The dependence between cape-verdean and portuguese inflations: a copula approach

Resumo: Cabo Verde é um país onde a estrutura produtiva é fraca, o que lhe torna fortemente dependente das importações de bens e mercadorias com destaque para alimentos e combustíveis que representam 2/3 das necessidades nacionais. Este trabalho tem como objetivo verificar o grau de dependência entre a inflação cabo-verdiana e a portuguesa. Será adotada a metodologia de cópulas por não fazer nenhuma suposição a respeito da distribuição das variáveis, e por ser capaz de captar a presença de associação não linear entre as variáveis e ainda conhecer o formato desta relação. Neste trabalho estima-se uma série de cópulas paramétricas com o intuito de se encontrar qual delas melhor pode representar a relação de dependência entre as variáveis em questão. Fez-se uso das medidas de dependência Rho de Spearman e Tau de Kendall e os resultados indicam que a inflação de Cabo Verde apresenta uma relação de dependência muito fraca com a inflação de Portugal..

Palavras-chave: Cabo Verde; inflação; dependência; cópulas.

Abstract: Cape Verde is a country where the production structure is weak, which makes it heavily dependent on imports of goods and commodities, especially food and fuel which represent two thirds of the national needs. This study aims to determine the degree of dependence between Cape Verdean and Portuguese inflation. Copula methodology will be adopted because it does not make any assumptions about the distribution of variables, and is able to capture the presence of non-linear association between the variables and also know the format of this relationship. This paper estimates a series of parametric copulas in order to find out which of them can best represent the dependency relationship between the variables in question. It were computed the dependence measures Spearman's Rho and Kendall's Tau and the results indicate that Cape Verde´s inflation has a very weak dependence relationship with the Portuguese inflation.

Keywords: Imported inflation; Cape Verde; copula.

Classificação JEL: C1, E30, E52, F1

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1. Introduction

The main goal of Central Banks is to keep the prices stable. High inflation rates are not welcomed, since it brings costs to the national economy, for instance, it reinforces the income concentration (inflationary tax), it difficult the formation of expectations and consequently diminishes the investment level, it facilitates the unbalance on the balance of payments; it disrupts the development of the capital market, etc.

In that sense, either Central Banks or the academic community seek to understand who are the determinants of inflation, looking for its control. One of the reference papers in this type of study is Harberger (1963) for the economy of Chile. Later, other academic researches arised, for example, Hanson (1985) which included the importation cost, in order to verify how the price variation of imports affect the domestic price levels. This process is called Imported Inflation.

African coutries have been the target of researches about the inflation determinants, in which are included the price of imported goods. For example, Blavy (2004) for Ginea, Moriyama (2008) for Sudan, Olubusoye e Oyaromade (2008) for Nigeria, Klein e Kyei (2009) and Carvalho, Massala e Santos (2012) for Angola, Ndanshau (2010) for Tanzania, Kinda (2011) for Chade and Durevall e Sjö (2012) for Ethiopia and Kenia.

This relation between inside and outside inflations, is caused by the commerce streams through the borders. In this sense, it is common in the economic literature discussions about inflation and exchange rates regime. According to Poirson (2001), when exists a dominant commercial partner, it is adopted fixed regime, whereas when the economy intend to diversify the production and exportation, it is chosen floating rates. For Dornbusch (2001), lower inflation levels can be associated to rigid exchange rate regimes, and it would lead to a decrease on the domestic interest rate and on the uncertainty about the economy, which would incentive the investment, and consequently, the growth pace.

Husain et al. (2005) found out on an econometric research that for the case of developing countries, the inflation presents an increasing pattern according to the degree of flexibility of the exchange rate regime. Therefore, when this type of country adopt the fixed regime, they obtain a lower inflation rate, due to the greater assumed commitment on the control of the macroeconomic variables in order to maintain that regime without compromising the economic growth. On the other hand, on developed coutries, the results suggest that more flexible regimes can be associated to a lower inflation and bigger growth rates.

It is in this perspective that some developing countries adopt the fixed exchange rate regime, intending to stabilize the prices and the economy. This is the case of Cape Verde, which in 1998, adopted an exchange rate regime of fixed parity between the Cape-Verdean Escudo and the Portuguese Escudo, seeking to eliminate the exchange rate instability and guarantee the price stability. It is important to notice that Portugal is the main economic partner of Cape Verde, a result from the relations of the colonial period. Hence, it is admitted that the Cape Verde economy is extremely dependent from the foreign sector, specially the Portuguese economy. Some studies as Baptista e Silva (2004), Delgado e Santos (2006) and Pina (2008) showed that the Portuguese inflation is a variable that should be considered on the estimation of prediction models for the Cape-Verdian inflation, mainly because of the adoption of the fixed Exchange rate regime in 1998.

Given these facts, this paper has the goal to verify the dependence degree between the Cape-Verdean and Portuguese inflations. To do that, the literature usually utilize the linear correlation coefficient to measure how much the variables are dependent, ignoring the possible presence of a non-linear dependence. It is also possible the adoption of regression models that estimate the dependence parameter. This approach, however, carries numerous assumptions, as homoscedasticity, residuals normality and correct specification of the model, which are not always valid. On the other hand, for this present article, it will be adopted the methodology of Copulas, because it allows some gains in

comparison to the previously cited models. For instance, it does not make any assumption regarding the probability distribution of the variables. It is also capable of detecting the presence of non-linear dependence and getting to know the shape of this relation.

This paper is divided in four sections, besides this small introduction. On the secont section, it is shown an analysis of Cape Verde economy, focusing on the relation between the monetary policy and the inflation dynamics. On the third section it is described the empiric methodology which will be utilized on the estimations. On the fourth sections it is presented the obtained results. On the fifth and last section it is done the final considerations.

2. Economic contextualization of Cape Verde

For a long time since the colonial period, Cape Verde was economic delayed with lack of resources. Its production structure was weak, with a subsistence agricultural sector and a practically inexistent industry. These facts lead to the questioning of the economic viability of the country, like it is argued in Rocha (2006). After the independence, Cape Verde passed through a period of strong centralization of the main economic activities. In fact, from 1975 to 1991, it was a responsibility of the State, with socialist features, to run almost every commercial, industrial and services activities, leaving to few private entrepreneurs the role of economic agents of small and medium dimension.

During the 1991/2000 period, the government actions intended to transform the nationalized economy to a Market economy. The democratization of institutions, the change on the role of the private sector on the country development and the opening to Direct External Investment were the more important measures. On the second half of this decade, according to the Great Options from the Plan 1997-2000, it were also goals of the government to guarantee internal and external balances, a GDP growth rate above 5%, the maintenance of the public defcit below 5%, decrease on unemployment, improve the quality of the national production and food safety.

There wore fiscal and Exchange rate reforms that intended to insert the country on the world economy, by the economic stabilization, which would increase the productivity, reduce the unitary costs and stabilize prices. In 1998, the government of Cape Verde together with the Portuguese State, signed an exchange rate agreement that linked the Cape-Verdian Escudo with the Portuguese currency, and later with Euro by a fixed parity.

On the 2001/2011 period, the goverment efforts purused the goal of controlling the unbalances on the public accounts, to start the foundations of a development sustained on structural reforms, decrease in poverty, improvement of basic and economic infrastructure and promotion of the territorial ordering to achieve a balanced development. The price stability and the reinforcement of international reserves were the priorities of the monetary policy.

Various events happened during this period. On the year of 2004, Cape Verde was contemplated on the North-American development help program, Millenium Challenge Corporation[1] (MCA), obtaining a help of 117.8 million dollars, for a five year period. By the end of 2007, the country started to benefit from a special partnership with European Union (EU) based on the criteria of Maastrich[2], which lead the country to adopting economic governance directed to the balance of public finance and price stability.

On 2008, Cape Verde joined the World Trade Organization (WTO), which is pointed as a capability of following rules of International Trading. In the same year, it was changed the status of Cape Verde, who started to be part of the group of Medium Development Coutries. This change demands structural changes that are capable of turning Cape Verde to be more competitive and a better generator of own resources to finance its development process, once that it will happen a gradual reduction on the help resources that the country has been receiving since its independence, which consists in one of the biggest challenges for the future.

[1] Seeking the sustainable development of its economy, turning the country less dependente to foreign coutries. Due to the good performance and results, the MCA was renewed in 2009.

[2] They are criteria which members of European Union should achieve in order to participate in the Economic and Monetary Union and adopt the Euro as currency. The cooperation in politics, public safety, regional integration and poverty elimination are the priorities.

1.1. The external sector framework

Since 1990, the economy of Cape Verde has started a gradual economic opening process, therefore, inserting the country on the world scenario, intending to increase its productivity, foreign direct investments and price stability.

Cape Verde has a weak production structure, which makes it strongly dependent of the importation of products, especially food and fuels, which represent 2/3 of the national needs. According to Tavares (2012), this fact has been increasing the external deficit along the years. There are only a few products that are exported, which maintains the coverage rate in extremely low levels.

According to data from World Bank, during the 1990/2011 period, the importations and exportations had an average increase of 7,6% and 7,8%, respectively. The importations corresponded to 66,4% of the GDP, whereas the exportations were equivalent to 26,5%. Given this large difference between them, it is clear that the balance of trade does not supply the financing needs of the external sector.

The countries which Cape Verde imports more products and services are Portugal, Netherlands, Spain, France, Germany, United Kingdom and Senegal. On the other hand, the countries that Cape Verde exports more are Portugal and Spain. The existing data about the External Trade of Cape Verde, provided by the General Direction of Customs of Cape Verde, confirms that Portugal is the main Trade Partner, since it is responsible for 51,4% of Cape Verde´s importations, and 22,7% of Cape Verdean exportations, resulting in the first and second place respectively.

According to the Trade Chamber between Portugal and Cape Verde, the main category of Cape Verde´s imported products, originated in Portugal, in reason of the total of importations from Portugal in 2009 are: Built Machines and Materials (19%); Minerals and Base Metals (18,5%); Transport Machines and Accessories (18%); Foods and Drinks (17,7%); Electrical Machines and Devices (15%). In this sense, Cape Verde economy has a strong relationship with the external sector, especially with Portugal.

1.2. Monetary policy and inflation

The Cape Verde Bank (BCV) performs the function of Central Bank and, according to the Law 10/VI/2002, it also works jointly with the government on the definition and execution of Monetary and Exchange Rate Policies, and it orients the Monetary, Financial and Exchange Markets.

The BCV´s Monetary Policy has the primary goal of maintaining the price stability, that is, the maintenance of the power of purchase of the currency, in order to promote the economic growth and job creation (BCV, 2012). The operational framework of the Monetary Policy assumes the interest rate as an operational goal, the exchange rate stability as intermediate goal and the maintenance of the price stability as the final goal.

From 1998[3], the Monetary Policy of Cape Verde has been characterized by the change on the exchange rate regime. On March 1998, Cape Verde and Portugal signed the Exchange Rate Cooperation Agreement (ACC), which intended to link the Cape Verdean currency to the Portuguese one, through an exchange rate regime with fixed parity, and the creation of conditions which guarantee the convertibility of the Cape Verdean Escudo (CVE), and the price stability, protecting the value of the national currency, functioning as creditable nominal anchor of the Monetary Policy. Since 1999, the Portuguese currency was replaced by Euro, which allowed Cape Verde to benefit, through the Portuguese currency, of the access to the entire Euro Zone.

According to BCV (2008), the goals of the ACC are reflexes of the macroeconomic scenario of the period, which was characterized by unsustainable unbalances, that the main restriction was the exchange rate instability that increased the risk of exhausting the foreign currencies reserve. Moreover, as stated before, Cape Verde has an extremely open and vulnerable economy, strongly dependent of the resultant influxes of current transfers, what makes Cape Verde unprotected to fluctuations of the exchange rates.

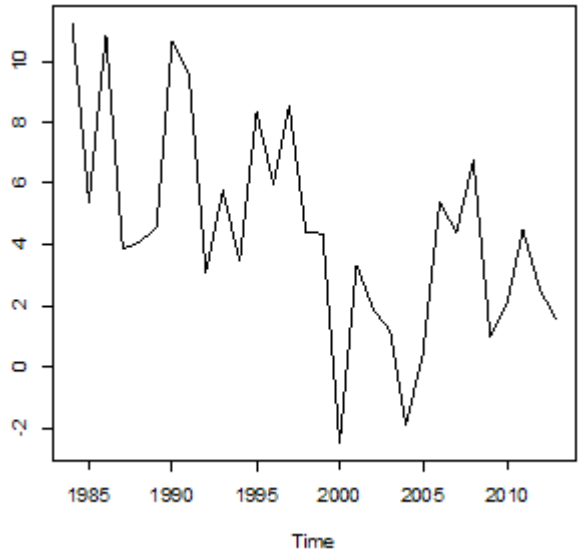
[3] In 1993, there was a separation of the functions of central and commercial bank, creating two independent institutions. The Monetary Policy was conducted basically by establishing limits to the expansion of credit. The interest rates were fixed managerially, and they were used as an selection instrument on credit distribution. The Monetary Policy intended to protect the Balance of Payments and guarantee the price stability and the internal liquidity control, ensuring the increase of reserves.

BCV (2010) argues that this fact allowed Cape Verde, as a small economy, to strengthen the economic bonds to Portugal and Europe, which assured favorable conditions to the implementation of structural reforms that intended to adjust and transform the national economy. By compromising to adopt the convergence criteria of European Union, as the reference of conducting the Economic Policy, Cape Verde obtained a better credit condition to reinforce its foreign currency reserve.

After the start of the Fixed Parity Regime, the inflation presented a decreasing trajectory, with comparable levels with the inflation of Portugal, a country that has a major importance on the importations of Cape Verde, suggesting that the exchange rate has been working as an effective nominal anchor on the promotion of price stability (DELGADO and SANTOS, 2006). According to Marta (2006), this exchange rate relation, has been maintained stable along the last years, which benefited the National Economy, mainly regarding the price stability.

This fact can be observed on Figure 1, which illustrates the inflation from 1984 to 2011, averaging 4,7%. However, it can be noticed that during the 1980 decade, Cape Verde faced high inflation rates, which influenced the successive governments to pursue the stability of the price levels. It is visible that after the adoption of the fixed exchange rate regime, the inflation presented a lowering behavior, which is interrupted from 2006 to 2008, when it was recorded an international food crisis, jointly with an increase on the international price of oil. This two types of goods represent more than 2/3 of the overall importations, as shown in Tavares (2012)

Figure 1 – Evolution of the Price Level, 1984/2013



Source: Own elaboration based on *World Bank* data.

By analyzing the economic history of Cape Verde, in can be noticed that the country experimented high inflation rates on the first half of the 1980´s, exceeding 20% in 1982 and 1983 (MARTA, 2006). There was a depreciation of the national currency (Cape Verdean Escudo – ECV) in relation to the main international currencies, except the Portuguese Escudo (PTE). On the 1980-1984 period, the nominal exchange rate depreciated approximately 24,2%.

It is important to stress that Cape Verde started a process of progressive reduction of the inflation rate; hence, it is almost stabilized nowadays. This fact is due to: the entrance of Portugal on the European Union; the stabilization of the PTE; the reduction on the inflation rate on the Cape Verde´s main trade partners; and the commercial opening on the beginning of the 1990´s.

3. The copula method

To understand better the application of copulas, it is essential to know the theorem of Sklar (1959), which can be formally described as: Assume that H is a joint distribution function with margins F and G. Thus, there is a copula C that for any x and y belonging to $\bar{R}$,

$$H(x,y) = C\big(F(x), G(y)\big)$$

In that sense, the estimation of copulas consists in finding a parametric copula which better represents the bivariate probability distribution function H.

Sendo assim, a estimação de cópulas consiste em encontrar uma cópula paramétrica que melhor representa a função de distribuição de probabilidade bivariada H. As the functional form of $F(x)$ and $G(y)$ is also unknown, it is adopted the procedure of Silva (2013) to use pseudo-observations to estimate the parametric copulas.

This paper estimates a diversity of parametric copulas in order to find which one of them better represent the dependence relationship between the analyzed variables. The copulas are formally shown on Table 2, whereas the dependence measures can be found on Table 1.

Table 1 – Dependence Measures

Gumbel	Kendall´s Tau	Inferior Tail Index
$\tau_{X,Y} = 4\iint_{I^2} C(u,v)dC(u,v) - 1.$	$\lambda_L = \lim_{v\to 0^+} \frac{C(v,v)}{v}$	$\lambda_U = \lim_{v\to 1^-} \frac{S(v,v)}{1-v}$

Source: Own elaboration as from Nelsen (2006) and Trivedi and Zimmer (2005).

Table 2 – Estimated Parametric Copulas

Clayton	$C(u_1,u_2;\theta) = \left({u_1}^{-\theta} + {u_2}^{-\theta} - 1\right)^{-1/\theta}$
Frank	$C(u_1,u_2;\theta) = -\theta^{-1}\log\left\{1 + \frac{\left(e^{-\theta u_1}-1\right)\left(e^{-\theta u_2}-1\right)}{e^{-\theta}-1}\right\}$
Gumbel	$C(u_1,u_2;\theta) = exp\left(-\left((-\log u_1)^{\theta} + (-\log u_2)^{\theta}\right)^{1/\theta}\right)$
AMH	$C(u_1,u_2;\theta) = \frac{u_1u_2}{1-\theta(1-u_1)(1-u_2)}$
Joe	$C(u_1,u_2;\theta) = 1 - \left[(1-u_1)^{\theta} + (1-u_2)^{\theta} - (1-u_1)^{\theta}(1-u_2)^{\theta}\right]^{1/\theta}$
Gaussiana	$C(u_1,u_2;\theta) = \int_{-\infty}^{\Phi^{-1}(u_1)}\int_{-\infty}^{\Phi^{-1}(u_2)} \frac{1}{2\pi(1-\theta^2)^{1/2}} \times\left\{\frac{-(s^2-2\theta st+t^2)}{2(1-\theta^2)}\right\}dsdt$
T-student	$C(u_1,u_2;\theta,v) = \int_{-\infty}^{t_v^{-1}(u_1)}\int_{-\infty}^{t_v^{-1}(u_2)} \frac{1}{2\pi(1-\theta^2)^{1/2}}\left\{1 + \frac{(s^2-2\theta st+t^2)}{v(1-\theta^2)}\right\}^{-(v+2)/2}$
Galambos	$C(u_1,u_2;\theta) = u_1u_2exp\left(\left((-\log u_1)^{-\theta} + (-\log u_2)^{-\theta}\right)^{-1/\theta}\right)$
Husler-Reiss	$C(u_1,u_2;\theta) = exp\left\{-\tilde{u}_1\Phi\left(\theta^{-1} + \frac{1}{2}\theta\ln\left(\frac{\tilde{u}_2}{\tilde{u}_1}\right)\right) - -\tilde{u}_2\Phi\left(\theta^{-1} + \frac{1}{2}\theta\ln\left(\frac{\tilde{u}_1}{\tilde{u}_2}\right)\right)\right\}$
Tawn	$C(u_1,u_2;\theta) = u_1u_2exp\left\{-\theta\frac{\log u_1\log u_2}{\log(u_1u_2)}\right\}$
T-EV	$C(u_1,u_2;\theta,v) = exp\left(\log(u_1u_2)\boldsymbol{A}_{\theta,v}\left(\frac{\log(u_1)}{\log(u_1u_2)}\right)\right)$, Onde: $\boldsymbol{A}_{\theta,v}(w) = wt_{v+1}\left(\frac{\left(\frac{w}{1-w}\right)^{1/v} - \theta}{\sqrt{1-\theta^2}}\sqrt{v+1}\right) + (1-w)t_{v+1}\left(\frac{\left(\frac{1-w}{w}\right)^{1/v} - \theta}{\sqrt{1-\theta^2}}\sqrt{v+1}\right)$
FGM	$C(u_1,u_2;\theta) = u_1u_2\left(1 + \theta\left((1-u_1)(1-u_2)\right)\right)$
Plackett	$C(u_1,u_2;\theta) = \frac{[1+(\theta-1)(u_1+u_2)] - \sqrt{[1+(\theta-1)(u_1+u_2)]-4u_1u_2\theta(\theta-1)}}{2(\theta-1)}$

Obs: $\tilde{u}_i = -\ln u_i$

Source: Own elaboration as from Silva (2013).

3.1 Genest e Rémillard (2004) independence test

When investigating the dependence relationship between variables it is important to consider the hypothesis that they are independents with each other. Genest e Rémillard (2004) purpose a test based on the empiric copula. The test statistics is defined by:

$$T_{A,n}^{S} = \frac{1}{n}\sum_{i=1}^{n-p+1}\sum_{k=1}^{n-p+1}\prod_{j\in A}\left\{\frac{2n+1}{6n} + \frac{R_{i+j-1}(R_{i+j-1}-1)}{2n(n+1)} + \frac{R_{k+j-1}(R_{k+j-1}-1)}{2n(n+1)} - \frac{\max\ (R_{i+j-1},R_{k+j-1})}{n+1}\right\} \quad (1)$$

Under the null hypothesis of Independence, the limit distribution of $T_{A,n}^{S}$ is the same of $\xi_{|A|}$, where

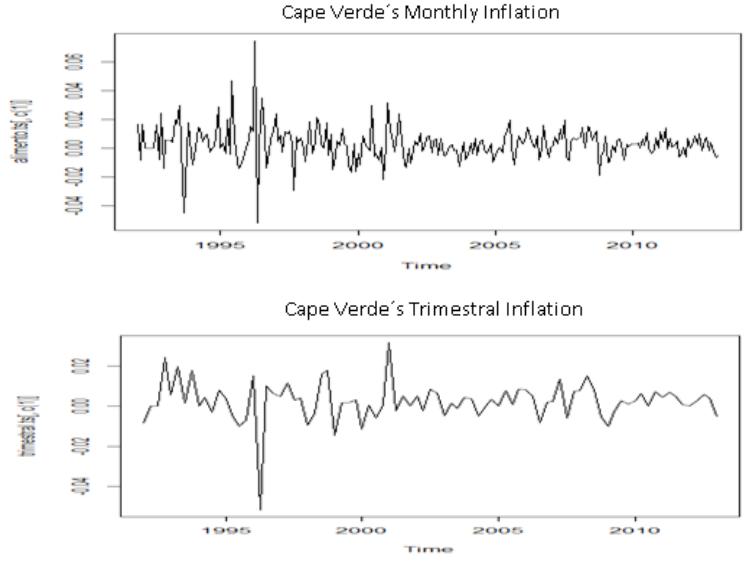
$$\xi_k = \sum_{(i_1,\ldots,i_k)\in \mathbb{N}^k} \frac{1}{\pi^{2k}(i_1,\ldots,i_k)^2} Z_{i_1,\ldots,i_k}^2, \quad (2)$$

where $Z_{i_1,\ldots,i_k}$ are independente random variables N(0,1). The critical values of this test are found on Table 1 of Genest e Rémillard (2004).

4. Data and results

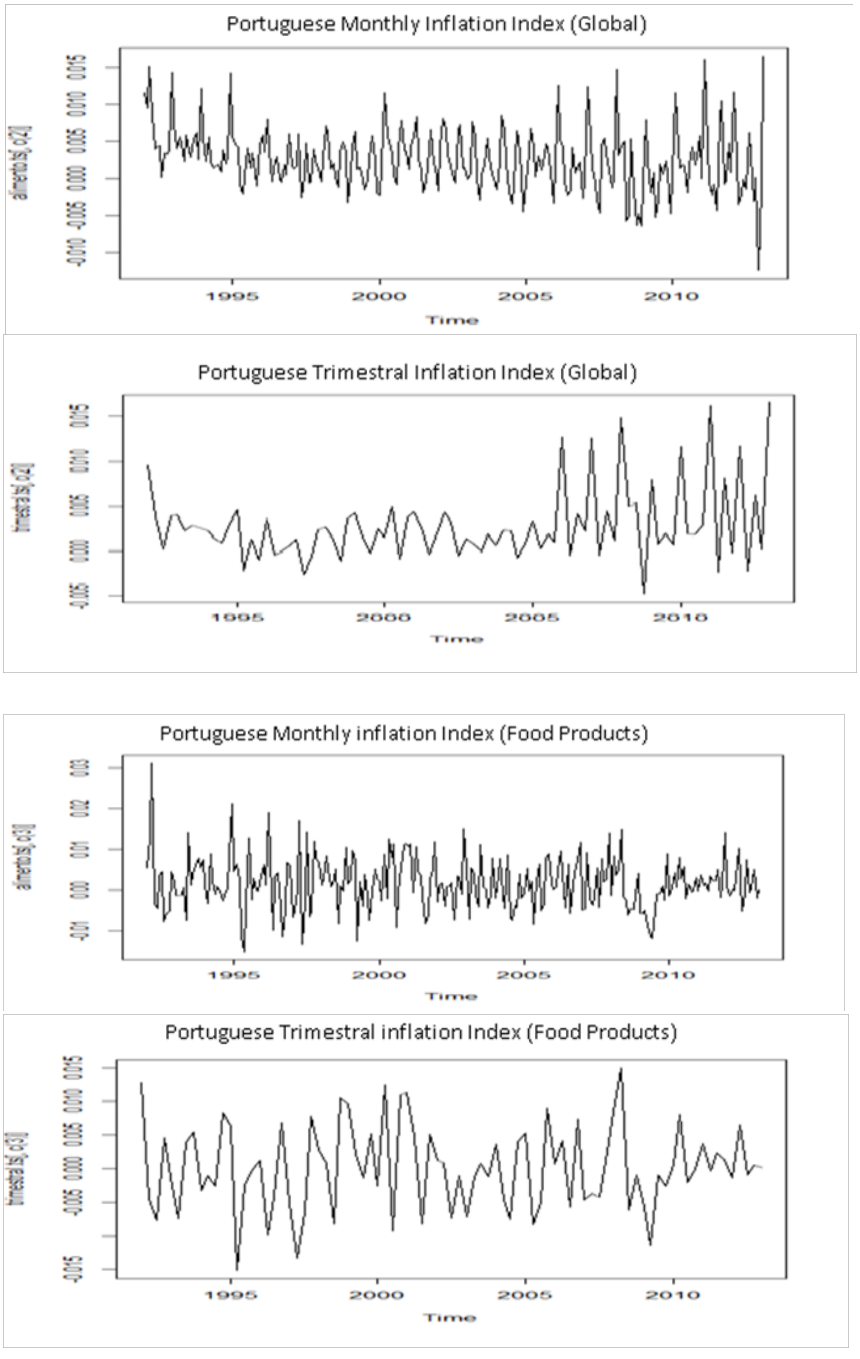
This study intended to analyze the relationship between the inflation rates of Cape Verde and Portugal. O adopted Cape Verdean inflation index is the Consumer Price Index, which is reported monthly by Cape Verde Bank. For Portugal, it is used two indexes: 1) The Global Consumer Price Index; and 2) The Consumer Price Index for Food Products and Non-Alcoholic Beverages. These series are presented both on monthly and trimestral periodicity. By estimating copulas with trimestral data, it is possible to observe a larger dependence between the series, since prices can take more than a month to be transmitted from Portugal to Cape Verde. This study sample begins in January 1992 and goes to March 2013.

Figure 2 – Variation of the Cape Verdean Consumer Price Index



Source: Own Elaboration from Cape Verde Bank data.

[11] Ver, por exemplo, Luenderberg e Ye (2008).



Source: Own Elaboration from Bank of Portugal data.

To obtain the data presented on Figure 2, it was necessary to add two different series of Cape Verde´s IPC: The IPC (1989 = 100) and the IPC (2007 = 100). There were some changes in the methodology of the official inflation index, hence it produces different results. Although they are different indexes, the coupling of one series to another does not bring large prejudices, since general inflation indexes of the same country tends to behave in a collinear way.

From Figure 3 it can be observed that despite of the weight of foods on the Global Index, the series are different between each other. Thus, it is possible to expect that Cape Verde inflation has a different dependence between each Portuguese Index. The

justification of using the Consumer Price Index of Food Products and Non-alcoholic Beverages is due to the fact that these products has a large weight on the consuming structure of the Cape Verdean IPC, representing 57,6% and 40% for the series IPC (1989 = 100) and (2007 = 100) respectively.

This study also intend to realize the estimation of Copulas, considering the period after the signature of the ACC (Exchange Rate Cooperation Agreement), because it created conditions which would favor the trade between Cape Verde and Portugal. As long as the two countries intensified their trade relationship, it is possible to imagine that the dependence relationship of their inflation rates might have grown. For simplicity matters, the variables used on this study will be treated by its respective code, which is shown on Table 3.

Table 3 – Variables Codes

Gumbel	**Variável**
Monthly Cape Verdean IPC	**CV**
Trimestral Cape Verdean IPC	**triCV**
Monthly Cape Verdean IPC after ACC	**CV98**
Trimestral Cape Verdean IPC after ACC	**triCV98**
Monthly Portuguese IPC (Global)	**gPT**
Trimestral Portuguese IPC (Global)	**trigPT**
Monthly Portuguese IPC after ACC (Global)	**gPT98**
Trimestral Portuguese IPC after ACC (Global)	**trigPT98**
Monthly Portuguese IPC (Food Products)	**aPT**
Trimestral Portuguese IPC (Food Products)	**triaPT**
Monthly Portuguese IPC after ACC (Food Products)	**aPT98**
Trimestral Portuguese IPC after ACC (Food Products)	**triaPT98**

Source: Own Elaboration.

From these variables it is estimated the parametric Copulas for eight pairs of variables. Table 4 summarizes the estimations for the first four pairs, those which consider the full sample. On the other hand, Table 5 presents the results from the variables pairs which consider only the after ACC period.

Table 4- Estimation Results of Copulas for the full sample.

		CV-gPT	triCV-trigPT	CV-aPT	triCV-triaPT
Clayton	Parameter	0.004195	0.03867	0.15508	0.2969
	Standard Error	0.064223	0.13427	0.07658	0.154
	Log-likelihood	0.002168	0.042664	1.977352	1.862085
Frank	Parameter	-0.1698	0.279	0.9591	1.4572
	Standard Error	0.3739	0.6267	0.353	0.5802
	Log-likelihood	0.098872	0.085636	2.897129	2.086017
Gumbel	Parameter	NA	1.0104	1.12279	1.20465
	Standard Error	NA	0.0853	0.04886	0.08676
	Log-likelihood	NA	0.008289	4.279425	3.180493
Amh	Parameter	-0.08215	0.1202	0.3755	0.559
	Standard Error	0.19453	0.2904	0.1348	0.1836
	Log-likelihood	0.09406	0.075972	2.515942	1.950433
Joe	Parameter	NA	NA	1.171	1.283
	Standard Error	NA	NA	NA	NA
	Log-likelihood	NA	NA	3.938379	2.916656
Fgm	Parameter	-0.08191	0.1211	0.3687	0.4761
	Standard Error	NA	NA	NA	N A
	Log-likelihood	0.095575	0.074583	2.250001	1.399152

Plackett	Parameter	**0.9172**	1.161	1.7201	2.4019
	Standard Error	0.1715	0.3648	0.2989	0.6822
	Log-likelihood	**0.100599**	0.091912	3.332288	2.627275
Normal	Parameter	-0.00509	0.04584	0.15941	0.22595
	Standard Error	0.065222	0.1143	0.05633	0.08732
	Log-likelihood	0.003044	0.075833	3.035207	1.916112
T	Parameter	-0.0056	**0.0449**	**0.1553**	**0.21859**
	Standard Error	0.112732	0.1699	0.0708	0.06586
	Log-likelihood	0.000247	**0.121923**	**6.464992**	**6.112845**
	Degrees of Freedom	325.3258	15.4818	4.4894	2.31091
Galambos	Parameter	NA	0.2055	0.35066	0.43848
	Standard Error	NA	0.1878	0.06038	0.09578
	Log-likelihood	NA	0.059996	4.186907	2.723756
huslerReiss	Parameter	NA	0.4797	0.66817	0.7637
	Standard Error	NA	0.2627	0.07861	0.1196
	Log-likelihood	NA	0.067571	4.112299	2.499571
Tawn	Parameter	NA	NA	0.2956	0.4882
	Standard Error	NA	NA	0.105	0.1523
	Log-likelihood	NA	NA	3.767566	3.806643
Tev	Parameter	NA	-0.3424	0.2512	0.4453
	Standard Error	NA		NA	NA
	Log-likelihood	NA	0.030323	4.286817	3.134087
	Degrees of Freedom	NA	4	4	4

Source: Own Elaboration.

Table 5 – Copulas Estimation with after-ACC data.

		CV98-gPT98	triCV98-trigPT98	CV98-aPT98	triCV98-triaPT98
Clayton	Parameter	-0.02617	-0.04503	0.09429	0.3391
	Standard Error	0.05782	0.13453	0.089	0.1826
	Log-likelihood	0.074194	0.045456	0.467346	1.422322
Frank	Parameter	-0.6311	-0.1215	0.7529	1.6666
	Standard Error	0.4413	0.7605	0.416	0.7017
	Log-likelihood	0.950132	0.010967	1.256644	1.798041
Gumbel	Parameter	Na	NA	1.09761	1.2683
	Standard Error	NA	NA	0.05254	0.1217
	Log-likelihood	NA	NA	2.035048	3.44286
Amh	Parameter	-0.3139	-0.04716	0.3123	0.6225
	Standard Error	0.2525	0.38993	0.1693	0.2052
	Log-likelihood	0.893798	0.008433	1.135673	1.713946
Joe	Parameter	NA	NA	1.142	1.395
	Standard Error	NA	NA	NA	NA
	Log-likelihood	NA	NA	2.046013	3.520676
Fgm	Parameter	-0.2944	-0.05324	0.2887	0.5225
	Standard Error	NA	NA	NA	NA
	Log-likelihood	0.896467	0.009614	0.970965	1.145744

Plackett	Parameter	**0.7236**	0.9367	1.5434	2.7918
	Standard Error	0.1591	0.3558	0.3175	0.9479
	Log-likelihood	**0.975454**	0.011806	1.461325	2.374551
Normal	Parameter	-0.07765	-0.01962	0.10808	0.2726
	Standard Error	0.07552	0.14117	0.06656	0.1055
	Log-likelihood	0.49155	0.008928	0.955948	1.845435
T	Parameter	-0.08186	**-0.02203**	**0.12839**	**0.244715**
	Standard Error	0.14021	0.28606	0.02672	0.003535
	Log-likelihood	0.507711	**0.109996**	**3.764869**	**5.82721**
	Degrees of Freedom	51.06323	8.16372	4.08171	1.796113
Galambos	Parameter	NA	NA	0.31187	0.5114
	Standard Error	NA	NA	0.06849	0.131
	Log-likelihood	NA	NA	1.7564	3.00144
huslerReiss	Parameter	NA	NA	0.61024	0.8532
	Standard Error	NA	NA	0.09031	0.1623
	Log-likelihood	NA	NA	1.625554	2.781752
Tawn	Parameter	NA	NA	0.2644	0.5618
	Standard Error	NA	NA	0.1214	0.1825
	Log-likelihood	NA	NA	2.022694	4.134086
Tev	Parameter	NA	NA	0.1723	0.5404
	Standard Error	NA	NA	NA	NA
	Log-likelihood	NA	NA	2.032545	3.384222
	Degrees of Freedom	NA	NA	4	4

Source: Own Elaboration.

According to Table 4, it can be noticed that in most cases of copulas between the Cape Verdean IPC and the Global Portuguese IPC, the parameters are small in relation to the Standard error, revealing that they could not be statistically different from zero. Besides that, the log-likelihood criteria indicates that the Plackett and T-student copulas were those which better adjusted to the pairs CV-gPT and triCV-triGPT respectively.

In the case of the relation of Cape Verde´s inflation and Portuguese IPC of Food Products, the estimated parameters were more significant, and every copula converged on its estimation. Besides that, the estimated parameters for the trimestral case were different from those of the monthly case, indicating that the dependence degree might be different by considering different periodicities. The T-student Copula was chosen according to the Log-likelihood criteria for both monthly and trimestral cases.

The estimations realized considering only the after-ACC period on Table 5, presented similar results from the Table 4. On cases referent to the Global Portuguese IPC, many parameters were not significant, and some copulas did not converge. The Plackett Copula was chosen according to the highest Log-likelihood for monthly and trimestral periodicities.

The results referent to the Food Portuguese IPC presented significant parameters, and the convergence problems were solved. Like in the full sample estimations, the estimated parameters vary on the monthly and trimestral cases, indicating different dependence degrees. The T-student Copula was chosen as the one which is better adjusted to both cases.

Table 6 – Dependence Measures

	Kendall´s Tau	Spearman´s Rho	Lower Tail Index	Upper Tail Index
CV-gPT	-0.01947	-0.02880	0.00000	0.00000
triCV-trigPT	0.02859	0.04288	0.00149	0.00149
CV98-gPT98	-0.07225	-0.10745	0.00000	0.00000
triCV98-trigPT98	-0.01402	-0.02103	0.01342	0.01342
CV-aPT	0.10881	0.16166	0.00000	0.14423
triCV-triaPT	0.14029	0.20916	0.25953	0.25953
CV98-aPT98	0.08196	0.12268	0.10657	0.10657
triCV98-triaPT98	0.15739	0.23427	0.27006	0.27006

Source: Own Elaboration.

From the chosen Copulas for the eight variable pairs, it was calculated the dependences measures presented on Table 1. Its results can be found on Table 6. It can be noticed that the Global Portuguese IPC has a very weak dependence to the Cape Verdean inflation. In some cases, this measure is negative, which would contradict the a priori expectations of this study. For the case of the Food Products IPC, the results behave more accordingly to what was expected.

When it is estimated the Copulas from the trimestral data, it shows a growth in the dependence degree in both cases, i.e., considering the full sample or the after ACC period. Comparing the initial estimation results to those after ACC, it can be verified that on the monthly case occurs a decrease on the dependence degree between the series. On the other hand, when considering the trimestral series, it can be noticed that the series become more dependent after the signature of the Exchange Rate Cooperation Agreement.

The Tail Index results reveal that on most cases it was chosen symmetric Copulas. On this case, positive and negative variations in one series should have an equivalent effect into the other.

Table 6 results also rebeal that the dependence degree between the series is weak, even considering the Food Products Portuguese IPC. Therefore, it is needed to verify the hypothesis of independence among these pairs of variables.

Table 7 - Genest e Rémillard (2004) Independence Test

	Statistic	P-value
CV-gPT	0.018657	0.71978
triCV-trigPT	0.012189	0.963537
CV98-gPT98	0.038429	0.172328
triCV98-trigPT98	0.01531	0.87962
CV-aPT	0.06834	0.033467
triCV-triaPT	0.057317	0.049451
CV98-aPT98	0.039511	0.165335
triCV98-triaPT98	0.049449	0.094406

Source: Own Elaboration.

The results presented on Table 7 indicate that null hypothesis of independence is not rejected every time when considering the Portuguese Global IPC. Thus, it justifies the results of Table 6, in which the estimated dependence degree was very low and even negative in some cases.

Regarding the Food Products Portuguese IPC, the null hypothesis of independence

was rejected in three out of four cases, when considering a 10% significance level. The non-rejection on the CV98-aPT98 case should be analyzed with caution, because the test statistics depends on the size of the sample, as stated on equation (2).

5. Conclusion

As a result of the colonial period, Portugal continued to be the main trade partner of Cape verde, and therefore, it is admitted the existence of a strong dependence between Cape Verde economy and the external sector, especially the Portuguese economy. Previous studies about Cape Verde indicate that the Portuguese Inflation should be considered as an important variable on the estimation of predictions for Cape Verde´s inflation, especially after the signature of the Exchange Rate Cooperation Agreement (ACC) between these two countries.

In order to verify the dependence degree between these two variables, differently from the empiric strategy which uses the linear correlation coefficient, in this paper it were estimated several families of parametric Copulas for eight pairs of variables, intending to identify which one of them better represents the dependence relationship between the Cape Verdean and Portuguese inflations. It was used trimestral and monthly series, considering the periods before and after the Exchange Rate Cooperation Agreement (ACC). Besides that, for the case of Portugal, it was utilized the Global and the Food Products IPC´s. Regarding to the Log-Likelihood criteria, in a broad vision, the Copulas which better adjusted were the T-student and Plackett.

It was also calculated the dependence measures Spearman´s Rho and Kendall´s Tau. Their results indicate that the Global Portuguese Inflation has a very weak dependence relationship to the Cape Verdean inflation. For the cases when it is used the Global Portuguese IPC, the dependence measures are negative in most cases, what contradicts the a priori expectations of this study. On the other hand, considering the Food Products IPC, the results behave more accordingly to what was expected. When estimating Copulas from trimestral data, it can be noticed an increase on the dependence degree considering the cases of the full sample and the after ACC period sample. It suggests that the required time to transmit the Portuguese inflation to Cape Verde might be longer than a month. This result is plausible to the firms stock planning and the required transportation time of goods.

Even considering the best case, when it is utilized the Food Products IPC, the dependence degree between the pairs of series was weak. Hence, it was estimated the Independence Test of Genest and Rémmilard. Their results do not reject the null hypothesis of independence between the Global Portugeuese inflation and the Cape Verdean IPC. On the other hand, when considering the Portuguese Food Products IPC, the null hypothesis was rejected in three out of four cases, on a 10% significance level.

In short, the obtained results do not concur with previous researches results, that is, of a strong relationship between Cape Verdean and Portuguese inflations. However, it is admitted a small dependence between Cape Verde´s inflation and the Portuguese Food Products and Non-alcoholic Beverages IPC. It can be suggested for future researches which intend to model predictions to the Cape Verdean inflation, the utilization of this Food Products IPC and give a special attention to other national economic variables.

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