 19: Empirical Kendall's tau matrix for PI and DI[13]

	GDP	**CPI**	**PI**
GDP	1	0.06413923	-0.03110307
CPI	0.06413923	1	-0.04713488
PI	-0.03110307	-0.04713488	1
Sum	1,0952423	1,11127411	1,07823795
	GDP	**FDI**	**DI**
GDP	1	0.1515638	0.3964181
FDI	0.1515638	1	0.3541834
DI	0.3964181	0.3541834	1
Sum	1,5479819	1,5057472	1,7506015

Source: R Software

[13] The Empirical Kendall's tau matrices for the rest of channels are contained in Appendix A. Table 24

4.1.2. Building Blocks and Parameter estimation

Following the process of parameter estimation for the vine copula, we conduct first the sequential MLE in order to obtain the initial value for the C-vine and D-vine copulas. The selected copula for each pair of variables in the sequential estimation is the one which has the lowest AIC. Second, taking the initial value from the first step, we apply the MLE in order to estimate the final parameters of the pair-copulas.

Table 20-21 report, respectively, the parameter estimation of the C-vine and D-vine for Political Instability and Domestic Investment.

Table 20: Results of estimated parameters for the C-vine copula[14]

DI							
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Joe-Clayton	0.45	1.28	1.40	0.28	0.61
	$\boldsymbol{C_{1,3}}$	Gumbel	0.37	1.59	0.00	0.45	-
2	$\boldsymbol{C_{2,3\|1}}$	Clayton	0.07	0.15	0.00	-	0.01

PI							
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.06	0.10	2.8	0.15	0.15
	$\boldsymbol{C_{1,3}}$	Student's t	-0.76	-0.93	2.0	0.00	0.00
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	-0.03	-0.05	30.0	0.00	0.00

Source: R Software

Tableau 21: Results of estimated parameters for the D-vine copula[15]

PI							
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.06	0.10	2.83	0.15	0.15
	$\boldsymbol{C_{2,3}}$	Student's t	-0.03	-0.05	2.98	0.10	0.10
2	$\boldsymbol{C_{1,3\|2}}$	Student's t	-0.77	0.93	2.00	0.77	0.77

DI							
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Joe-Clayton	0.45	1.28	1.40	0.28	0.61
	$\boldsymbol{C_{2,3}}$	Student's t	0.12	0.18	2.00	0.25	0.25
2	$\boldsymbol{C_{1,3\|2}}$	survival Gumbel	0.30	1.44	0.00	-	0.38

$C_{i,j}$Copula between variable ordered i and variable ordered j

Source: R Software

$C_{i,j|k}$Copula between variable ordered i and variable ordered j given variable ordered k

[14] Results of estimated parameters for the C-vine for the rest of channels are contained in Appendix A Tables 25-26

[15] Results of estimated parameters for the D-vine for the rest of channels are contained in Appendix A. Tables 27-28

τ is the Kendall's tau of the specified copula, θ is the copula parameter and ϑ is the degree of freedom.

From the C-vine and D-vine copulas estimation results, we observe that there is a predominance of the student-t copula for many pairs.

4.1.3. Vine model selection

We select the best vine copula that fits our data using the LL, AIC and BIC criterions. From the results provided in **Table 22**, we find that the C-vine structure for DEBT and HC is more appropriate than the D-Vine, whereas the latter is more suitable than the former for rest of the channels.

Table 22: Vine copula model selection

Channel	Criterion	C-vine	D-vine	Choice
FDI	LL	20.08	21.54	D-vine
	AIC	-28.16	-31.08	
	BIC	-13.36	-16.28	
PI	LL	48.86	50.21	D-vine
	AIC	-85.71	-88.43	
	BIC	-70.92	-73.63	
DEBT	LL	22.95	21.81	C-vine
	AIC	-35.89	-33.62	
	BIC	-23.56	-19.77	
DEFICIT	LL	9.97	11.49	D-vine
	AIC	-7.94	-12.97	
	BIC	6.86	-0.64	
HC	LL	28.47	28.13	C-vine
	AIC	-44.93	-44.27	
	BIC	-30.14	-29.47	
DI	LL	43.54	46.27	D-vine
	AIC	-79.09	-82.55	
	BIC	-69.22	-70.22	
ICT	LL	13.67	13.88	D-vine
	AIC	-15.33	-15.76	
	BIC	-0.54	-0.96	
FD	LL	26.36	26.76	D-vine
	AIC	-43.52	-44.71	
	BIC	-31.19	-34.85	

Source: R Software

After estimating and selecting the appropriate vine model for each channel, we plot the tree structure of our vine copula models that give us a clear vision about the nexus between each channel, corruption or/FDI and economic growth. Figures below represent the hierarchical trees of the vine copulas for each of the channels. The selected copulas and their estimated dependence given by Kendall's tau are contained in these figures.

4.2. Results analysis

4.2.1. Indirect effect of Corruption

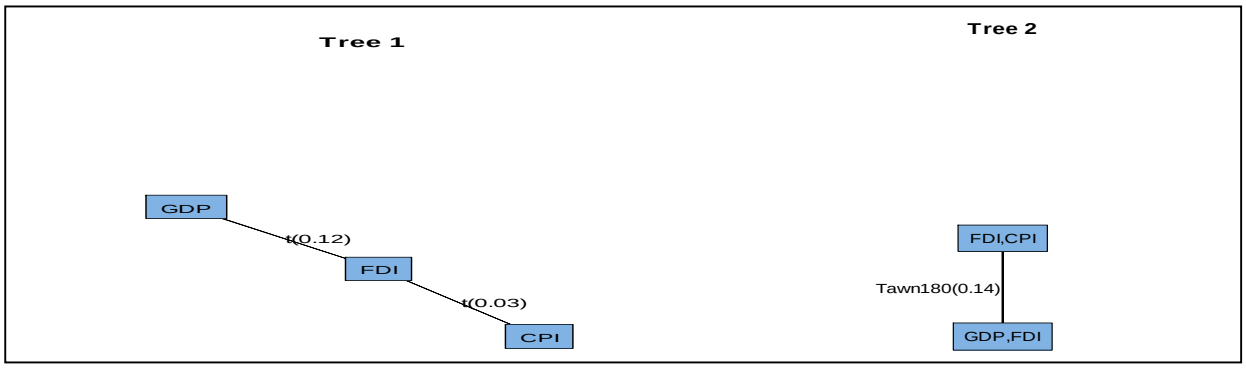
A. Political instability

Figure 7: D-vine trees for CPI , PI and GDP

Source: R Software

The first tree shows symmetric upper and lower tail dependence between all pairs indicating similar dependence during upward and downward periods. In addition, a negative relationship was found between PI and GDP with a Kendall's tau value of -0.03. This result is consistent with previous empirical literature on the determinants of economic growth which has argued for a negative impact of political instability **(Alesina et al., 1992; Jong-A-Pin, 2006; Kaplan and Akçoraoğlu, 2017).** An unstable political system of Tunisia could hamper economic progress. Taking the second tree, we find a strong negative dependence on average (-0.77) as well as during extreme conditions (0.77) between CPI and PI conditional on GDP. As a result, we can conclude that an increase of corruption (a decrease of CPI) is likely to lower economic growth through its positive effect on political instability.

B. Foreign Direct Investment



Source: R Software

Figure 8: D-vine trees for CPI, FDI and GDP

In the first tree, we observe a positive dependence on average between the two pairs GDP-CPI and CPI-FDI .Taking the second tree, we see a positive dependence on average with lower tail in dependence given by the Rotated Tawn 2 copula between CPI and GDP conditional on FDI .As a result corruption indirectly decreases economic growth by lowering FDI because international investors hesitate to invest in an economy where there is a high level of corruption. This result is consistent with study of **Gründler and Potrafke (2019)** who find that FDI is an important variable through which corruption is likely to influence negatively economic growth.

C. Public Debt

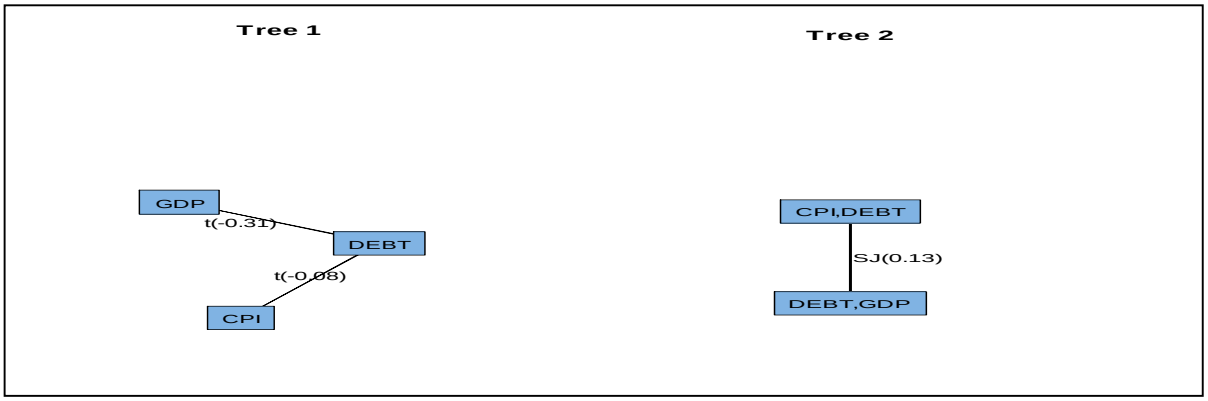


Figure 9: C-vine trees for CPI, DEBT and GDP

Source: R Software

Regarding the first tree, we observe a negative dependence on average between GDP and DEBT (-0.31) as well as between CPI and Debt (-0.08) . These results suggest that an increase of the level of public debt leads to a decrease of GDP.. This can be explained by the fact that the Tunisian government borrows to meet its commitments and not to stimulate investment and growth. Furthermore, an increase of the public debt can affect prices by rising inflation, creating uncertainty and macroeconomic instability which consequently reduces the growth. In this context, **Abdelkafi (2018)** assumed that an increase of the level of public debt has a significant negative impact on monetary policy and growth in Tunisia. Moreover, we find that an increase of corruption (a decrease of CPI) raises the amount of public debt. Moving to the second tree, we find a positive dependence on average between CPI and GDP conditional on DEBT. Thus, public debt may be considered as a channel through which corruption affects economic growth.

D. Budget Deficit

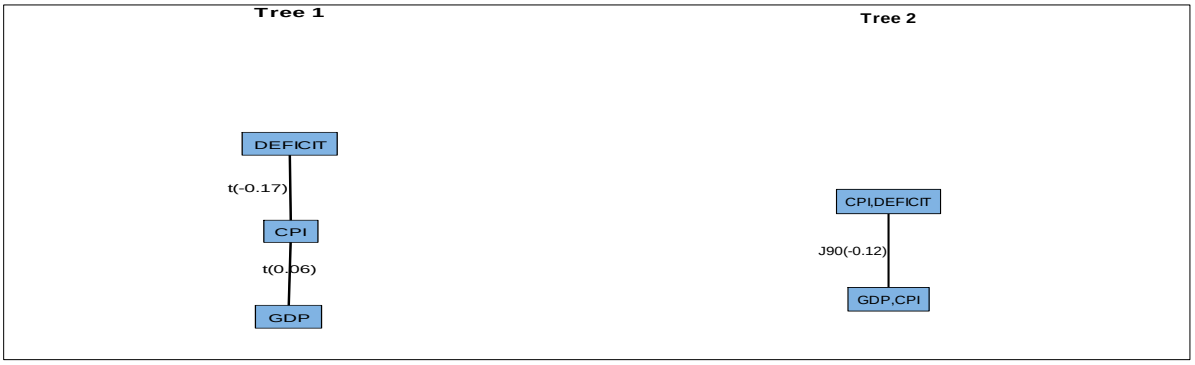
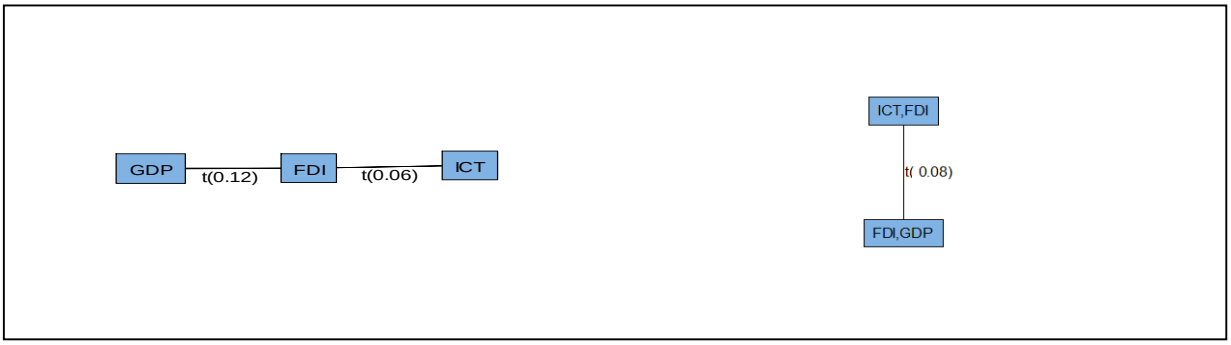


Figure 10: d-vine trees for CPI , DEFICIT and GDP ***Source: R Software***

In the first tree, we observe a negative dependence on average between CPI and DEFICIT (-0.17) suggesting that a higher level of corruption is associated with a higher budget deficit . We observe also a positive dependence between GDP and CPI (0.06). In the second tree, we find a negative dependence on average between GDP and DEFICIT conditional on CPI (-0.12) implying that the negative effect of DEFICIT on economic growth is dependent upon the positive effect of corruption on DEFICIT. According to these results, we can conclude that corruption contributes to reduce economic growth through its positive impact on budget deficit.

4.2.2. Indirect effects of FDI

A. Technology transfer



Source: R Software

Figure 11: D-vine trees for FDI , ICT and GDP

Taking the first tree, we observe a positive dependence between GDP and FDI (0.12) and between FDI and ICT (0.06). Regarding the second tree, there a positive dependence between GDP and ICT conditional on FDI. Thus, FDI contributes to improve economic growth through transfer of technology.

B. Domestic Investment

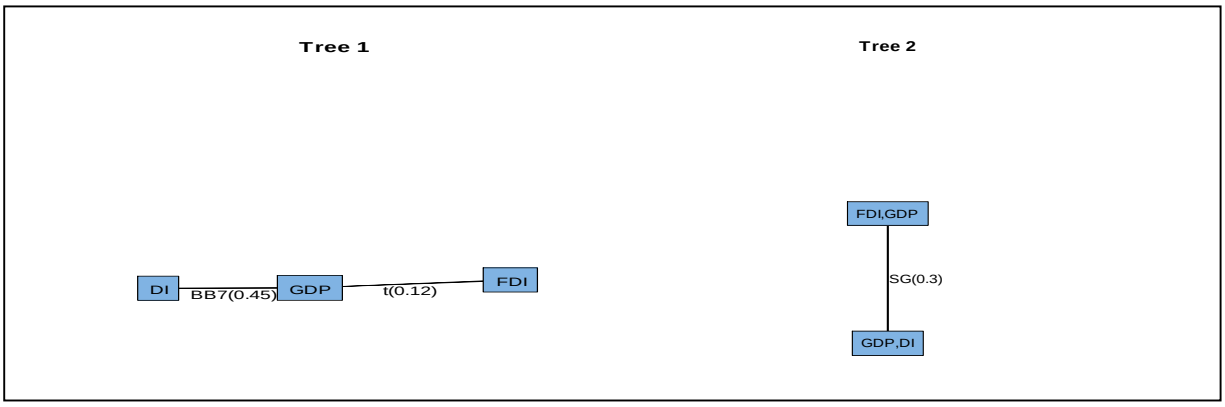


Figure 12: D-vine trees for FDI , DI and GDP

Source: R Software

According to the first tree, there is a positive impact of FDI and DI on GDP with Kendall's tau values of 0.12 and 0.45 respectively. In addition, GDP and DI are highly dependent in the upper tail and the strength of the dependence given by Joe-Clayton copula is 0.61.Therefore, domestic investment generate a lot of benefits for the growth. This result is in contrast with **Mkadmi et al. (2021)** who find that this relationship is negative. However , results of **Bouchoucha and Bakari (2019)** show that domestic investment affects economic growth in Tunisia only in the short-run The second tree shows a positive dependence on average between FDI and DI conditional on GDP, thus confirming the crowding in effect which supports the view that domestic firms can benefit from the new technologies derived from multinational firms. Furthermore, basing on these positive dependences, FDI promotes economic growth through its indirect positive effect on domestic investment.

C. Human Capital

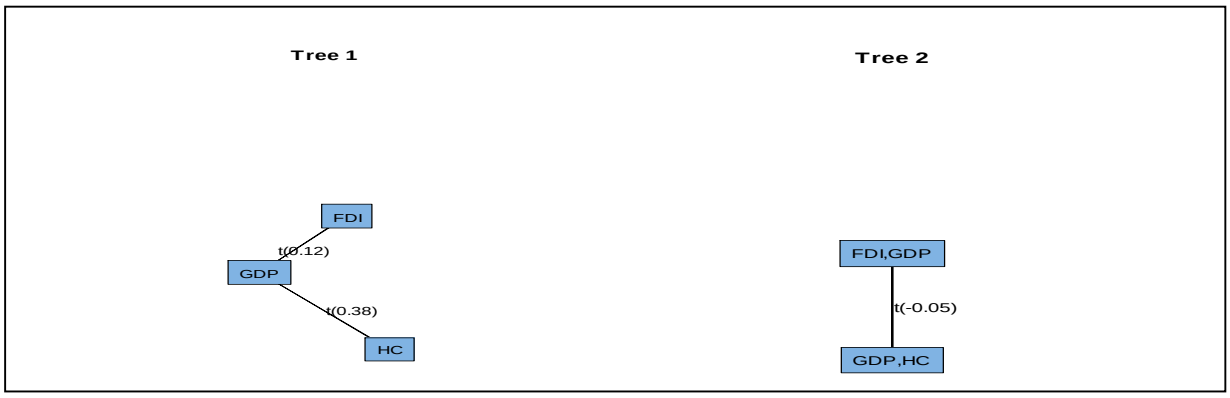


Figure 13: C-vine trees for FDI , HC and GDP

Source: R Software

The first tree indicates a strong positive relationship between HC and GDP (0.38). Indeed, human capital can help to promote economic growth by improving knowledge and skills of

people. We observe also a positive dependence between FDI and GDP. Somewhat surprisingly , we find in the second tree a weak negative dependence on average between HC and FDI conditional on GDP. Although theory predicts that FDI affects positively human capital, empirical studies on this hypothesis do not reach consensus. For instance, basing on Lloyd's[16] (1996) explication, the majority of FDI in Tunisia was allocated to industry, followed by energy and services. Skill levels are relatively low in these sectors and the demand for lower-skilled labor may not have a positive effect on tertiary schooling.

D. Financial Development

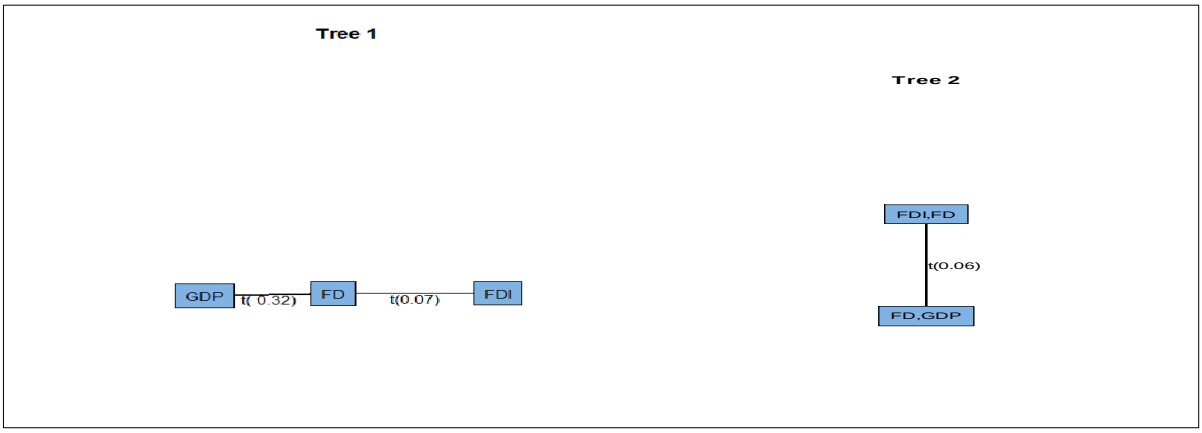


Figure 14: D-vine trees for FDI , FD and GDP

Source: R Software

The first tree indicates a strong positive dependence on average between GDP and FD (0.32) which is in line with the previous empirical studies **(Ghali. KH, 2008, Shan and Qi, 2006).** Hence, FD plays an important role in driving economic growth. Such discovery is consistent with **Ben Jedidia et al. (2014)**'s findings that show that domestic credit to private sector exerts positive impact on Tunisia economic growth. A positive dependence was also observed between FD and FDI with kendall'tau value of 0.07. The second tree shows that there is a weak positive dependence between FDI and GDP conditional on FD. Hence, financial development is considered as a channel through which FDI affects positively economic growth.

4.3. Discussion

Our findings are in line with previous empirical literature on the determinants of economic growth that have supported a positive effect of financial development, investment ,

[16] Lloyd (1996) documents that "FDI (in East Asia) is predominantly in the manufacturing and service sectors."

human capital and technological advancement on economic growth and, on the other hand, a negative impact of political instability public debt and budget deficit.

In addition, our results reveal that:

- Corruption hurts economic growth mainly through its detrimental impacts on political instability. As documented by **Mulloy (1999),** corruption "challenges the popular legitimacy of democratic institutions, and it feeds political instability and the violence that can flow from it". For **Bardhan (1997)**, political discontent is fueled by the belief that governments and public servant are corrupt, and this discontent allows political violence to flourish. According to **Mo (2001),** corruption contributes to political instability by increasing income inequality. On the other hand, empirical results show also that during extreme conditions, there is a significant negative effect of corruption on growth through political instability. This is obviously due to the revolution period where Tunisia has experienced a policy transition which affects the stability of the country and creates uncertainties. Indeed, in 2011, the CPI has marked a significant decrease in its history to reach 3,8.

- An increase of level of corruption reduces the impact of FDI on economic growth, suggesting that the presence of strong institution quality and regulatory mechanism have an impact in attracting foreign investors. In this context, **Hamdi and Hakimi (2019)** assume that corruption may be the main reason for the downturn of investment activities in Tunisia. Therefore, even if we find that FDI exerts positive effect on growth, these effects could be more important if corruption is lower.

- Public debt and budget deficit constitute as channels through which corruption adversely affects economic growth. Hence, corruption was an issue that contributes to an increase of the level of public debt and budget deficit in Tunisia. Indeed, corruption is a conductive of the accumulation of larger public debt and budget deficit because it leads to an increase of public expenditures and a decrease of public revenues through tax evasion. These findings are consistent with results obtained by **Kim et al. (2017).**

- According to empirical literature such as **Kallal et al. (2020),** in terms of ICT use and diffusion, developing countries are still behind developed countries. Therefore, it is crucial for them, to turn toward FDI aiming to attract ICT. Our findings suggest that FDI located in Tunisia represents one of the generating resources of technology transfer. This brings an important advantage to the economic growth of Tunisia through the transfer of a new

technology for a country that seeks to develop. Such finding is in line with those reported by **Zenasni and Benhabib (2013*)*.** Furthermore, according to FIPA, investments are increasingly specializing in information and communication technology sectors.

- FDI contributes to boost economic growth by bringing positive impact to domestic investment. Multinational firms stimulate rather than crowd out local firms. More precisely, the presence of foreign investment on the Tunisian market allows feed the local market through the advantageous competition, pushing local firms to higher productivity. This positive effect may occur through several factors, such as the contribution to the productive efficiency, the integration of the new technologies, the transmission of the techniques of control and quality, the improvement of their management and the adaptation of the best strategies of marketing.

- FDI exerts positive externalities on banking sector by improving the monetary availability of banks, which allows them to grant more credit. Indeed, financial development through bank credit improves the positive impact of FDI on growth in Tunisia. An increase of the level of financial development will contribute in attracting FDI further as the technological spillovers to domestic firms and the diffusion process are more effective when the financial sector of the host economy is more developed **(Fauzel, 2016)** . **Alfaro et al. (2004**) and **Azman-Saini et al. (2010)** found evidence that financial development is an important precondition for FDI to have a significant impact on economic growth. However, in this study, we specify only banking sector to measure financial development and we ignore the stock market which suffers from narrowness.

- Attracting FDI into the country will not contribute to increase the quality of human resources yet the latter improves perfectly the country's economic growth. Indeed, FDI in Tunisia is predominantly in sectors that not require skilled labor, thus FDI is not expected to have a positive impact on tertiary school enrollment rate. Such result do not validate those of **Abdouli and Omri (2020)** who find a unidirectional causal running from FDI to human capital in Tunisia. In this regard, it is important to note that they include also secondary enrollment rate to measure human capital.

5 Conclusion

The main objective of this chapter was to assess the effect of corruption and FDI on Tunisian economy. To this end, we have firstly analyse the dependence between each pair using bivariate copula. Then, we explore the channels through which this effect may occur basing on multivariate copula. Our results are in line with previous empirical studies that confirm a positive effect of FDI and a negative effect of corruption on economic growth. Moreover, we find that political instability, public debt, budget deficit and FDI are channels through which corruption impacts economic growth where political instability constitutes the main important channel. For FDI, findings show that foreign investments influences growth indirectly by generating resources of technology transfer, bringing positive impact to domestic investment and enhancing financial development.

GENERAL CONCLUSION

Sustainable economic growth was and still remains one of the main goals of every government. There have been various measures undertaken by government aiming to attract FDI, as it is considered as a source to promote the economy of Tunisia. Concurrently, corruption appears as a grave concern that would hurt not only investment by the overall economy. In this thesis we attempt to assess the roles of these two factors by analyzing the channels through which they may affect growth.

By analyzing the bivariate dependence , we find a negative dependence between corruption and GDP per capita, as well as a bidirectional causality exists from corruption to growth confirming thus the "sand the wheels" hypothesis which predicts that corruption decreases economic growth. We are thus interesting in looking into their effects on various aspects of the economy. Indeed, we include public finance variables, political instability and FDI as transmission channels.

The situation of public finances remains at the top of the Tunisia's priorities due to an expansion of public spending that far exceeds that of GDP, leading, despite the efforts made and the adoption of new fiscal measures, to an increase in the budget deficit and a significant rise in the stock of public debt. In this perspective, we are inspired to study if corruption is an issue that contributes to affect public finances. Very few empirical studies have included public finances as transmission channels through which corruption brings negative impact to economic growth. More surprisingly, no empirical contribution has focused on these mechanisms in the Tunisian context. By applying vine copula, our results find evidence that corruption may lead to an increase of the level of public debt and budget deficit, which will reduce economic growth.

By emphasizing the political instability channel, we find that corruption causes political instability which in turn contributes to hinder economic growth. Additionally, results suggest that the negative effect of corruption on economic growth is mainly transmitted by this channel. Such discovery is similar to **Mo (2001)** and **Dridi (2013).** Results reveal also that corruption can hinder economic growth by reducing FDI.

On the other hand, an increase of the FDI will be obviously generating various positive effects on growth. Empirical results based on the copula theory confirm this positive relationship between these two variables. We are thus turning then to analyze how this effect may occur.

For this purpose, we include variables such as domestic investment, financial development, technology transfer and human capital.

The C-vine and the D-vine copulas show that foreign investments impacts growth indirectly by generating resources of technology transfer, bringing positive impact to domestic firms and improving financial development. However, no effect on the quality of human resources is shown, seen that FDI in Tunisia is predominantly in sectors that not require skilled labor.

- **Recommendations**

Despite the advantages generated by foreign investors, Tunisia has not succeeded in attracting FDI and has experienced insufficient levels of development. Policymakers must therefore focus their efforts on improving FDI attraction policies and absorption capacity in order to establish a more favorable environment for the development. Policies should focus on three important areas; enhancing macroeconomic stability, improving infrastructure and strengthening the good governance and anti-corruption strategy.

Besides all the anti-corruption actions and practices undertaken by governments and based on the results of this study, it is clear that corruption is and continues to be one of the serious obstacles to economic growth and social development in Tunisia. Therefore, efforts must be made to curtail all forms of corruption. Current and future Tunisian governments need to put forward huge efforts to fight corruption by implementing new rules and laws that aim to reduce corruption and encourage transparency. These efforts may bring positive impact on economic growth by reducing public debt and budget deficit, attaining higher political stability and attracting more FDI.

- **Limits**

In this work, we use the copula theory owing to its flexibility to capture a non-linear distribution and its ability to analyze upper, lower, symmetric and asymmetric tail dependencies which is not feasible with dependency methods applied in the literature. However, this theory is more applicable for a larger database to give better results. Unfortunately, high-frequency data are unavailable to treat macroeconomic issues. But, empirical literatures have shown that the use of this technique has spread economic domain. For instance, **Nikos and Athanassios (2020)** investigate dependence and asymmetry between the out-put and unemployment using quarterly data for the period 1994 to 2018.Furthermore, **Adan and Hussain (2021)** use annual data for the period 1998-2017. Therefore, the use of this theory remains our strong contribution in the field of economics even though our data is not large enough.

- **Perspectives**

Given the emergence and spread of the COVID-19 which has had a negative impact on FDI, and with scenarios for the spread of the epidemic ranging from a short-term stabilization to a continuation throughout the year, it will be more interesting for future research to conduct a study on the impact of FDI on growth in Tunisia during this period, and to compare it with that of the revolution to find out which crisis has a greater impact on the country's growth.

Concerning corruption, it is useful for future research to increase the sample size and show how corruption affects growth in countries with different institutional settings or at different stages of economic development. Future extensions should also examine in depth the influence of corruption on the usual determinants of economic growth.

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APPENDIX

a. Tables

Table 23: Results of LL, AIC and BIC criterions for the second sub-periods

	Elliptical copulas					
	Gaussian			Student-t		
	LL	AIC	BIC	LL	AIC	BIC
GDP-FDI	1.5108	-1.0216	1.4443	+∞	−∞	−∞
GDP-CPI	0.8474	0.3053	2.7712	+∞	−∞	−∞
CPI-FDI	0.3406	1.3187	3.7846	+∞	−∞	−∞

	Archimedean copulas								
	Gumbel			Clayton			Frank		
	LL	AIC	BIC	LL	AIC	BIC	LL	AIC	BIC
GDP-FDI	0.0013	1.9973	4.4633	0.3879	1.2242	3.6901	0.0244	1.9511	4.4170
GDP-CPI	20.7626	-39.5252	-37.0593	0.0793	1.8414	4.3073	5.5155e-04	1.9989	4.4648
CPI-FDI	4.9312	-7.8624	-5.3965	0.3167	1.3667	3.8326	0.1557	1.6886	4.1545

	Elliptical copulas					
	Gaussian			Student-t		
	LL	AIC	BIC	LL	AIC	BIC
GDP-FDI	37.8798	-73.7597	-71.2937	44.4193	-86.8386	-84.3727
GDP-CPI	0.0070	1.9859	4.4518	+∞	−∞	−∞
CPI-FDI	2.22 e-04	1.9996	4.4655	+∞	−∞	−∞

	Archimedean copulas								
	Gumbel			Clayton			Frank		
	LL	AIC	BIC	LL	AIC	BIC	LL	AIC	BIC
GDP-FDI	**46.9168**	**-91.8336**	**-89.3677**	5.2761	-8.5521	-6.0862	11.5843	-21.1686	-18.7027
GDP-CPI	10.0386	-18.0773	-15.6114	0.3770	1.2460	3.7119	0.2511	1.4979	3.9638
CPI-FDI	18.7600	-35.5201	-33.0542	0.9760	0.0479	2.5138	0.0215	1.9569	4.4229

Table 24: Empirical Kendall's tau matrices for the rest of channels

	GDP	CPI	FDI
GDP	1	0.06413923	0.15156375
CPI	0.06413923	1	0.02565569
FDI	0.15156375	0.02565569	1
Sum	1,21570298	1,08979492	1,17721944
	GDP	**CPI**	**DEBT**
GDP	1	0.06413923	-0.25634857
CPI	0.06413923	1	-0.08295340
DEBT	-0.25634857	-0.08295340	1
Sum	1,3204878	1,14709263	1,33930197
	GDP	**CPI**	**DEFICIT**
GDP	1	0.06413923	-0.10077519
CPI	0.06413923	1	-0.16163085
DEFICIT	-0.10077519	-0.16163085	1
Sum	1,16491442	1,22577008	1,26240604
	GDP	**FDI**	**ICT**
GDP	1	0.1515638	0.0686982
FDI	0.1515638	1	0.06442128
ICT	0.0686982	0.06442128	1
Sum	1,220262	1,21598508	1,13311948
	GDP	**FDI**	**HC**
GDP	1	0.1515638	0.3777065
FDI	0.1515638	1	0.0521251
HC	0.3777065	0.0521251	1
Sum	1,5292703	1,2036889	1,4298316
	GDP	**FDI**	**FD**
GDP	1	0.1515638	-0.2493986
FDI	0.1515638	1	0.07939054
FD	-0.2493986	0.07939054	1
Sum	1,4009624	1,23095434	1,32878914

Table 25: Results of estimated parameters for the C-vine copula

			FDI				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.15	0.24	2.39	0.23	0.23
	$\boldsymbol{C_{1,3}}$	Student's t	0.06	0.10	2.72	0.16	0.16
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	0.04	0.06	2.39	0.17	0.17
			DEBT				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.31	-0.46	2.00	0.06	0.06
	$\boldsymbol{C_{1,3}}$	Student's t	-0.08	-0.12	3.89	0.06	0.06
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	0.13	1.27	0.00	-	0.27
			DEFICIT				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.17	-0.27	3.36	0.05	0.05
	$\boldsymbol{C_{1,3}}$	Student's t	-0.11	-0.17	5.85	0.02	0.02
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	0.02	0.04	3.06	0.12	0.12

Table 26: Results of estimated parameters for the C-vine copula

			ICT				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.18	2.00	0.00	0.25	0.25
	$\boldsymbol{C_{1,3}}$	Student's t	0.15	3.19	0.00	0.07	0.07
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	0.09	4.10	2.39	0.09	0.09
			HC				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.38	0.57	3.87	0.30	0.30
	$\boldsymbol{C_{1,3}}$	Student's t	0.12	0.18	2.00	0.25	0.25
2	$\boldsymbol{C_{2,3\|1}}$	Student's t	-0.05	-0.08	4.53	0.05	0.05
			FD				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.25	-0.38	2.39	0.06	0.06
	$\boldsymbol{C_{1,3}}$	Student's t	0.15	0.24	2.39	0.23	0.23
2	$\boldsymbol{C_{2,3\|1}}$	Clayton	0.07	0.14	0.00	-	0.01

Table 27: Results of estimated parameters for the D-vine copula

			FDI				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.12	0.18	2.00	0.25	0.25
	$\boldsymbol{C_{2,3}}$	Student's t	0.03	0.05	2.00	0.20	0.20
2	$\boldsymbol{C_{1,3\|2}}$	Tawn 2(180)	0.14	1.99	0.19	-	0.17
			DEBT	**(debt gdp corr**			
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.31	-0.46	2.00	0.06	0.06
	$\boldsymbol{C_{2,3}}$	Student's t	0.06	0.10	2.80	0.15	0.15
2	$\boldsymbol{C_{1,3\|2}}$	Joe	0.06	1.11	0.00	0.14	-
			DEFICIT				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.17	-0.27	3.36	0.05	0.05
	$\boldsymbol{C_{2,3}}$	Student's t	0.06	0.10	2.80	0.15	0.15
2	$\boldsymbol{C_{1,3\|2}}$	rotated Joe	-0.12	-1.23	0.00	-	-

Table 28: Results of estimated parameters for the D-vine copula

			ICT				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.12	1.18	2.00	0.25	0.25
	$\boldsymbol{C_{2,3}}$	Student's t	0.06	0.10	4.04	0.10	0.10
2	$\boldsymbol{C_{1,3\|2}}$	Student's t	0.08	0.13	3.56	0.06	0.06
			HC				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	0.38	0.57	3.87	0.30	0.30
	$\boldsymbol{C_{2,3}}$	Student's t	0.04	0.07	2.96	0.14	0.14
2	$\boldsymbol{C_{1,3\|2}}$	Student's t	0.13	0.20	2.14	0.24	0.24
			FD				
#Tree	Blocks	Family	τ	Parameter		λ_U	λ_L
				$\boldsymbol{\theta}$	$\boldsymbol{\vartheta}$		
1	$\boldsymbol{C_{1,2}}$	Student's t	-0.32	-0.47	2.00	0.06	0.06
	$\boldsymbol{C_{2,3}}$	Student's t	0.07	0.12	2.00	0.22	0.22
2	$\boldsymbol{C_{1,3\|2}}$	Student's t	0.06	0.09	7.99	0.02	0.02

b. Figures

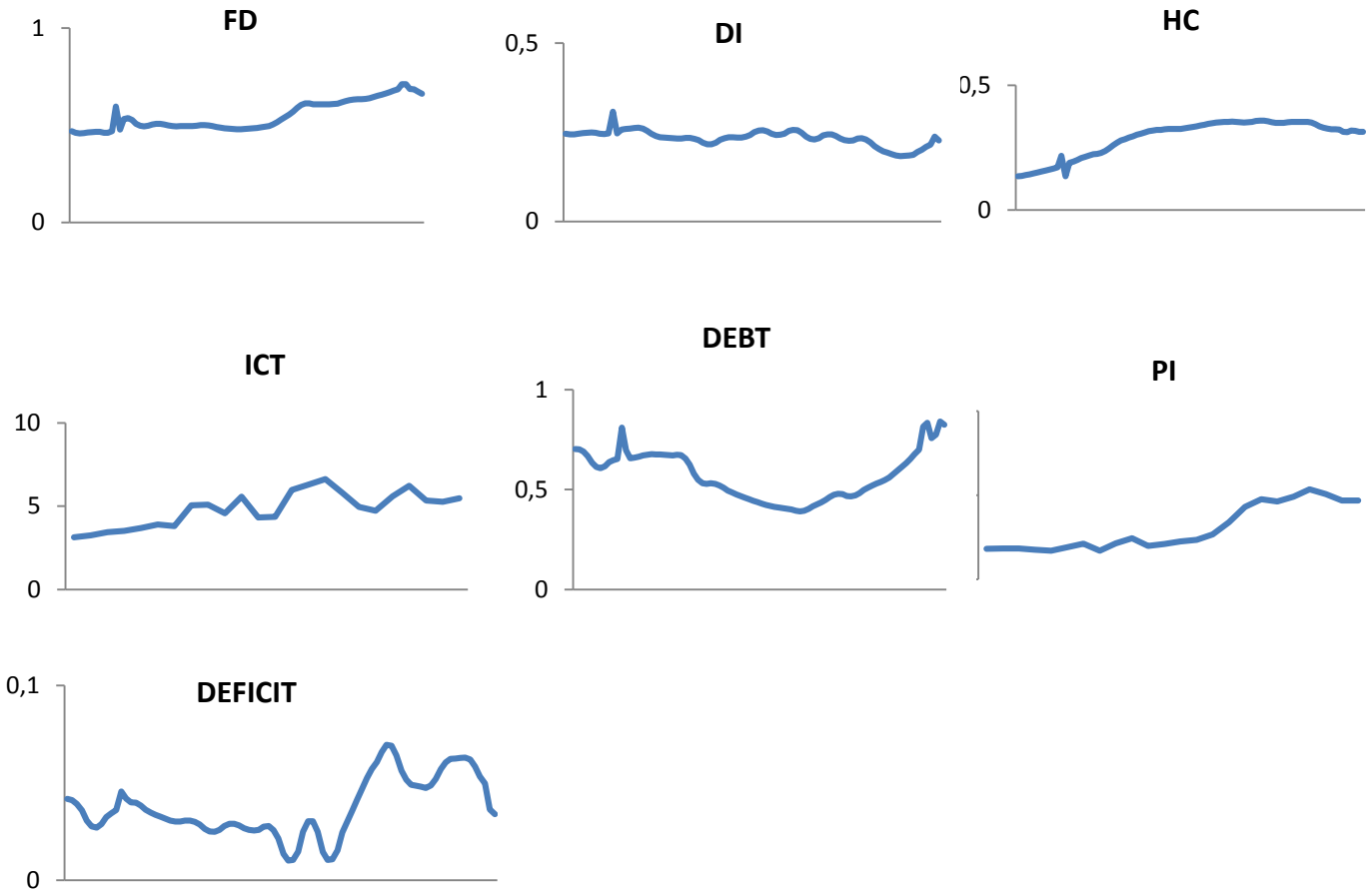

Figure 15: Evolution of the rest of the variables

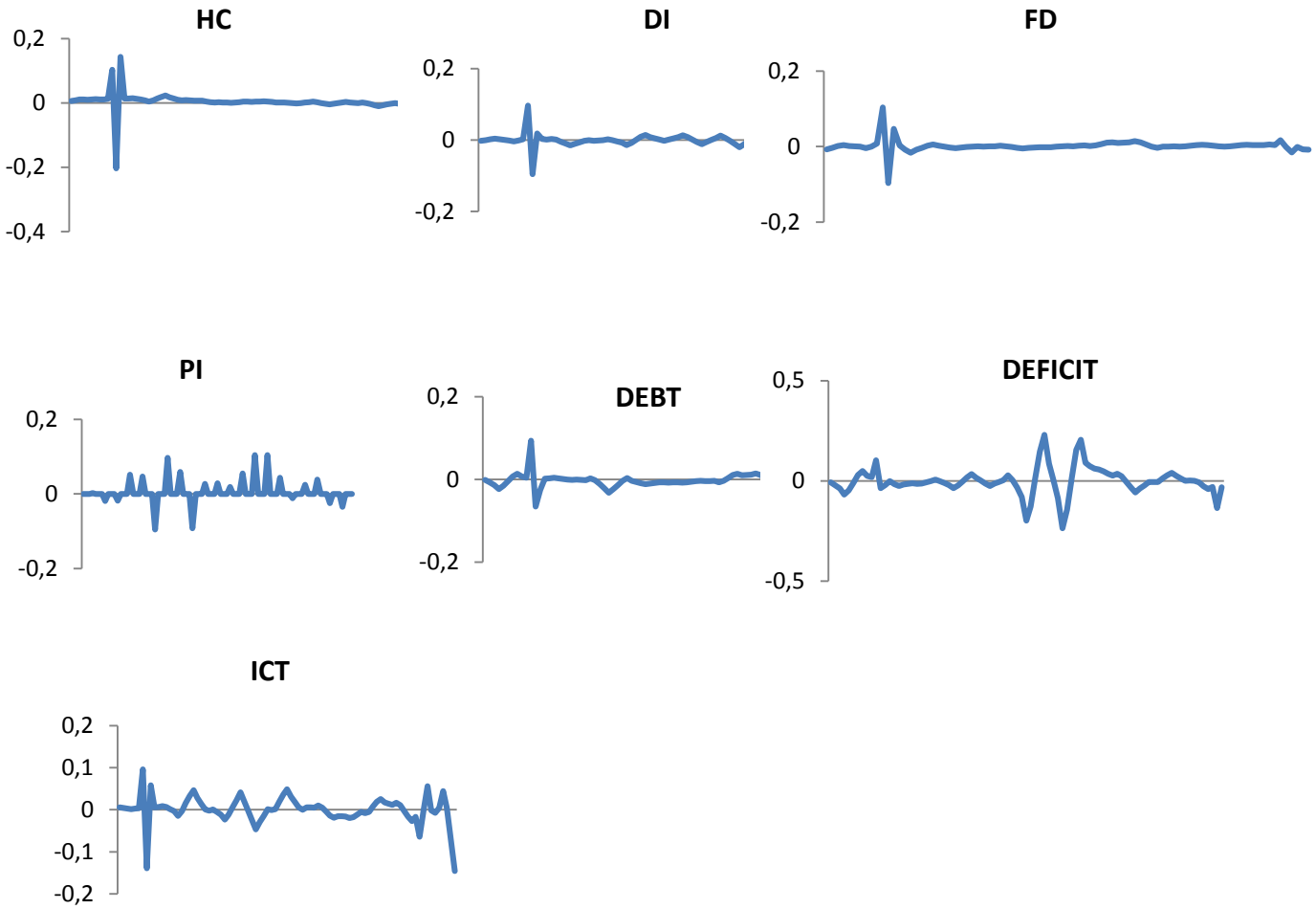

Figure 16: Evolution of the returns of the rest of variables

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