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# Thèse

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# Credit Risk determinants and connections in the Euro Zone

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*À mes parents, à ma famille et à mes amis.*

« An economist is an expert who will know tomorrow why the things he predicted yesterday didn't happen today. »

Laurence J. Peter

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# Résumé

Le déclenchement de la dette des Subprime en 2007, suivie de la crise de la dette Européenne en 2011, a attiré l'attention vers le risque de crédit, ses causes et ses implications. Depuis, Les décideurs des politiques économiques cherchent à trouver un moyen pour réguler les mouvements sur le marché des obligations et des dettes. Ainsi, sous l'impulsion du Conseil de stabilité financière, les accords de Bâle III sont apparus. Ce sont des réformes visant à renforcer le système financier afin d'affirmer la solidité financière des banques en imposant des conditions d'emprunt dont un niveau minimum de capitaux propres.

Les travaux étudiant les risque de crédit avec ses différentes façades ont connu un boom.

Il y a notamment la modélisation du risque de crédit qui s'est énormément développée. Cette thèse s'inscrit dans une branche macroéconomique à l'échelle Européenne. Nous essayons d'identifier les déterminants du risque de crédit aux niveaux souverains et bancaires et d'étudier les connections entre les deux.

Dans une première partie, nous utilisons une modélisation Autoregressive à retards échelonnés [1] (ARDL) afin de définir les déterminants macroéconomiques d'un échantillon de pays européens. Nous suggérons que le risque de crédit de ces derniers dépend largement des fondamentaux macroéconomiques avec des élasticités différentes selon les conditions économique du pays. Plus précisément, nous trouvons que le taux du chômage est la variable la plus influente notamment lorsqu'il s'agit des pays économiquement fragiles. Les relations déterminées sont significa-

1. Autoregressive Ditributed Lag Model

tives et globalement stable à long terme.
Dans la deuxième partie, nous nous intéressons aux déterminants du risque de crédit d'un échantillon de groupes bancaires Européens. Depuis 2007, Ces derniers ont été affectés par les deux crises (Subprime et la crise de la dette Européenne). Les relations de long terme définies selon les tests de cointégration via l'approche des Bounds Tests [2], montrent qu'une dévaluation de l'Euro baisse le risque de crédit des banques étudiées en rendant leurs dettes libellées en Euro moins coûteuses. Aussi, notre analyse indique que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la banque est inscrite sont inconsistant dans l'explication du risque de crédit de cette dernière.
Dans la dernière partie nous étudions les relations de causalité entre les risques de crédit des entités souveraines et bancaires étudiées dans les chapitres précédents. Les tests de causalité au sens de Granger révèlent que les relations trouvées sont asymétriques et dynamiques. Ces liens varient considérablement en fonction de l'état de l'économie de la région. L'analyse montre aussi que juste avant les période de grandes turbulences financières, notamment les crises financières, le transfert du risque de crédit est très important augmentant ainsi les contagions et par la suite le risque systémique. Cependant, la propagation de la méfiance et de la prudence pendant les périodes d'incertitude et des crises, fait baisser significativement le transfert du risque de crédit. Ceci s'accentue dans une zone monétaire comme la zone Euro puisque les pays adoptent forcément les mêmes politiques monétaires voire fiscales malgré leur hétérogéniété.
**Mots-clés** : Risque de Crédit, La Zone Euro, Fondamentaux Macroéconomiques, Transfert du risque de crédit, Risque systémique, Connectivité.

2. Bounds testing approach to cointegration

# Abstract

The outbreak of the Subprime debt in 2007, followed by the European debt crisis in 2011, drew attention to credit risk, its causes and implications. Since then, the economic policy makers are seeking to find a way to regulate the movements on the bond and debt market. Thus, the Basel III appeared under the guidance of the Financial Stability Board. These are reforms aiming at strengthening the financial system in order to assert the financial soundness of banks by imposing loan conditions and requirements including a minimum level of Capital.

Works studying the credit risk with its different fronts boomed. Credit risk modeling has expanded tremendously. This thesis fits into a macroeconomic branch on a European scale. We try to identify the determinants of credit risk on the sovereign and banking levels and to study the connections between both.

In the first section, Using Autoregressive Distributed Lag Modeling (ARDL), we empirically investigate the link between the macroeconomic fundamentals and sovereign credit risk for particular countries in the Euro zone. The studied sample was affected by disadvantageous economic conditions.

We did not retain the same macroeconomic factors to explain the risk of default for the selected countries. The results, indicate that the creditworthiness of the studied entities depends largely on macroeconomic fundamentals with various elasticities which require a different economic policy for each country. The assessment of the results shows that the unemployment rate is the most influential variable especially for countries with disadvantageous economic conditions. The estimated relationships are globally stable in the long run (for 7 out of 9 countries), while

the short run links are rare (except the unemployment rate).
In the second section, we investigate the long-run relationships between European Banks' Credit default swap spreads and contextual factors using Bounds testing approach to cointegration (ARDL-ECM). The results reveal that in the long run, an increase of the inflation and/or the home countries' credit risk rise the European banks' credit risk as measured by credit default swap spreads. The estimates suggest that the devaluation of the Euro, makes Euro-denominated debt less costly which lowers the credit risk of the European entities. Yet, unlike what is expected, our analysis shows that the market value of an entity as well as the stock index in which the firm is registered are becoming insignificant in explaining its credit risk.
In this last section, we investigate the evolution and the expansion of the CDS network among the studied entities over the 2008 - 2013 period by splitting it into three sub-periods. We highlight the variation of the connectedness according to the financial and economic characteristics of each studied sub-period. We found that the resulting relationships are not symmetrical and that they vary considerably depending on the state of the region economy. We also show that just before huge financial turmoil phases, the risk transfer is very important increasing contagion and the systemic risk, while it drops significantly during uncertainty times marked by mistrust spread. This is particularly important in the European Union as countries adopt the same monetary policies while being heterogeneous.
**Keywords**: Credit Risk, Euro-Zone, Macroeconomic fundamentals, Credit risk transfer, Systemic Risk, connectivity.

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# Introduction générale

## Introduction

L'étude du risque de crédit a connu un développement rapide en raison de son importance croissante et de ses effets de plus en plus globaux. Les individus, les banques, les organismes de crédit, voire les économies sont interliés à travers leurs endettements et leurs solvabilités. Le défaut ou le non remboursement d'une entité a un effet direct sur les entités prêteuses mais aussi un effet indirect sur les autres entités prêteuses et emprunteuses de celle-ci. Les activités d'endettements entraînent des liens étroits entre les contreparties qui s'accompagnent par un transfert du risque de crédit. Ceci se fait généralement par le biais des produits financiers complexes ce qui engendre une opacité quant à la qualité du produit.
Depuis la crise des Subprimes dont les manifestations sont devenues publiques à partir de 2007, une grande partie des sommets économiques, notamment les européens essayent d'étudier les causes de ce risque afin d'en limiter les effets et la propagation. En effet, cette crise a pris au dépourvu les régulateurs qui ne s'y attendaient pas d'où la déclaration des experts du Fonds monétaire international qu'" en dépit de la volatilité récente sur les marchés financiers, la croissance mon-

diale devrait rester vigoureuse en 2007 et en 2008".
La crise de la dette Européenne qu a suivi, n'a fait qu'empirer la situation des systèmes financiers et économiques internationaux. Cette crise est une manifestation des effets du risque de crédit à l'échelle macroéconomique.

# Motivation

les chocs récents sur le marché de la dette europénne ont attiré l'attention des intervenants des marchés financiers sur la forte croissance des montants concernés par le risque de crédit bancaire et souverain dans le système financier global. Après la crise des Subprimes, Ces préoccupations se sont accrues avec l'élargissement rapide de tous les spreads de crédit dans toute l'Europe dans le sillage de la crise de la dette Grecque et Irlandaise. Cet élargissement a également soulevé des craintes que le risque de crédit souverain soit beaucoup plus de nature systémique que ce qui a été prévu.
Comprendre les causes, le transfert et les implications de ce risque est essentiel et fondamental pour les régulateurs et les décideurs politiques. Cependant quelques difficultés limitent notre capacité à étudier empiriquement le phénomène global. Par exemple, il n ya toujours pas de consensus quant au meilleur estimateur du risque de crédit, ce qui est primordial dans l'appréciation de la qualité d'un créancier. Le choix d'un proxy fiable peut emmener les débiteurs à rentabiliser leurs investissements e tout en minimisant les risques.
Dans ce contexte, nous essayons de comprendre le risque de crédit dans la zone euro au niveau souverain ainsi qu'au niveau bancaire et les canaux de transmission entre les différentes entités.
Pour ce faire, nous nous proposons d'étudier empiriquement les déterminants du risque de crédit pour des échantillons de souverains et groupes bancaires Européens

et d'identifier comment se fait la contagion et comment le défaut d'une entité peut prendre des dimensions systémiques.

# Overview

## Chapitre I

Dans le premier chapitre, on présente la revue de la littérature la plus importante et la plus influente portant sur le sujet. Le risque de crédit a connu plusieurs modélisations s'inscrivant dans différentes approches. La première est la l'approche structurelle initiée par Merton 1974 en 1974. La deuxième famille de modèle à savoir les modèles de forme réduite a vu le jour avec celui de Jarrow and Turnbull 1995. La troisième approche est l'approche économétrique lancée par Wilson 1998, son modèle a été publié par McKinsey & company en 1998.

## Chapitre II

Dans ce chapitre, nous étudions empiriquement le lien entre les fondamentaux macroéconomiques et le risque de crédit souverain pour certains pays de la Zone euro, à savoir: l'Autriche, Pays-Bas, Luxembourg, Belgique, France, Allemagne, Italie, Espagne et Portugal. L'échantillon étudié a été affecté par des conditions économiques défavorables.
Ainsi, l'identification des déterminants du risque de crédit est cruciale et nécessaire pour une meilleure compréhension de la crise. À l'aide du modèle autorégressif à retards échelonnés (ARDL), nous n'avons pas validé les mêmes facteurs macroéconomiques pour expliquer le risque de défaut des pays sélectionnés. Les modèles retenus, en plus d'expliquer dans quelle mesure le risque de crédit réagit aux variations des variables explicatives, ils servent d'outils pour les stress tests. Les résul-

tats indiquent que la solvabilité des entités étudiées dépend en grande partie des fondamentaux macroéconomiques avec des élasticités différentes ce qui nécessite une politique économique distincte pour chaque pays. Par ailleurs, l'évaluation des résultats montre que le taux de chômage est l'une des variables les plus influente quant à la solvabilité des pays Européens étudiés, notamment quand il s'agit des pays ayant des conditions économiques assez critiques.

## Chapitre III

le chapitre 3 examine les relations de long terme entre les credit default swap CDS d'un échantillon de groupes bancaires Européens avec des facteurs contextuels macroéconomiques et spécifiques aux banques étudiée en utilisant les Bounds testing approach to cointegration (ARDL-ECM).
En utilisant les Credit default swap spreads comme proxy du risque de crédit, les résultats révèlent que dans le long terme, une augmentation de l'inflation et / ou du risque de crédit du pays d'origine s'accompagnent de l'accroissement du risque de crédit de l'entité étudié. Les estimations suggèrent que la dévaluation de l'euro, rend dette libellée en euros moins coûteuse ce qui baisse le risque de crédit des entités Européennes. Cependant, contrairement à ce qui est attendu, notre analyse montre que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la société est inscrite ne sont pas pertinents dans l'explication de son risque de crédit.

## Chapitre IV

Dans ce chapitre nous allons nous concentrer sur le transfert du risque de crédit entre les entités étudiées dans les chapitres précédents. En effet, la connectivité croissante des marchés mondiaux est due à plusieurs facteurs. Toutefois, après les dernières crises financières, le facteur du risque de crédit est devenu le plus déterminant. en utilisant les tests de causalité au sens de Granger, nous avons construit un réseau de Credit default Swap reliant des entités souveraines et bancaires européennes. Nous étudions l'évolution et l'expansion de ce réseau durant la période de 2008-2013. Nous soulignons la variation des connectivités en fonction des caractéristiques économiques et financières de chaque sous-période étudiée. Nous avons observé que les liens obtenus ne sont pas symétriques et qu'ils varient considérablement en fonction de l'état de l'économie de la Zone Euro. Nous montrons aussi que juste avant les phases de turbulences financières, le transfert de risque est très important ce qui engendre la monté de la contagion et favorisant le risque systémique. Néanmoins, ce transfert diminue de façon significative pendant les périodes d'incertitude marquées par la propagation de la méfiance. Ceci est particulièrement important dans l'Union européenne où des pays hétérogènes adoptent les mêmes politiques monétaires.

# Littérature

## Introduction

Le risque de crédit est le premier risque auquel est confronté un établissement financier dès lors qu'il décide d'accorder un crédit et de se mettre en situation d'attente de fonds en remboursement de la part d'une autre partie. Il est lié á l'ambiguïté quant aux conséquences futures du contrat établit. L'exposition au risque représente le montant de la perte que l'établissement pîeteur peut encourir dans le cadre des opérations de crédit à partir du moment où l'emprunteur se trouve incapable d'honorer ses engagements au cours de la vie de l'opération; ainsi, le risque de crédit provient du défaut ou de la détérioration d de la qualité de la contrepartie créancière.
Plus généralement, on peut dire que ce risque nait de l'incertitude quant à la possibilité ou la volonté des contreparties ou clients de remplir leurs engagements c à d le remboursement du crédit octroyé par l'institution prêteuse.
Le risque de crédit est alors fonction de trois paramètres principaux à savoir le montant de la créance, la probabilité de défaut et la partie qui ne pourra pas être recouvrée en cas de survenance de défaut ce qui correspond à (1 - R) où R est le

taux de récupération.
L'objectif est d'arriver à une estimation de la probabilité de défaut, pour ce faire il existe plusieurs modèles qui s'inscrivent dans différentes approches : modèles structurels, modèles de forme réduite, et modèles économétriques.

Les modèles structurels

Appelés aussi les modèles de valeur de la firme [3] dans la mesure où cette approche essaye d'expliquer le défaut par les variables économiques de la firme, ainsi cette dernière est en faillite dès lors que la valeur de ses actifs passe en dessous de la valeur de sa dette.

Les modèles de forme réduite

Dans ces modèles, le défaut est un évenement imprévisible qui suit un processus de poisson qui se traduit par une baisse brusque de la valeur de la firme.

Les modèles économétriques

Ces modèles sont surtout utilisés pour un secteur de l'économie ou un pays et prennent en considération l'état de l'économie comme facteur provocant le défaut, ainsi, la probabilité de défaut s'explique par différents facteurs macroéconomiques tels que le taux d'intérêt de long terme, le taux de croissance du PIB...

## Les modèles structurels

Initié par Merton 1974 en application directe du modèle Black-Scholes 1973, les modèles structurels sont purement dictés par la théorie, en effet, en évaluant la dette risquée, l'évènement de défaut survient lorsque les actifs de la firme (à savoir la valeur de marché de ses actions) perdent de la valeur de telle sorte que l'entreprise n'est plus en mesure de payer sa dette, concrètement on peut dire que ce qu'elle possède est inférieur à ce qu'elle doit rembourser. Dans cette approche,

3. les composantes de son bilan comptable

l'évalution de la dette se fait par la théorie des options. L'action ainsi que la dette de la firme s'analysent comme étant des produits dérivés sur la valeur totale de ses actifs.
Dans cette première partie théorique, nous allons présenter le modèle structurel de base à savoir celui de Merton 1974 ainsi que les extensions les plus marquantes. Black and Cox 1976 ont développé le premier prolongement du modèle initial en essayant de remédier à certaines limites de ce dernier. Sur le plan pratique, il y a notamment le modèle de KMV qui utilise le cadre structurel pour calculer la distance au défaut pour une entité donnée.

## le modèle de Merton

Les travaux de Robert Merton (Merton 1974)pour les quels il a reçu le prix Nobel en économie en 1997 ont aboutit au premier modèle structurel de risque de crédit, celui-ci se base sur le fait que les valorisations ainsi que les risques des actions et de la dette d'une entreprise sont rigoureusement liées puisqu'elles s'appuient sur les mêmes cashflow générés par les actifs de cette dernière, il adapte par la suite le modèle de Black-Scholes-Merton [4] sur les produits dérivés au risque de crédit.

### calcul de la probabilité de défaut

Si l'on considère une entreprise dont le bilan économique est représenté par le tableau suivant: Ainsi l'actif de cette entreprise est financé par des fonds propres

| Actif | Passif |
|---|---|
| Actif...$V_t$ | Capital...$S_t$<br>Dette...$D_t$ |

4. Le modèle Black-Scholes-Merton est un modèle mathématique du marché pour une action dans lequel le prix de l'action est un processus stochastique (see Black and Scholes 1973)

à la propriété des actionnaires (Capital $S_t$) ainsi que par une dette zéro coupon détenue par les créanciers(Dettes$D_t$) (valorisés tous les deux en valeur de marché). Les actifs de l'entreprise suivent un processus de diffusion [5] Wiener Standard qui est un processus continu, il est de la forme:

$$dV_t = rdt + \sigma_V dB_t \tag{1}$$

Où:

- r est le taux d'intèrêt sans risque (fixe)
- $\sigma_V$ est la volatilité de la valeur des actifs (supposée constante (voir GROUARD et al. 2003) [6])
- B est un processus de Wiener Standard [7].

les hypothèses du modèle sont :

- la dette est constituée d'un zéro coupon [8] de valeur nominale D et de maturité T=1 qui correspond à une période.
- L'entreprise est liquidée à l'échéance T de la dette.

À l'échéance, deux situations sont alors possibles:

1. $V(T) < D$: la société est en faillite, les actionnaires font défaut et paient les créanciers par la valeur des actifs.
2. $V(T) > D$: solder les actifs, rembourser les créanciers et empocher ce qui reste, le reliquat sera réparti entre les actionnaires au prorata de leurs parts

5. Un processus de diffusion est un processus de Markov à trajectoires continues donc le processus est indexé selon un temps continu
6. hypothèse très forte et ne reflète pas la réalité puisqu'on a empiriquement constaté que les actifs financiers sont généralement très volatils
7. Nommé en l'honneur de Norbert Weiner, appelé aussi mouvement brownien d'après Robert Brown; C'est une description mathématique d'un mouvement aléatoire à temps continu.
8. Une obligation à zéro coupon se définit comme étant une obligation sans versement d'intérêts durant toute sa durée de vie, les intérêts sont versés en totalité à l'échéance de l'emprunt après capitalisation

du capital de la société.

Dans cette perception, les actions ainsi que la dette peuvent être interprétées comme étant des produits dérivés sur les actifs de la société comme sous-jacent.
**Pour les actionnaires** : La détention d'une action est équivalente à être long [9] sur un call [10] sur la valeur des actifs $V_t$ de prix d'exercice [11] D et d'échéance T.

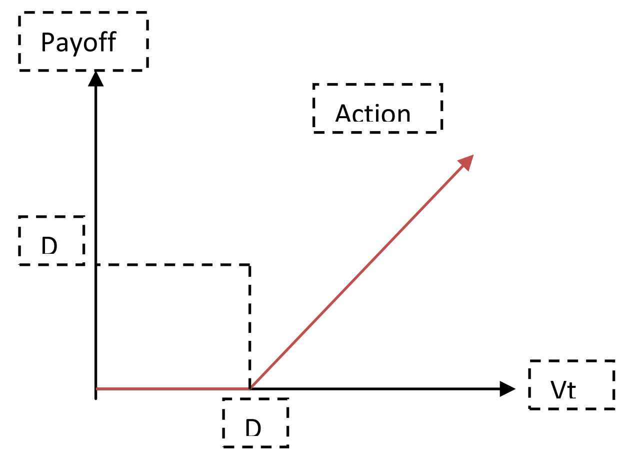



Figure 1: position des actionnaires

- $V_t$ c'est la valeur de l'actif qui varie.
- Le strike D qui représente le prix critique qui détermine s'il y a ou non exercice de l'option ( mise en faillite ou pas).
- Échéance T qui, dans le modéle de Merton, correspond a la date à laquelle l'entreprise peut ou non faire faillite.

**Pour les créanciers** : leur position est équivalente à la détention d'une zéro-coupon sans risque de valeur nominale D avec une position courte sur un Put sur

9. Une position acheteuse prise sur le marché
10. Un Call est une option donnant à son acheteur le droit, mais non l'obligation d'acheter l'actif sous-jacent
11. Le Prix d'exerciced'une option correspond au prix auquel est convenu d'être acheté ou vendu l'actif sous-jacent, appelé également le Strike

la valeur des actifs de Strike D et d'échéance T. En appliquant la valorisation par

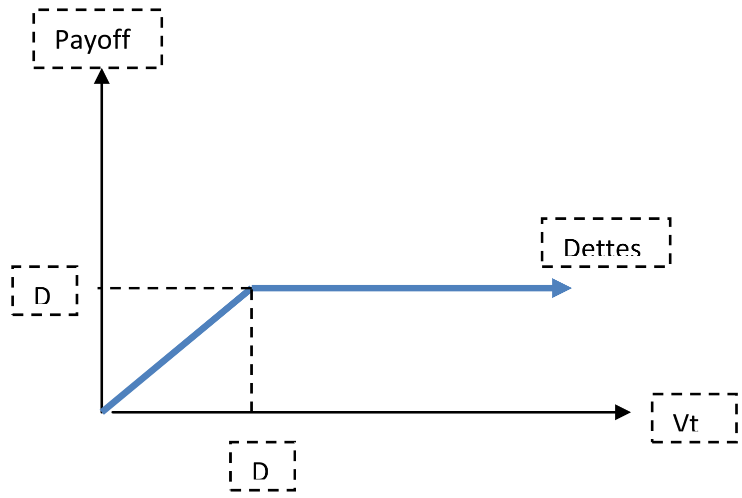



Figure 2: position des créanciers

actualisation selon l'éspérance des Cashflows sous probabilité risque-neutre à la valeur de la dette on obtient:

$$D_t = e^{-rT} * E[Min(V_T, D)] \tag{2}$$

$e^{-rT}$ est le facteur d'actualisation sans risque de date t et de maturité T:

$$D_t = e^{-rT}D - e^{-rT}E[Max(0, (D - V_T))] \tag{3}$$

car $[Min(a, b) = a - Max(0, a - b)]$

Comme présenté ci-dessous, le modèle de Merton se base sur la théorie d'option pour valoriser la dette et les actions, notamment sur la formule de Black and Scholes 1973 [12]

12. Formule de Black-Scholes pour un put : $P(V_0, D, r, t, \sigma) = -V_0\mathcal{N}(-d_1) + De^{-rt}\mathcal{N}(-d_2)$

$$D_t = e^{-rt}D - e^{-rt}E[Max(0,(D - V_T))] \tag{4}$$

$$D_t = e^{-rt}D - [-V_t\mathcal{N}(-d_1) + De^{-rt}\mathcal{N}(-d_2)] \tag{5}$$

$$D_t = V_t\mathcal{N}(-d_1) + De^{-rt}[1 - \mathcal{N}(-d_2)] \tag{6}$$

$$D_t = V_t\mathcal{N}(-d_1) + De^{-rt}\mathcal{N}(d_2) \tag{7}$$

Où:

$$d_1 = \frac{Ln(\frac{V_0}{D}) + (r + 0,5\sigma_v^2)(T - t)}{\sigma_v\sqrt{T - t}} et d_2 = d_1 - \sigma_v\sqrt{T - t} \tag{8}$$

Et $\mathcal{N}(.)$ : la fonction de répartition de la loi normale centrée réduite

**La valeur de marché des capitaux propres $S_t$**

$$S_t = V_t\mathcal{N}(d_1) - De^{-rt}\mathcal{N}(d_2) \tag{9}$$

**Probabilité de défaut**

$$P = \mathcal{N}(-d_2) = 1 - \mathcal{N}(d_2) \tag{10}$$

**Calcul du spread de crédit**

$$D_0 = De^{-r_i t} \Longleftrightarrow e^{-r_i t} = \frac{D_0}{D} \Longleftrightarrow r_i = \frac{Ln\frac{D}{D_0}}{t} \tag{11}$$

Où $r_i$ : Le taux de rendement de la dette Et S : Le spread de crédit $S = r_i - r$

**Calcul du taux de recouvrement R**

$$S = \frac{1}{tQ(1-R)} \tag{12}$$

Où Q : la probabilité cumulée de défaut.

**Limites du modèle**

Le modèle de Merton est très restrictif et est critiqué pour ses hypothèses irréalistes. En effet, il s'appuie sur l'hypothèse de l'efficience du marché des actions, ainsi la firme est considérée correctement évaluée par le prix côté. Aussi, le fait que le défaut ne peut survenir qu'à la date de l'échéance de la dette est une hypothèse utopique. La structure plate des taux d'intérêt fait qu'ils soient considérés constants par l'application du modèle B-S. Le modèle de Merton ne prend en compte que les obligations zéro-coupon et le défaut est totalement endogège aux variables économique de l'entreprise, il est parfaitement pévisible à travers celles-ci, or dans la réalité, il y a des firmes qui survivent bien que leurs valeurs soit au-dessous de la valeur nominale de la dette et d'un autre côté, il y a des entreprise en faillite alors que leurs valeurs restent au-dessus de la valeur nominale de leurs dettes.

## Le modèle de Black et Cox

Black and Cox 1976 dans une extension du modèle de Merton 1974 ont réussi à abandonner l'hypothèse de la date unique de banqueroute à savoir l'échéance de la dette. Ainsi la faillite de la firme peut survenir dès que la valeur de celle-ci passe en deçà d'un seuil critique à n'importe quel instant entre l'accord de la dette et son échéance.

### calcul de la probabilité de défaut

B-C assument que les actionnaires reçoivent des dividendes continuellement et proportionnellement à la valeur de la firme ($C = \kappa V$), ainsi, la valeur de cette dernière suit le processus :

$$dV_t = V(r - \kappa)dt + V\sigma_v dBt \tag{13}$$

Où $\kappa$ : représente le taux continu de paiement de dividendes qui est considéré constant.
Comme le montre le graphique,le modèle de Merton ne permet pas une faillite avant l'échéance même si la valeur des actifs de la firme passent en dessous de la valeur de la dette à rembourser à une date antérieure au terme du contrat du prêt, ainsi le modèle de B-C est le premier des First-Passage modèles, ainsi, la spécificité de ce modèle par rapport au modèle de Merton est que le temps de défaut est une fonction du temps.

$$\tau = inft > 0 : V(t) < K(t) \tag{14}$$

$$K(t) = Ke^{-\gamma(T-t)}$$

avec $K, \gamma > 0$ où K(t) est la barrière qui déclenche la faillite de l'entreprise, c'est-à-dire le premier instant où la valeur de celle-ci devient inférieure au seuil. si la firme fait défaut, les créanciers reçoivent alors un recouvrement proportionnel à la valeur de l'entreprise au moment du défaut :

$$\zeta_1 V(\tau) \text{ en } \tau \text{ si } \tau < T$$

$$\zeta_2 V(T) \text{ en T si } \tau = T$$

avec $\zeta_1, \zeta_2 > 0$
Black et Cox ont aussi introduit les pactes de sécurité (Safety convenants) qui donnent le droit aux créanciers de choisir, si l'entreprise se porte mal, entre la forcer à faire faillite et par la suite la liquider et vendre ses actifs dont le produit sera réparti entre les détenteurs de droits contre la firme selon leur classement, ou alors renégocier les termes du contrat.
Safety Covenants [13]
On parle de mauvaise performance selon B-C(76) en comparant la valeur de l'entreprise à une barrière déterministe.

$$K(t) = Ke^{-\delta(T-t)} \text{ Où } t \in [0, T] \text{ et } K, \delta > 0$$

Ainsi, la firme se porte mal dès que la valeur de ses actifs $V_t$ touchent cette barrière et les créanciers peuvent s'en emparer sinon il y a défaut à la maturité ou pas selon la valeur des actifs (si $V_T < D$ ou pas).

$$\text{La barrière } = K(t) \text{ si } \tau < T$$

$$k(T) = D \text{ si } \tau = T$$

13. M.Mahfoudhi,"the design of safety covenant-protected debts", Department of Finance, Laval University

L'instant de défaut $\tau$ peut alors être écrit :

$$\tau = \text{inf} t \in [0, T] : V_t \leq k(t)t \qquad (15)$$

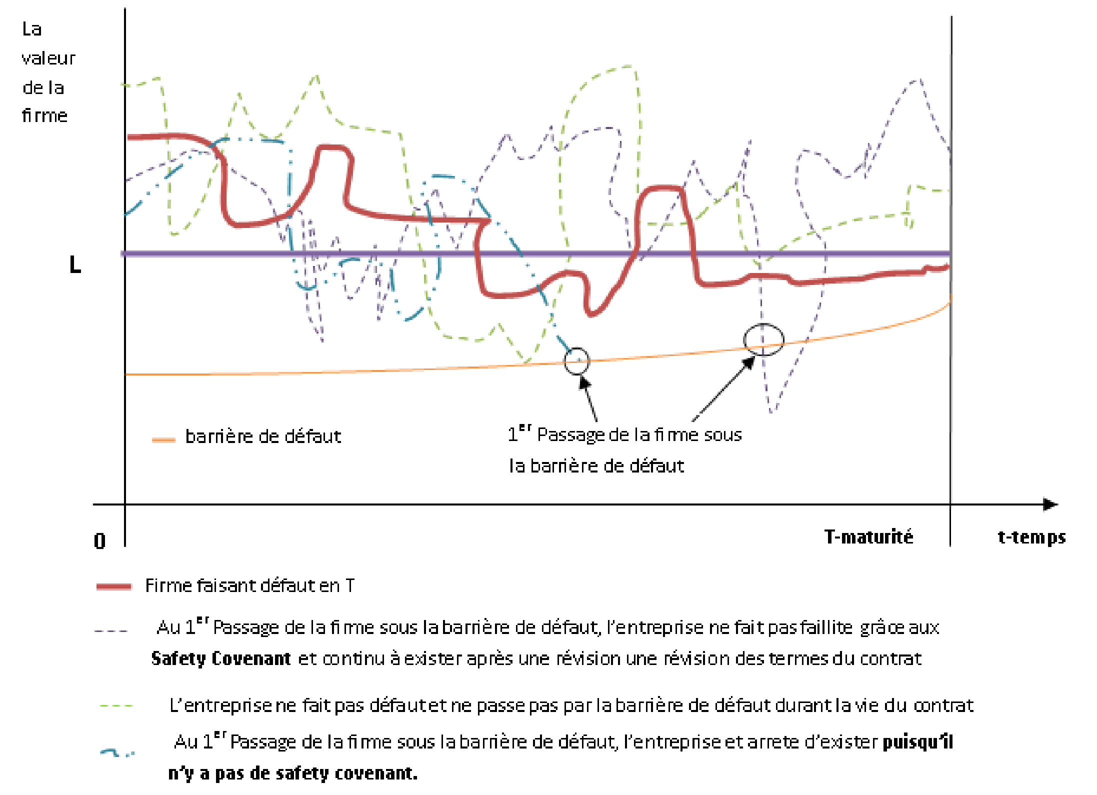



Figure 3: l'instant de défaut selon la valeur de la firme, la barrière et le contrat (Safety covenant ou pas)

Sachant que dans ce papier B-C ont pris le cas exceptionnel où $\zeta_1 = \zeta_2 = 1$ c. à. d que s'il y a défaut les créanciers se partagent toute la valeur des actifs de l'entreprise.

Il va de soi qu'il faut mettre la condition :

$$Ke^{-\delta(T-t)} \leq De^{-r(T-t)} \qquad (16)$$

Ce qui signifie que ce que perçoivent les créanciers ne peut en aucun cas dépasser la valeur de la dette actualisée au taux sans risque. On obtient alors :

$$D(t,T) = E_P^*(D(V_\tau,\tau)/F_t) \tag{17}$$

$$D(t,T) = E_P^*(De^{-r(T-t)} \sqcup \bar{\tau} \geq T, V_T \geq D/F_t)(A) \tag{18}$$

$$+E_P^*(\zeta_1 V_T e^{-r(T-t)} \sqcup \bar{\tau} \geq T, V_T \leq D/F_t)(B)$$

$$+E_P^*(\zeta_2 K e^{-\delta(T-\bar{\tau}} e^{-r(T-t)}) \sqcup t \leq \bar{\tau} \leq T/F_t)(C)$$

- $(A)$ : Valeur de la dette en cas de non défaut : puisque l'instant de défaut $\tau$ est postereieur à l'échéchance de la dette T et que la valeur des actifs de la firme dépasse le montant dû D.
- $(B)$ : Valeur de la dette en cas de défaut à la maturité (ou après) : on parle de défaut puisqu'à l'échéance T la valeur des actifs est inférieure au montant dû D.
- $(C)$ : Valeur de la dette en cas de défaut avant la matutité.

Ainsi, après défaut avant maturité càd dans le cas où $\tau < T$, ca qui présente le plus grand risque pour le prêteur, nous avons :

$$D(t,T) = \beta_2 K e^{-\delta(T-\bar{\tau}} e^{-r(T-t)} \tag{19}$$

La probabilité de défaut pour le modèle de Black et Cox sera donnée par :

$$P = \mathcal{N}(h_1) + e^{2[r-\frac{\sigma_v^2}{2}][Ln[\frac{K}{V_0}][\frac{1}{\sigma_v^2}]}\mathcal{N}(h_2) \tag{20}$$

Où $h_1 = \frac{Ln(\frac{K}{e^r T V_0})+0,5\sigma_v^2 T}{\sigma_v\sqrt{T}}$ et $h_2 = \mathcal{N}(h_1) - \sigma_v\sqrt{T}$

**Limites du modèle de B-C**

Même si le modèle de B-C corrige le défaut principal du modèle de Merton (Pas de défaut avant la maturité),cela n'empêche pas que Black et Cox se basent sur une hypothèse forte et pas réaliste à savoir celle de l'absence de coûts de faillite.

## le modèle de KMV

Le modèle KMV ( Kealhofer, McQuown et Vasicek) qui est détenu par Moody's [14] depuis 2002. Il a été développé par Morgan and Hunt 1994 et se base sur le modèle de Merton dans la determination de la probabilité du risque de défaillance dans la mesure où le défaut intervient lorsque la valeur des actifs sous un certain seuil.
Le modèle KMV considère les actions comme des Down-and-Out options [15], c'est-à-dire qui cessent d'exister lorsque le prix du titre sous-jacent atteint une barrière de niveau de prix particulier.
Si le prix du sous-jacent n'atteint pas cette barrière, l'investisseur à alors le droit d'exercer son call Européen ou son put au prix d'exercice du contrat. dans le modèle KMV, on peut assimiler les actions de l'entreprise ùne option perpétuelle.

$$\text{Distance au défaut DD} = \frac{\text{valeur de marché des actifs} - \text{point de défaut}}{\text{valeur de marché des actifs} * \sigma}$$

Où le point de défaut représente la barrière qui peut absorber la valeur de tous les actifs de la firme. Le risque de défaut accroît à mesure que la valeur des actifs devient plus proche de la valeur comptable des engagements. Si la DD obtenue

14. Agence de notation qui fournit des ratings ainsi que le logiciel Credit Monitor qui permet de calculer les valeurs de EDF par émetteur pour des horizons de 1 à 5 ans
15. C'est un type d'options Knock-out barrier, c. à. d une option à barrière qui s'active ou se désactive si le sous-jacent atteint ou n'atteint pas une valeur.
S.G.Kou, ON Pricing of discrete Barrier Options Statistica 13 (2003) 955-964

est égale à X, cela signifie, que pour atteindre le défaut, il faut que la valeur des actifs baisse de $X\sigma$.
les étapes suivies pour calculer la probabilité de défaut sont :

1. Estimation de la valeur des actifs de l'entreprise ainsi que leur volatilité
2. Calcul de la distance au défaut
3. Calcul de la probabilité de défaut

Dans le modèle de KMV, la structure de capital est très simplifiée, elle est financée par des actions et un zéro-coupon de maturité T. Si la valeur des dettes est connue et déterminée sur le marché, alors l'évaluation des actifs serait simple à savoir la somme des valeurs des actifs et de la dette. Or, pour la plupart des firmes, on ne peut observer que la valeur des actions, dans ce cas l'alternative est de passer par l'approche des Options-Pricing de Black-Scholes (1993) selon laquelle les actions sont des calls ayant pour sous-jacent les actifs de la firme. La figure 4 résume le processus entier :

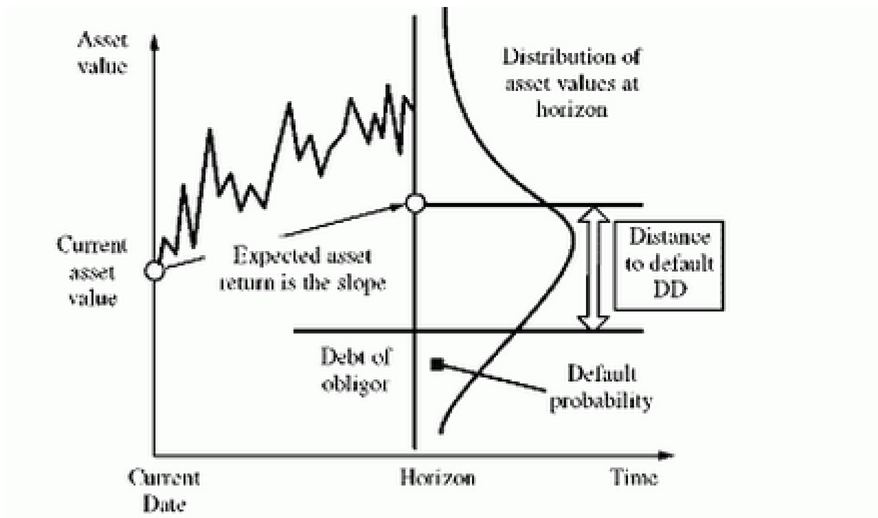



Figure 4: Modélisation de l'EDF selon KMV

C'est pourquoi, le modèle de KMV s'applique principalement aux firmes cotées en bourse.
Ainsi, on peut obtenir la valeur des Actifs et la volatilité de celle-ci d'après la relation:

$$E = f(V, \sigma_v, L, c, r)$$

$$\sigma_E = g(v, \sigma_v, L, c, r)$$

**Calcul de la probabilité de défaut**

Etant donnée la valeur des actions et la volatilité de celle-ci (si cette dernière est observable) on arrive à déterminer V et $\sigma_v$.
Dans le cas contraire, c'est-à-dire le cas où la volatilité des actions n'est pas observable ce qui est le plus réaliste, la solution est de passer par le Lemme d'Itô pour calculer V et $\sigma_v$ en fonction de E et $\sigma_E$, puisqu'il est indispensable de se doter d'une deuxième équation.
r: le taux d'intérêt sans risque, L: le ratio de Levier, c: le coupon de long terme.
Les actifs de la firme suivent un processus :

$$Ln(V(t)) = Ln(V) + (\mu + \frac{\sigma^2}{2})t + \sigma\sqrt{t}\varepsilon \qquad (21)$$

Où $\mu$ représente le rendement attendu des actifs de la firme(c'est à dire le t'intérêt risqué).
le défaut survient dès que la valeur de l'entreprise passe en deça de la valeur de ses engagements. C'est-à-dire :

$$\log(V(t)) \leq \log(D(t)) \qquad (22)$$

$$\leftrightarrow \log(V) + (\mu + \frac{\sigma^2}{2}t + \sigma\sqrt{t}\varepsilon) \leq \log(D(t)) \tag{23}$$

$$\leftrightarrow \frac{Ln(\frac{V}{D(t)}) + (\mu - \frac{\sigma^2}{2})t}{\sigma\sqrt{t}} \leq -\varepsilon \tag{24}$$

Ainsi, la probabilité que la firme fasse défaut est :

$$P(t) = Proba[\frac{Ln(\frac{V}{D(t)}) + (\mu - \frac{\sigma^2}{2})t}{\sigma\sqrt{t}} \leq -\varepsilon] \tag{25}$$

$$\leftrightarrow P(t) = \mathcal{N}[-\frac{Ln(\frac{V}{D(t)}) + (\mu - \frac{\sigma^2}{2})t}{\sigma\sqrt{t}}] = \mathcal{N}[-d_2]$$

:EDF : Expected Default Frequency (26)

Où la distance au défaut $DD = \frac{Ln(\frac{V}{D(t)})+(\mu-\frac{\sigma^2}{2})t}{\sigma\sqrt{t}}$

En effet, plus la distance au défaut est grande, moins la probabilité de défaut est importante.

L'avantage que présente le modèle KMV c'est que contrairement à la majorité des approches de risque de crédit utilisées par les agences de notation, celle-ci fournit un classement cardinal. Si l'on a des informations exactes et opportunes sur le marché des actions, on peut réussir un suivi et un monitoring continu ce qui augmente le degré de vigilance.

### Limites du modèle

Bien que plus réaliste que la plupart des autres modèles structurels, dans le modèle KMV, il est indispensable de passer par l'hypothèse de la normalité des

rendement des actifs afin de construire de EDF théorique, ce qui n'est pas réaliste; Aussi l'un des problème de cette modélisation c'est qu'on distingue pas entre les différents types d'obligations à long terme en fonction de leur seniorité, les garanties, les engagements, ou la convertibilité.
Pour les entreprises qui ne sont pas côtées, on ne peut déterminer les EDF qu'en passant par une analyse comparative.
En pratique, la probabilité de défaut ne suit pas une loi normale ce qui explique les bases de données historiques utilisées par KMV. Dans ces Tables, on trouve pour chaque horizon temporel, le pourcentage d'entreprise ayant fait défaut pour une distance au défaut donnée.

## Les modèles de forme réduite

Cette approche essaye de modéliser le défaut mais pas à partir de ses causes, elle néglige notamment les origines économiques de la défaillance; En effet, on considère qu'il n y a pas de lien entre la structure de l'entreprise et le risque de défaut. Ainsi on se base principalement sur les données que l'on observe sur le marché.
Pour les modèles de cette approche, le défaut est un évènement imprévisible, de ce fait, ils supposent qu'il survient au premier saut d'un processus de poisson(Jacod 2003) (qui est un processus de diffusion continu généralement utilisé pour modéliser les évènements rares). Ceci va nous permettre d'identifier la date de défaut, et plus le saut est important, plus l'ampleur du défaut est grande.
L'intensité de défaut que l'on cherche à déterminer correspond à l'intensité du processus de poisson étudié qui n'est autre que la probabilité instantannée de défaut, c'est pourquoi ils sont aussi appelés modèles d'intensité. Le premier modèle de forme réduite est celui de Jarrow and Turnbull 1995 suivi par celui de Duffie

and J Singleton 1999

## Cadre général des modèles de forme réduite

L'hypothèse principale est l'absence d'arbitrage qui se traduit par le fait que les prix des actifs financiers actualisés sont égaux aux éspérance des pay-offs futurs actualisés. Ainsi on se place dans le cadre d'un éspace probabilisé $(\Omega, \mathcal{G}, \mathbb{P})$ [16] où $\mathbb{P}$ est une probabilité risque-neutre pour que les prix des actifs financiers actualisés soient des martingales.
On considère en outre une première filtration [17] entrainée par les prix des actifs financiers.
$\mathbb{F} := (\mathcal{F}_t)$où$t > 0$ : C'est à dire l'ensemble des informations apportées par le marché à travers les données et les prix des actifs ( comme une information apportée par la baisse des prix...).
L'instant de défaut $\tau$ est modélisé par une variable aléatoire positive définie sur $(\Omega, \mathcal{G}, \mathbb{P})$.

$(\mathcal{H}_t) := 1_{\tau<t}$ : Le processus qui vaut 1 si le défaut survient c'est à dire lorsque $\tau < t$ et 0 sinon.

D'où la filtration engendrée par ce processus :

$$\mathbb{H} := (\mathcal{H}_t)_{t>0} \text{où} \mathcal{H}_t = \sigma(H_u, u < t) \tag{27}$$

Cette filtration nous donne des informations apportées par l'instant de défaut. Les modèles de forme réduite supposent l'existence d'une filtration $(\mathcal{G}_t)$ contenant l'ensemble des informations à propos du défaut. On introduit alors cette filtration

16. $\Omega$ : L'univers, $\mathcal{G}$ : évenements
Philippe Briand :"Espaces Probabilisés", Septembre 2003
17. Olivier Roustant "Martingales" Janvier 2009

$\mathbb{G} := \mathbb{F} \vee \mathbb{H}$ qui nous donne une information encore plus riche contenant à la fois des renseignement provenant des prix des actifs et de l'instant de défaut.
$H_t$ est une sous-martingale $\forall t < s$ on a

$$1_{\tau<s} = 1_{\tau<t} + 1_{t<\tau<s} \tag{28}$$

En appliquant l'éspérance conditionnelle des deux côtés de l'égalité, on obtient :

$$E*(H_s/\mathcal{G}_t) = E*(1_{\tau<t}/\mathcal{G}_t) + E*(1_{t<\tau<s}/\mathcal{G}_t) > H_t \text{ puisque } t < s \tag{29}$$

La propriété du théorème Doob-Meyer (voir Karatzas 1991) assure qu'une sous-martingale notamment le processus de défaut $H_t$ peut être décomposée en la somme d'une martingale et d'un processus continu prévisible et croissant tel que :

$H_t = M_t + A_t$ Où $M_t$ : La martingale, et $A_t$: Le processus prévisible croissant.

Ainsi, il existe un seul processus positif F-adapté $(\lambda_t)$ tel que :

$$M_t := H_t - \int_0^t 1_{u<\tau}\lambda_u.d_u \tag{30}$$

<u>La valorisation risque-neutre de la dette risquée:</u>

On traite dans le cas général des modèles de forme réduite des zéro-coupons risqués de maturité T et de nominal 1 qui sont introduits par le couple $\tau, Z$:

- $\tau$ : l'instant de défaut
- $Z$ : Le processus de recouvrement du zéro-coupon s'il y a défaut avant la maturité T.
- $r_t$ : Le taux sans risque
- $B_t = exp(\int_0^t r_u.du)$

Soit D : Le processus de dividendes, donc

D = Z : Le processus de recouvrement en cas de défaut

$= 1$ (Le nominal de la dette) s'il n y a pas de défaut et que la dette est remboursée

$$\Longrightarrow D_t := \int_0^t Z_u dH_u + (1 - H_T) 1_{t=T}$$

Or, le prix du titre risqué actualisé s'écrit comme l'éspérance sous la probabilité risque-neutre du pay-off actualisé :

$$V_t := B_t \mathbb{E}\left[\int_t^T B_U^{-1} dD_u | \mathcal{G}_t\right] \tag{31}$$

$$V_t := B_t \mathbb{E}\left[\int_t^T B_U^{-1} Z_u dH_u + B_T^{-1} 1_{T<\tau} | \mathcal{G}_t\right]$$

$$V_t := B_t \mathbb{E}\left[B_\tau^{-1} Z_\tau 1_{t<\tau<T} + B_T^{-1} 1_{T<\tau} / \mathcal{G}_t\right]$$

$$V_t := B_t \mathbb{E}\left[\int_t^T B_U^{-1} Z_u (dM_u + 1_{u<\tau} \lambda_u . d_u + B_T^{-1} 1_{T<\tau} / \mathcal{G}_t\right]$$

Or $M_t$ est une martingale donc $\Rightarrow dM_u = 0$

$$\Rightarrow V_t := B_t \mathbb{E}\left[\int_t^T B_U^{-1} Z_u 1_{u<\tau} \lambda_u . d_u + B_T^{-1} 1_{T<\tau} | \mathcal{G}_t\right] \tag{32}$$

<u>Le prix de la dette risquée</u>: On pose

$$\Lambda_t = exp(\int_0^t \lambda_u du), \text{ sachant que } B_t = exp(\int_0^t r_u du)$$

alors

$$\Rightarrow \tilde{B}_t = \Lambda_t B_t = exp(\int_0^t (r_u + \lambda_u) du) \tag{33}$$

$$S_t = \tilde{B}_t \mathbb{E}\left[\int_t^T \tilde{B}_U^{-1} Z_u \lambda_u du + \tilde{B}_T^{-1} | \mathcal{G}_t\right] \quad (34)$$

$$S_t := B_t \mathbb{E}\left[\int_0^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} | \mathcal{G}_t\right] - \int_0^t B_U^{-1} Z_u \lambda_u du \quad (35)$$

En appliquant le Lemme d'Itô [18] on obtient :

$$dS_t = (r_t + \lambda_t) S_{t-} - Z_t \lambda_t dt + B_t dE \int_0^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} | \mathcal{G}_t \quad (36)$$

Ceci nous permet la valorisation du zéro-coupon risqué:

$$V_t = 1_{t<\tau} B_t E \int_t^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} / \mathcal{G}_t \quad (37)$$

## Le modèle de Jarrow et Turnbull(95)

Jarrow and Turnbull 1995 est le premier modèle de forme réduite. Ce modèle ainsi que les autres modèles d'intensité, cherchent à modéliser la brusquerie et la soudaineté de la survenance de l'évènement de défaut. Le processus de défaut dans ce premier modèle correspond à un simple saut Poissonien, d'où la constance du taux instantanné de défaut dans le temps $(= \lambda)$

### Probabilité de défaut, probabilité de survie

$$\tilde{B}_t = B_t e^{-\lambda t}$$

Particulièrement $1_{t<\tau} \mathbb{P}^*(T < \tau / \mathcal{G}_t) = e^{-\lambda t}$

C'est la probabilité de ne pas faire défaut jusqu'à l'échéance sachant que l'entité

18. L'un des principaux résultats de la théorie des calculs stochastiques. Geneviève Gauthier :Le Lemme d'Itô, les méthodes stochastiques dans les sciences de la gestion. Juin 2003

n'en a pas encore fait jusqu'à l'instant actuel t. D'où la probabilité de faire défaut c'est à dire $\mathbb{P}[\tau < t] = 1 - e^{-\lambda t}$

**Processus de recouvrement**

Robert A.Jarrow et Stuart Turnbull supposent que le recouvrement capitalisé au taux sans risque vaut une fraction déterministe $\delta$ du paiement total normalement du à savoir 1 qui est la valeur du nominal de la dette dans ce modèle. ceci s'écrit :

$$\delta = Z_u e^{\int_u^T r_s d_s} = Z_u B_T B_u^{-1}$$

D'où l'exogénéité et l'indépendance du taux de recouvrement du processus de défaut. Ainsi 37

$$V_t = 1_{t<\tau} B_t \mathbb{E}\left[\int_t^T B_u^{-1} Z_u \lambda_u du + B_T^{-1} / \mathcal{G}_t\right]$$

$$= 1_{t<\tau} B_t e^{\lambda t} \mathbb{E}\left[\int_t^T B_u^{-1} e^{-\lambda u} Z_u \lambda_u du + B_T^{-1} e^{-\lambda T} / \mathcal{G}_t\right]$$

$$= 1_{t<\tau} B_t e^{\lambda t} \mathbb{E}\left[\int_t^T B_u^{-1} e^{-\lambda u} \delta B_T^{-1} B_u \lambda du + e^{-\lambda T} B_T^{-1} / \mathcal{G}_t\right]$$

$$= 1_{t<\tau} \mathbb{E}\left[(B_t B_T^{-1}(\delta(\int_t^T e^{-\lambda(u-t)} \lambda du + e^{-\lambda T} e^{\lambda t}) / \mathcal{G}_t\right]$$

Or on a $B_{(t,T)} = \mathbb{E}\left[(B_t B_T^{-1} | \mathcal{G}_t\right]$ C'est le prix à l'instant t d'un zéro coupon sans risque d'échéance T. Ce qui nous permet la décomposition :

$$V_t = 1_{t<\tau} B_{(t,T)}(\delta(1 - e^{-\lambda(T-t)}) + e^{-\lambda(T-t)})$$

**Calcul du spread**

Pour calculer le spread adéquat à l'entité en question, il faudra trouver celui annule la valeur initiale du swap du CDS portant sur cette entité, ceci revient à égaliser les deux jambes de ce contrat s̀avoir la jambe payeuse et la jambe de protection. Concrètement: Si l'on pose :

- C : l'entité sur laquelle porte la protection de nominal 1
- A : l'acheteur de protection
- B : le vendeur de protection
- $T_N$ : la date de maturité du CDS
- $\tau$ : l'instant potentiel de défaut de l'entité C

L'acheteur de protection A paie aux différentes dates de paiement $T_n$ :

$$\bar{s}\ \delta_n 1_{(T_n<\tau)}$$

Où

- $\bar{s}$ : le taux du CDS forward
- $\delta_n$ : les intérêts produits entre $T_{(n-1)}$ et $T_n$

A l'instant de défaut A verse à B un dernier paiement qui est égal à la somme due entre le dernier paiement éffectué et l'instant de défaut.
Ainsi si l'on pose $n^*$ : la date du dernier versement avant le défaut, alors :

$$\Rightarrow n^* = max(n/T_n < \tau) \tag{38}$$

B reçoit alors

$$V_t = \mathbb{E}^Q\left[\sum_{n=1}^{N}\frac{1}{B_T n}\delta_n 1_{(T_n<\tau)} + \frac{1}{B_\tau}\delta_{n^*}1_{(0<\tau<T_N)}|\mathcal{G}_t\right] \tag{39}$$

On détermine alors la valeur de la jambe de paiement avant défaut à savoir $\bar{s}\ V_t$, la valeur de cette jambe après défaut est nulle puisqu'il n y aura plus de paiement. Pour la jambe de protection, le vendeur de celle-ci perç des versements jusqu'au défaut et si ce dernier survient il indemnise l'acheteur de protection. Donc B paie A (1-R) à l'instant de défaut où R est le recouvrement de l'entité C $\Rightarrow$ $(1-R)1_{(0<\tau<T_N)}$

Or, en t avant défaut ($t < \tau$), cette jambe de protection vaut :

$$V_t^{Prot} = \mathbb{E}^Q[\frac{1}{B_\tau}(1-R)1_{(0<\tau<T_N)}/\mathcal{G}_t] \quad (40)$$

On obtient ainsi la valeur du "Fair Spread" c'est à dire celui qui annule le prix de ce swap : $s = \lambda(1-R)$
Parmi les modèles de forme réduite les plus utilisés en pratique, on note CreditRisk+.

## Le modèle CreditRisk+

Le modèle CreditRisk+ de Crédit Suisse First Boston a été développé en 97. Dans ce modèle, on se restreint à modéliser les probabilités de défaut c'est-à-dire qu'on n'étudie pas le cas de détérioration de la solvabilité des contreparties ce qui revient à ne pas prendre en considération les transitions des ratings dans la modélisation des probabilités de défaut.
Ainsi, entre les risques liés aux obligations, CreditRisk+ tente de modéliser uniquement le risque de crédit sans prendre en considération le risque de spread.

### Les hypothèses du modèle

1. Deux états possibles pour chaque crédit individuel (par débiteur) : défaut avec une probabilité $P_A$, ou bien pas de défaut avec une probabilité $(1-P_A)$
2. Les probabilités de défaut prises une par une sont faibles, fixes et indépendantes.
3. Indépendance du nombre de défaut dans un portefeuille entre les différentes périodes étudiées, ce qui nous permettra de supposer que le nombre de défaut suit une distribution de poisson.

**Calcul de la probabilité de la réalisation d'un nombre de défauts**

Si X : Le nombre de défaut, alors la distribution de probabilité de X suit une loi de poisson de moyenne $\mu$ et d'écart type $\sqrt{\mu}$.
La probabilité que$P(X = n) = \frac{\mu^n e^{(-\mu)}}{n!}$
Où n = le nombre de défauts (dont on cherche la probabilité de se réaliser) et $\mu$ = le nombre attendu de défauts. ainsi, si par exemple, si le nombre de défaut attendu pour le portefeuille étudié est de 5 ($\mu = 5$), alors, la probabilité de ne pas faire défaut (0 défauts : n=0) est de :
: $P(X = 0) = \frac{5^0 e^{-5}}{0!}$
CreditRisk+ regroupe les débiteurs dans des bandes en fonction de leurs niveaux expositions en arrondissant à la bande la plus proche.
Pour analyser la distribution de perte d'un portefeuille, on passe par la fonction génératrice du nombre de défaut.

$$F(Z) = \sum_{n=0}^{\infty} P(X = n) Z^n$$

Or, comme on l'a déja précisé, un débiteur peut ou bien faire défaut ou bien non, d'où la fonction génératrice d'un débiteur:

$$F_A(Z) = (1 - P_A) + P_A Z = 1 + P_A(Z - 1)$$

D'autre part,si l'on considère que le portefeuille est un ensemble de crédits individuels, c'est-à-dire des débiteurs à une obligation chacun et comme les évènements de défaut sont indépendants, alors la fonction génératrice d'un portefeuille sera le produit de toutes les fonctionsgénératrices des débiteurs qui le composent :

$$F(Z) = \prod_A F_A(Z) = \prod_A (1 + P_A(Z - 1))$$

$$\log(F(Z) = \sum_A \log(1 + P_A(Z - 1))$$

Et puisque le modèle suppose que chaque probabilité de défaut prise séparement est très petite, alors on peut obtenir cette écriture par approximation :

$$\log(1 + P_A(Z-1)) = P_A(Z-1)$$

$$\log(F(Z)) = \sum_A \log(1 + P_A(Z-1)) = \sum_A (P_A(Z-1))$$

$$F(Z) = e^{\sum_A P_A(Z-1)}$$

$$\mu = \sum \text{(les défauts des différents débiteurs qui composent le portefeuille)}$$

$$\mu = \sum_A P_A$$

$$\Rightarrow F(Z) = e^{\sum_A P_A(Z-1)} = e^{\mu(z-1)} = e^{-\mu} e^{\mu z}$$

$$\text{Or, } e^{\mu z} = 1 + \mu z + \frac{(\mu z)^2}{2!} + \frac{(\mu z)^3}{3!} + ... = \sum_{n=0}^{\infty} \frac{(\mu z)^n}{n!}$$ [19]

$$\text{Donc } F(Z) = e^{-\mu} e^{\mu z} = e^{-\mu} \sum_{n=0}^{\infty} \frac{(\mu z)^n}{n!} = \sum_{n=0}^{\infty} \frac{e^{-\mu}(\mu z)^n}{n!}$$

D'autre part, on peut partir du fait que CreditRisk+ dévise le portefeuille en bandes selon différents niveaux d'exposition.

m : Le nombre de bandes dans le portefeuille étudié.

j : Le numéro de la bande : $j \in [1, m]$

L : Exposition standard

$\nu_j$ : Le degré d'exposition exprimé en multiple de L pour la bande j

$\mu_j$ : Le nombre de défauts standard attendu pour la bande j

$\epsilon_j$ : Pertes attendues pour la bande j exprimée en multiple de L

on obtient alors pour la bande j

$$\epsilon_j = \nu_j * \mu_j \Rightarrow \mu_j = \frac{\epsilon_j}{\nu_j}$$

Pour le nombre de défauts attendus pour le portefeuille composé des différentes bandes on aura :

$$\mu = \sum_{j=1}^{m} \mu_j = \sum_{j=1}^{m} \frac{\epsilon_j}{\nu_j}$$

19. Expansion Maclaurin $e^x = 1 + x + \frac{(x)^2}{2!} + \frac{(x)^3}{3!} + ... = \sum_{n=0}^{\infty} \frac{(x)^n}{n!}$

Le fait que les évènements de défauts sont indépendants, donc il y a aussi indépendance des évènements de défauts entre les bandes, ce qui nous permet d'écrire :

$$F(Z) = \prod_j^m F_j(Z) \text{ avec } F_j(Z) = \sum_{n=0}^{\infty} \frac{e^{-\mu_j} \mu_j^n z^n}{n!}$$

Si l'on veut déterminer la fonction génératrice des pertes dans le portefeuille, on va pouvoir agréger la totalité des pertes des différentes bandes. Ainsi si $G_J(Z)$ est la fonction de distribution des pertes dans la bande j alors, la fonction de distribution des pertes du portefeuille étudié sera $G(Z) = \prod_j^m G_j(Z)$ puisque les expositions sont indépendantes. Avec :

$$G_j(Z) = \sum_{n=0}^{\infty} P(Y_j = k) z^k \text{ Où } k = n\nu_j$$

Ceci signifie que la distribution des pertes dans une bande est égale à la somme des probabilités que le montant des pertes subit par la bande j à savoir $Y_j$ soit égal à k qui est une perte possible de la bande j en fonction de son niveau exposition $\nu_j$ et de n : le nombre de défauts.

$$G_j(Z) = \sum_{n=0}^{\infty} P(Y_j = n\nu_j) z^{n\nu_j}$$

Or dire $P(Y_j = k)$ est équivalent à dire $P(X_j = n)$ (qui se lit la probabilité que le nombre de défaut dans la bande j soit égal à n)

$$P(Y_j = k) = P(X_j = n) = \frac{\mu_j^n e^{-\mu_j}}{n!}$$

$$\Leftrightarrow G_j(Z) = \sum_{n=0}^{\infty} \frac{\mu_j^n e^{-\mu_j}}{n!} z^k = \sum_{n=0}^{\infty} \frac{\mu_j^n e^{-\mu_j}}{n!} z^{n\nu_j} = e^{-\mu_j + \mu_j z_j^{\nu}}$$

Ainsi la fonction de distribution des pertes de tout le portefeuille peut s'écrire :

$$G(Z) = \prod_{j=1}^m G_j(Z) = \prod_{j=1}^m e^{-\mu_j + \mu_j z_j^{\nu}} = e^{-\sum_{j=1}^m \mu_j} + \sum_{j=1}^m \mu_j z^{\nu_j}$$

L'approche suivie par CreditRisk+ est applicable à n'importe quel portefeuille dès que la probabilité de défaut individuelle des emprunteurs est faible.

#### Limites du modèle

- CediRisk+ ne prend pas en considération le risque de marché.
- Le modèle ne considère pas les changement de rating.
- Les taux d'intŕêt sont supposés être fixes.

## Les modèles économétriques

Alors que les modèles structurels font dépendre le défaut des composantes de la firme, et que les modèles de forme réduite négliguet la cause du défaut; les modèles économétriques lient le défaut au cycle de l'activité de l'économie et ses facteurs macroéconomiques.
Dans la pratique, le modèle économétrique le plus connu est CreditPortfolioView [20] de McKinsey [21]

### Le modèle CreditPortfolioview de McKinsey

Ce modèle développé par Thomas Wilson et publié par McKinsey & company en 1997 stipule que les probabilités de défaut ne peuvent pas être neutre par rapport aux facteurs macroéconomiques tels que le taux de chômage, le taux de croissance du PIB... et ce avec des élasticités différentes de chaque secteur aux conditions économiques.

#### Calcul de la probabilité de défaut

Ce modèle considère que les probabilités de défaut sont suréstimées pendant les bonnes périodes du cycle économique et souséstimées pendant les periodes de

20. Thomas C.Wilson, Portfolio Credit Risk, Economic Policy Review, October 1998
21. Cabinet de conseil auprès des directions générales, Fondé à Chicago en 1926 par Oscar McKinsey

recession, et que les conditions financières des firmes jouent fortement, dans le sens que celles ayant une position faible sur le marché sont plus vulnérables aux recessions que celles ayant une bonne position compétitive.

Le calcul de la probabilité de défaut dans ce modèle passe par trois étapes, en effet, CPV necessite l'examen du portefeuille comme étant un ensemble de sous-portefeuilles fractionnés selon plusieurs critères dont principalement la qualité du crédit. En outre, le cadre de CPV exige un modèle pour prévoir les valeurs futures des variables économiques, ensuite, grâce à ces valeurs éstimées des différents facteurs on calcule les probabilités de défaut. Ainsi ces taux de défaut détérminés sont liés à ces facteurs et varient quand ces derniers changent

1. Dans un premier temps, on essaye d'éstimer les valeurs futures des facteurs macroéconomiques sur l'horizon temporel souhaité et ce à partir des valeurs historiques de ces dernières.
2. On modélise la relation liant les taux de défaut des firmes aux facteurs macroéconomiques par un modèle économétrique multifactoriel.
3. Finalement, on utilise les résultats trouvés pour calculer les probabilités de défaut pour chaque année etet chaque pays et/ou industrie.

Pour s'assurer que la valeur de la probabilité de défaut, estimée dans la dernière étape, soit comprise entre zéro et un; Wilson a opté pour une fonction logit où l'on explique le taux de défaillance par un indice composite caractérisant chaque pays et chaque industrie et il est déterminé à partir des variables macroéconomiques.

Soit $y_{j,t}$ : l'indice composite qui explique l'état général de la santé par différentes variables macroéconomiques [22].

$$y_{jt} = b_{j0} + b_{j1}X_{j1t} + b_{j2}X_{j2t} + b_{j3}X_{j3t} + \nu_{jt}$$

Avec :

22. dans la pratique, on a montré que trois variables sont capables d'expliquer l'état général de l'économie

- $b_{ji}$ : les paramètres spécifiques pour chaque secteur et/ou pays (j) à estimer par la méthodes des MCO.
- $X_{jit}$: Les variables explicatives à l'instant t pour l'industrie et/ou le pays (j)
- $\nu_{jt}$: Un bruit blanc $\nu_{jt} \sim \mathcal{N}(0, \sigma^2_{\nu j})$

Or, dans la première étape, les facteurs macroéconomiques sont calculés ̀partir de leurs historiques, c'est pourquoi on opte pour un processus retard tel qu'un Processus Autoregressif suggéré par Crouhy et al. 2001:

$$X_{jit} = \delta_{ji0} + \delta_{ji1} X_{j,1,t-1} + \delta_{ji2} X_{j,i,t-2} + \varepsilon_{jt} \tag{41}$$

Avec $\varepsilon_{jt} \sim \mathcal{N}(0, \sigma^2_{\varepsilon j})$
$X_{j,1,t-1}$ et $X_{j,i,t-2}$ sont les valeurs retardées de la variable macroéconomique $X_{jit}$
Où l'on estime les paramètres : $\delta_{ji0}, \delta_{ji1}, \delta_{ji2}$
La probabilité de défaut du pays (secteur) j pour l'année t sera donnée par :

$$P_{jt} = \frac{1}{1 + e^{-y_{jt}}} \tag{42}$$

Avec le vecteur d'innovations $E_t = \begin{pmatrix} \nu_t \\ \varepsilon_t \end{pmatrix} \sim \mathcal{N}(0, \sum)$
Avec

$$\mathcal{A} = \begin{pmatrix} \sum_\nu & \sum_{\nu,\varepsilon} \\ \sum_{\varepsilon,\nu} & \sum_\varepsilon \end{pmatrix}$$

Où $\sum_{\nu,\varepsilon}$ et $\sum_{\varepsilon,\nu}$ sont les matrices de corrélation croisée.

On commence par calculer les probabilités moyennes de défaut au cours d'un an grâce aux probabilités de défaut historiques obtenues à travers la matrice de transition inconditionnelle de Markov qui est elle même basée sur les données historiques des agences de notations notamment Moody's ou encore Standard & Poor's ce qui nous permettra d'obtenir des probabilités inconditionnelles de défaut

qu'on notera $\phi M$.
Les probabilités de transition inconditionnelles sont appelées ainsi puisque ce sont des moyennes historiques calculées sur des données de vingt ans pour différents secteurs, différentes industries et plusieurs pays.
On dévise par la suite les probabilité de défaut courantes simulées par les probabilités inconditionnelles pour obtenir un ratio supérieur à 1 quand on s'attend à une probabilité de défaut plus que la moyenne càd en période de récession et inférieur à 1 en période d'expansion de l'économie, et on ajuste ainsi via l'opérateur de déplacement (Shift Operator) définit par Tom Wilson les probabilités de e défaut des portefeuille. Ainsi quand l'économie se contracte le Shift Operator fait varier les probabilités de migration vers la droite càd qu'il y a plus de chance de se dégrader ou se déclasser et vise versa.
Et puisque l'on peut estimer $P_{jt}$ sur n'importe quel horizon de temps donc on peut générer une matrice de transition multipériode:

$$M_T = \Pi_{1\ldots T} M(P_{jt}/\phi M)$$

**Limites du modèle:**

Les données macroéconomiques indispensables pour ce modèle peuvent être indisponibles ou difficile à trouver pour une industrie ou un pays donnée.
C'est un modèle macroéconomique qui ne peut être appliqué pour un émetteur.
Dans la pratique ce modèle est utilisé pour déterminer les taux de défaut des contre parties de qualité inférieure (Speculative grade).

# Conclusion

Avec le comité de Bâle [23], l'intérêt à la mesure du risque de défaut s'est vu croître, et ce afin de refléter au mieux le contexte interne et externe d'une entité donnée et qui est susceptible d'affecter sa solvabilité et le risque qu'elle ne soit plus en mesure d'honorer ses engagements.
Dans les modèles structurels, la valeur de la firme qui est utilisée comme in-put principal pour mesurer le risque de crédit n'est pas simple à valoriser; En plus, il y a un certain nombre d'hypothèses fortes qui rendent cette approche peu réaliste. Le statisme est aussi un inconvénient important dans le sens où s'il y a un changement de la qualité de l'emprunteur traduit par un changement du rating par exemple, ces modèles ne sont pas capable de l'intégrer dans les calculs alors qu'en réalité les prix des actifs sont très sensibles à ces informations. Le problème majeur des modèles structurels est le fait de ne pas prendre en compte le caractère imprévisible de l'évenement de défaut en considérant que celui-ci est prédectible grâce au processus continu de la firme.
Le caractère imprévisible est modélisé dans l'approche de forme réduite et ce par le processus de poisson généralement employé pour les évènements rares. Mais le grand problème de cette classe de modèle c'est que les changements des termes des contrats, une éventuelle renégociation entre prêteur et emprunteur des conditions de remboursement ou encore le rééchelonnement du crédit, ne peuvent pas être pris en compte dans cette approche, en effet, Duffie and J Singleton 1999 montre que ces modèles n'expliquent pas la structure par terme des spreads de crédit. Il y a eu ensuite, des modèles voulant améliorer la prévisibilité de l'instant de défaut et ce

23. Comité de Bâle sur le contrôle bancaire (Basel comittee on banking Supervision, BCBS) est un forum où sont traités de manière régulière les sujets relatifs à la supervision bancaire. Il est hébergé par la Banque des règlements internationaux et formule les accords de Bâle qui sont un ensemble de recommandations visant à assurer la stabilité du système bancaire

en essayant de réconcilier les modèles structurels avec ceux de forme réduite dont on cite le modèle de Zhou 1997 dans le quelle la valeur de la firme est modélisée par la somme d'un processus continu et d'un processus de poisson.
Ces deux approches ne prennent pas en considération l'état général de l'économie pour expliquer le risque de crédit, en revanche, les modèles économétriques présentent l'avantage d'expliquer le risque de défaut par le contexte économique ce qui est plus réaliste, le problème est que la logique économique derrière le choix de la fonction Logit pour calculer la probabilité de faire faillite, n'est pas justifiée.

# Macroeconomic Determinants of Sovereign Credit Risk

## Introduction

Credit risk is the possibility to failure in credit payment. When the borrower is a country, this is called sovereign credit risk and it measures the ability and the tenacity of a state to fulfill its obligations. This case has been examined for a long time and has led to several findings like the evaluation systems of the borrower quality by giving scores to individuals and ratings to States and important corporates. The Basel committee on banking supervision - whose aim is to strengthen the regulation through the Basel accords [24] - tries to improve these latters to adapt them to innovations and movements on the market. Nevertheless, Credit risk models aiming to estimate a borrower default probability are being developed very quickly and widely. Structural, stochastic or econometric models try to predict the probability that a borrower will default on maturity and / or when this event is most likely to occur. This paper attempts to explain what happens in an economy before seeing its risk of bankruptcy increases. As documented in Asghar and Kevin 2010 in their research on the United States of America and Aus-

24. http://www.bis.org/bcbs/basel3.htm

tralia where the variable used to measure the default risk is the ratio of provisions for risky debt to total debt, there is a negative relationship between the GDP level and the default rate, as well as a positive link between this latter with the debt with more responsiveness of the American economy to macroeconomic chocks. A number of recent studies like Hilscher and Nosbusch 2010 have investigated the empirical determinants of Sovereign credit spreads as a proxy for credit risk, and they found a significant link with the macroeconomic fundamentals. Plank 2010 applies a structural model of sovereign credit risk with macroeconomic fundamentals as determinants on a sample of emerging economies. He defines the repayment capacity of a country as the maximum amount of foreign currency available for the payment of external debts. This ability improves with the expectations of future exports as well as foreign exchange reserves. However, it is negatively correlated with the present value of future imports. Nevertheless, the model is not validated for Turkey which is the most developed country in the sample. To follow the default probabilities evolutions, Canuto et al. 2012 use ratings provided by rating agencies. The authors confirm that a good rating (i.e low risk) is associated with a low inflation, high economic growth, unimportant level of debt, significant trade openness, and a low past events of default since 1975. The choice of In-Mee et al. 2005 is rather focused on the bond yield spread as a dependent variable to describe the evolution of default risk. Their conclusion is that a higher GDP growth, larger foreign reserves, and an appreciation of domestic currency lead to a decrease in the bond yield spread. On the other hand, the more important the inflation is, the higher the bond yield spread is also. GAPEN et al. 2008 extended the Merton Model to implement it for countries using Sovereign Bond Yields to measure credit risk. On the basis of this, Kilponen et al. 2012 developed a model to study the effects of the European Central Bank monetary policy and the European Crisis on the default risk of a sample of European countries using the 10 year Sovereign

Bond Yield as a proxy for default risk. In this chapter, we choose the same proxy for credit risk (i.e Sovereign Bond Yields). In what follows, we present the evolution of the default probabilities and Bond yields for the same sovereigns and the same period. We notice a significant similarity in the trends of the two curves. This makes us think of a certain consistency in our choice of proxy. Next, we present our modeling, the choice, the tests of variables, and the regression results for each country of the sample. The graphs below show the 10 year default probabilities (in percentage) and the 10 year bond yield (in percentage) evolutions [25] of a sample of Euro zone countries. They confirm what states the modern portfolio theory, that return and risk are inseparable concepts, taking additional risk is only accepted if coupled with a higher Yield. Countries are no exceptions to the rule, the greater the risk that a state will default and finds itself unable to honor its commitments, the more the lenders require higher Treasury bond Yield. Indeed, the risk premium is a part of the required return. It represents what claims an investor willing to place his funds in risky assets. The more the risk incurred is, the higher the premium is, which leads the demand of greater yield.

## Data and model specification

As suggested by the graphs above, the chosen dependent variable in this modeling, is the 10 Year Treasury bond yield. This choice is justified by the fact that this variable reflects the sovereign default risk and by data availability. Selected explanatory variables are:

1. Long term (10 years) Government Bond Yield.
2. Exports growth rate.

25. traced from default probabilities calculated by CMA Credit Market Analysis Ltd http://www.cmavision.com

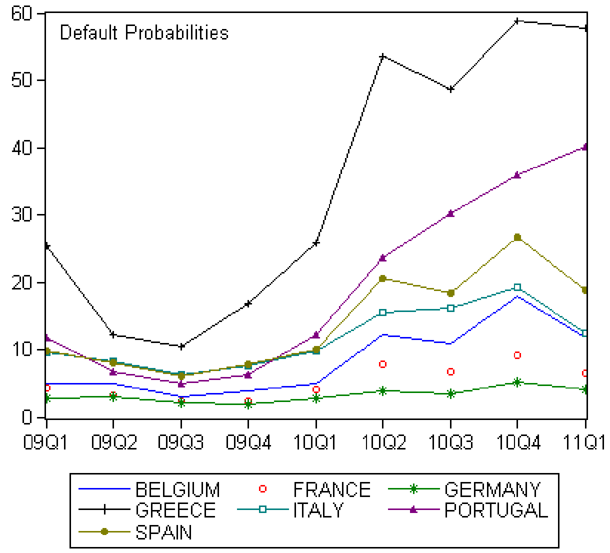



Figure 5: 10 Year Default Probabilities(in percentage)

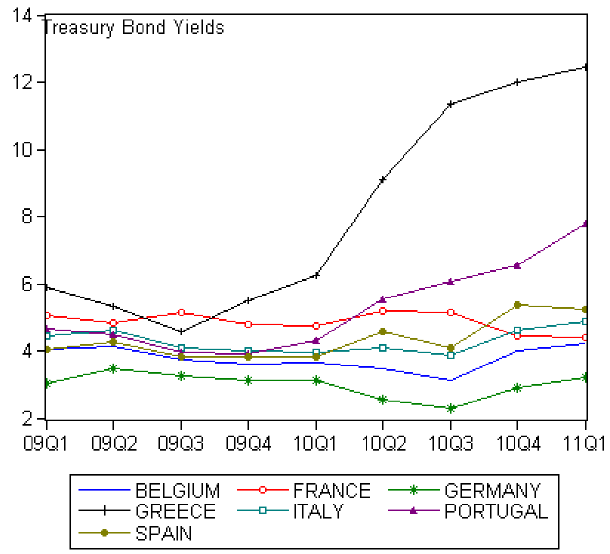



Figure 6: 10 Year Bond Yields(in percentage)

3. Real Gross domestic product.
4. Government Long Run Debt in percentage of GDP.
5. Unemployment to population rate.

Appendix A.1 provides data description and expected signs for each of these determinants. For reasons of data availability, estimates are done using quarterly frequency over the 1999-2014 period.

The sample on which we work is: Austria, Germany, Netherlands, Luxembourg, Belgium, Spain, France, Italy, and Portugal. The unavailability of recent data and the disrupted economic context of the Greece, make it impossible to identify a valid model which has forces us to exclude it from the sample.

After testing the presence of unit root and the order of integration of the data, the chosen model to explain the link between the treasury bond yield and the macroeconomic variables is an Autoregressive Distributed Lag Model (ARDL)[26]. In this modeling we can work with a mixture of I(0) and I(1) variables. ARDL is a dynamic model combining distributed lag models and autoregressive ones (see Hendry et al. 1984). In this modeling the regressors may include lagged values of the dependent variable and current and lagged values of one or more explanatory variables. It is a dynamic model since it describes the time path of the dependent variable by its history. In economics, there are not a lot of instantaneous relationships between regressors and dependent variable. The variations of the values taken by the dependent variable are an answer to observed changes in the explanatory variables, but after a time interval. This represents the duration necessary for the new information to be integrated into the replica of the endogenous variable. This duration, also called delay, depends on the speed of response to new information received from different evolutions of explanatory variables. The

26. Hendry and Pagan and Sargan 1984, Dynamic specification. In Griliches, Z. and M. D. Intriligator ed Handbook of Econometrics, vol.2 Ch.18, Amsterdam, North Holland

coefficients corresponding to regressors in first difference are called short-term multipliers. The coefficients of the lagged variables are the long run multiplier, and it provides us with a full description, or long-term relationship between exogenous and endogenous variables.

The general form of an ARDL model

$$Y_t = b_0 + \sum_{i=1}^{p} b_i Y_{t-i} + \sum_{j=1}^{m} \sum_{i=0}^{n_j} a_{ji} Xj_{t-i} + \epsilon_t \tag{43}$$

The condition $\sum_{i=1}^{p} b_i < 1$ is regularly imposed in the ARDL literature to ensure that the dependent variable $Y_t$ is stationary.

In our modeling:

- Y = Long-Term Government Bond Yields.
- p = Lags of dependent variable (autoregressive).
- $X_j$ = The explanatory macroeconomic variable number **j**.
- m = The number of selected exogenous variables (Distributed lags).
- $n_j$ = lags of regressor **j**.

Our model can be rewritten as shows the equation 44 In order highlight the short-term and long term effects:

$$D(Y_t) = b_0 + \sum_{i=1}^{p} b_i D(Y_{t-i}) + \sum_{j=1}^{m} \sum_{i=1}^{n} a_{ji} D(Xj_{t-i}) + Y_{t-1} + \sum_{j=1}^{m} c_j Xj_{t-1} + \epsilon_t \tag{44}$$

In the equation 44, the variables in level enable us to identify the long-term relationships, whereas those that are differentiated are used to extract the short-term effects.

### The regression results

Before performing estimates, we conducted unit root tests (results are reported in Appendix A.2) to be sure that there is no series Integrated of order 2 (I(2)). In order to identify the number of lags to consider, we use VAR Lag Order Selection Criteria (results are reported in Appendix A.3). Considering the selected lag number, we can conduct our estimates using our variables that, necessary, are I(0) or I(1).

Table 1 reports results that are presented by country.

At this point, we have to check the the residuals correlation and the stability (see Brown et al. 1975) of the models (Results are reported in Appendix A.4). Outcomes affirm the non-autocorrelation of residuals and the stability of the estimated models.

## Interpretation

### Gross Domestic Product

The Gross Domestic Product GDP is the global output of services and goods created within a country's borders in a time span. Following this definition, this indicator is commonly used to evaluate an economy performance since it measures the added value. Higher GDP means that the economy is improving and that its activities are more cost-effective. Hence, it is intuitive to think that an increase of this fundamental leads to an upswing in the creditworthiness of an entity. Using GDP in current prices can be misleading because inflation (contained in prices) can distort the effect of it. Thus our choice was rather focused on the GDP in volume (Real GDP).

As expected, The. Real GDP is adversely linked with the credit risk as measured

| Country | Real GDP | Exports variation | LR-Gvrnmt-Debt%GDP | Unemployment rate |
|---|---|---|---|---|
| Austria | -0,0435***<br>(-2.041) | -0,114***<br>(-2.196) | 0,398**<br>(2.0017) | 1,791<br>(1.376) |
| France | -0,183***<br>(-2.608) | -0,0661**<br>(-2.003) | 0,07<br>(0.132) | 2,027***<br>(2.281) |
| Germany | -0,304***<br>(-2.975) | -0,0241**<br>(-1.985) | 0,225***<br>(2.067) | 2,178***<br>(2.591) |
| Italy | -0,0045<br>(-0.0108) | 0,078<br>(0.661) | 0,101**<br>(1.8567) | 4,924***<br>(3.559) |
| Luxembourg | -0,248***<br>(-2.455) | -0,00189<br>(-0.0229) | 0,559<br>(1.67) | 1,328***<br>(2.674) |
| Netherlands | -0,0458***<br>(-3.482) | -0,0843***<br>(-2.141) | 0,173***<br>(2.098) | 0,917**<br>(1.738) |
| Spain | 0,018<br>(0.155) | -0,065***<br>(-2.063) | 0,901***<br>(2.505) | 3,922***<br>(2.189) |
| Portugal | -1,561***<br>(-2.527) | 0,431<br>(1.391) | 1,335***<br>(2.71) | 8,91***<br>(2.704) |
| Belgium | -0,074***<br>(-2.77) | -0,0053<br>(-0.221) | 0,242***<br>(2.081) | 1,509***<br>(3.928) |

Source: Author calculation.
t-statistics are between parentheses.

Table 1: Results Summary: Explanatory variables' Long-run relationships

by the sovereign bond yield. For most of the studied European countries, this variable is statistically significant. GDP varies between (-0.0435) for Austria and (-1.561) for Portugal. In this our results meet the findings of Asghar and Kevin 2010. For Italy and Spain that have critical economic situations ans solvency issues, the Real GDP appear to be not consistent in explaining the credit risk of these countries.

### Exports change

Exports to the rest of the world represent all goods and services produces within a country and furnished to other ones.
They are composed off valuable commodities attracting sales worldwide, what makes them one of the most important sources of Foreign-Exchange Reserves. Basically, their primary reason for being is to maintain market confidence in the national currency and to show that the country has the capacity to resist any shock (rising prices of raw materials or manufactured goods, credit crisis , foreign trade, etc.). These reserves are increasingly held and used as a mean to influence their domestic exchange rate or to pay off international debt obligations, in fact, If a country has consequential foreign debt, detaining foreign currency reserves can help to give more confidence in the country's reimbursement capacity. More Exports of goods and services to the World shows a the country's industrial and economic developments and generates an influx of cash especially in foreign currencies. Hence the increase of this variable is expected to be beneficial and to have positive effects on the creditworthiness of the Country. Thus, it is sensible to think that the relationship between credit risk and the change in exports is negative.
According to our estimates, this variable appears significant for 5 out of the 9 countries on which we worked. The coefficient associated to this variable is, as expected, negative, confirming that treasury bond yields vary inversely with Exports.

## Unemployment rate

The unemployed population is a portion of the active one, that are not occupying a position. Further information about the economic conditions impact on the creditworthiness of an entity can be provided by the unemployment rate. Indeed, its increase reflects adverse economic conditions. Higher rates of this latter lead to the lowering of cash flows in the economy. For firms, this stands for the decline in production due a decrease of the employed staff, but mainly because of the fall of the effective demand.
Therefore, we expect this variable to move in the same direction with the treasury bond yields. Castro 2013 concludes that the credit risk increases significantly when the unemployment rate rises.
It is one of the variables that proved to be most significant for most countries. The link between the dependent variable and this one is, as awaited, positive. Also, the coefficients associated with this variable are the most important (up to 8, 91 for Portugal). An upsurge in this independent variable is accompanied by a rise in the country's credit risk. This attests of the meaningful weight of the economic conditions on the creditworthiness of a country.
Higher Unemployment rate denotes a slump in the economy and generates the slowdown of the economic cycle. Growth depends, inter alia, on the increase of productivity per capita and the evolution in the workforce. These parameters go down with the rise of this explanatory variable. Hence the economy becomes less profitable and there will be a drop in the generated cash flows.

## Long Run Debt in percentage of GDP

The government long-run debt in percentage of GDP, is a ratio of a country's national debt to its gross domestic product. It can be used as an indicator of the

country's adeptness to reimburse its debts. In fact, this ratio measures what a country produces to to which extent it is beholden to its creditors. An increase of this ratio can make it more complicated to pay back a country's external debts. This could push lenders to ask for greater compensation for additional risk taking which translates into the requirement oh higher interests. This makes governments strive to take down their debt-to-GDP ratios.
Jakubik and Schmieder 2008 used this variable in his study about the credit risk in Czech Republic and Germany. The authors found this variable significant for both countries and associated to important positive coefficient. Studying the credit risk of six developed countries (i.e US, France, Germany, Italy, Spain, and the U.K.), Chinn and Frankel 2005 found that the link of the debt-to-GDP ratio with the sovereign bond yields is positive. The effect differs on a small scale from one country to another with a greater impact among European countries. Regressions performed by Kinoshita 2006 show that an increase of the ratio of debt-to-GDP rises the interest rates of 19 developed sovereigns by around 2-5 basis points.
Our results join the previous works in the change directions of the credit risk and the debt-to-GDP ratio. The most important effect is on the Portuguese and Spanish Treasury bond yields (coefficients are respectively 1,335 and 0,901). Portugal and Spain are among the countries with the less stable economic conditions and having issues to pay back their debts.

## Long run evidence and short run relationships

Roughly, the obtained results are, as evidenced by Appendix A.5, are stable in the long term. At at least a 90% level of confidence, there is a confirmation of the stability for the estimated relationships (Except for Italy and Luxembourg).
In the short run, the relationships keep the same directions (see the Appendix A.6). Coefficients associated to the real Gross domestic product are negative without

being significant for most countries (Only for Austria and France with two lags and Netherlands with one lag). With as expected, a positive link with the credit risk, in the short term, more countries are affected by the change in exports to the world (5/9 countries). For Austria and Netherlands, it is even significant for both first and second lags.

The debt-to-GDP, that is significant for most countries in the long run, appears not to be consistent in the short run. This variable affects in a much more meaningful way in the long term. Information provided by this ratio does not instantly affect the treasury bond Yields, but once integrated, the impact lasts long.

As in long term, the unemployment rate in the short term is the most significant among the studied explanatory variables (consistent for 8 out of 9 countries). Only one quarter is selected as significant lag.

## Conclusion

The creditworthiness of the sample of countries in the Euro zone depends largely on macroeconomic fundamentals. As attests the table below (2), estimated models explain a considerable part of the evolution of the treasury bond yields for European countries. The long-term multipliers, once computed, the stability of

| | Aust | Belg | Fra | Ger | Italy | Lux | Nether | Port | Spn |
|---|---|---|---|---|---|---|---|---|---|
| $R^2$ | 0.47 | 0.568 | 0.42 | 0.501 | 0.207 | 0.458 | 0.471 | 0.47 | 0.244 |

Table 2: Coefficient of determination

long-term relationships hypothesis has been tested and accepted for most countries (7 out of 9). This informs us about the long run equilibrium. In that saying that the obtained relationships between the variables are still valid and applicable in the long term. The retained models, besides explaining how the Treasury bond yields respond to the increases and decreases of the macroeconomic regressors,

they provide a base for scenario analysis to determine the economies reactions to different situations by stress testing.
The short-term effects are rare and mainly concern unemployment rate. Its immediate impact is, as its long-term one, important and significant.
The Gross domestic product evaluates, in a country, the total added value of the production by economic agents residing within its territory. Overall, an increase in the real GDP positively affects the economic conditions of a country. It means an increase in the investment, revenues and subsequently a country's ability to fulfill its commitments.
A rising debt-to-GDP increases the country's engagements compared to its production and hence the creditor's risk of failure. The long-term effect of this variable is much more important than its short-run one.
The unemployment rate is the most influential variable in both short-run and long-run. This is especially important among the least creditworthy countries with the weakest economic conditions (between 3,9 for Spain and 8.9 for Portugal). It affects treasury bond yields through the channel of the economic cycle. less investment discourages recruitments and rises this rate. This lowers cash flows in the economy and brakes the growth.
Exports to word is selected to explain the evolution of 5 out of to 9 countries' treasury bond yields. This variable is favorable to improve the solvency of the studied entities. This occurs mainly through the increase of the country incomes especially in foreign currencies.

# What drives European Banks' CDSs?

## Introduction and Literature

The recent global financial crisis has emphasized the importance of understanding financial instability particularly in the context of managing credit risk with special attention on the banking sector. The latter crisis has critically harmed the banking industry. Banks have played a major role in fuelling and propagating the recent financial crisis [27]. This was done especially through credit derivatives. Banks that went bankrupt or who have almost failed were all very active in the Credit Default Swap (CDS) market. This has brought special consideration for this credit derivative and his association to the credit risk. Dickinson 2008 argues that CDS have participated largely in worsening and accelerating the financial crisis, specially the subprime one. Indeed, he showed that the CDS contracts have generated the possibility for relatively few market participants to shake and disturb the global economic system. Since the credit crisis triggering, the CDS market has aroused more attention as a measure of credit risk. In fact, a credit default swap (CDS) is a kind of insurance against credit risk. The buyer hedges against

27. Subprime and European debt crisis

the eventual default of the underlying entity whose default probability perception following a credit event is reflected in the price of the instrument. The higher the risk of default is, the more the buyers are willing to pay to protect themselves against this risk. In return, the protection seller is obliged to refund the purchaser if the credit event occurs. In doing so, the default risk is transmitted from the holder of the fixed income security to the seller of the swap. Hence, The price of the credit default swap, also called the premium or the spread reveals what level of risk do market operators associate with the reference entity. In this sense, market prices can be used to compute default probabilities, namely in the reduced-form approach which is based on the work of Jarrow and Turnbull 1995. The credit event (failure to pay, bankruptcy...) is treated as a sudden surprise and thus is modelled as the first event of a Poisson Counting Process that takes place at a default instant $\tau$ situated in the time interval [t, t+dt] with a probability P specified as :

$$P = Pr[\tau < t + dt | \tau > t] = \lambda(t)dt \tag{45}$$

Where :

- $\lambda(t)$ : A time dependent function (assumed to be deterministic for simplification).
- $\tau > t$ : Means that there was no default until time t.

Therefore, the probability that the entity does not default at $\tau$ is:

$$1 - P = 1 - Pr[\tau < t + dt | \tau > t] = 1 - \lambda(t)dt \tag{46}$$

In a continuous timing economy where $dt \to 0$, the probability that an entity does not default (i.e the survival probability) until maturity T knowing that it did not bankrupt until $t_p$ is given by:

$$\bar{P}(t_p, T) = \left[ -\int_{t_p}^{T} \lambda(s)ds \right] \tag{47}$$

Hence, a CDS contract has two Cash Flow legs: The fee premium leg and the contingent Cash flow leg. Here we'll outline how the premium of the CDS is determined to understand its link to the default probability.
The figure (fig24) shows the payoff ratio process in multi-period model.

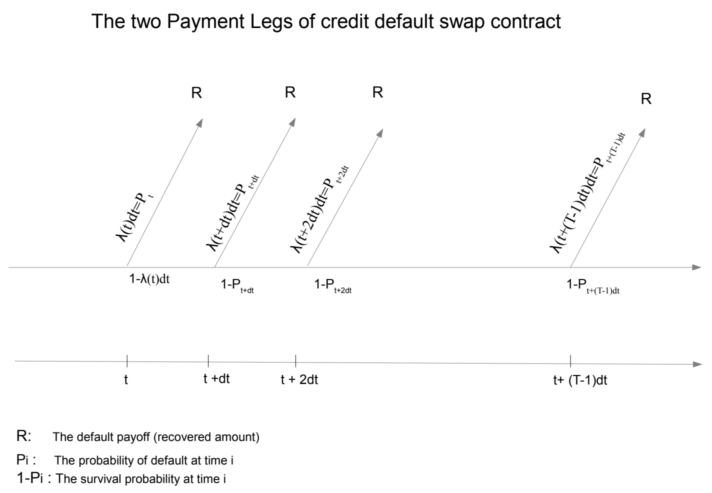



Figure 7: Source: Jarrow& Turnbull calculations & author presentation.

This allows us to value the CDS premium Leg which is the leg of the regular fee payments (in opposition to the contingent leg in case of default) The horizontal leg in the figure 7.
To do so, let's assume :

- n = 1...N : the contractual payment dates ($t_1$ ...$t_N$)
- $Sp_N$ : The maturity contractual default swap spread (CDS premium for the maturity N)
- $\bar{P}_{t_n}$ : The No-Default probability
- $RFD_n$ : The risk-free discount factor from valuation date to premium payment date n
- $AP_n$ : The accrual period from $t_{n-1}$ to $t_n$

The present value of the Non-Default Premium Leg is:

$$PL_pv = Sp_N \sum_{n=1}^{N} AP_n.RFD_n.\bar{P}_{t_n} \tag{48}$$

According to the no-arbitrage principles that have to be respected, the two legs must have the same value. This can be rearranged to find the CDS spread formula (to understand the development and the steps, see Jarrow and Turnbull 1995) :

$$Sp_N = \frac{(1-R)\sum_{n=1}^{N} RFD_n.(\bar{P}_{t_{n-1}} - \bar{P}_{t_n})}{\sum_{n=1}^{N} RFD_n.\bar{P}_{t_n}AP_n + RFD_n.(\bar{P}_{t_{n-1}} - \bar{P}_{t_n}).\frac{AP_n}{2}} \tag{49}$$

The following table shows a numerical example of a CDS spread computation. It reveals that the no-default probability ($PND_i$) and the spread of CDS ($S_N$) change oppositely attesting of a negative link between these two variables.

Another model attesting of the good predictive power of the default probability of an entity by the CDS spread above, is the J.P.Morgan[28] one.

In the J.P.morgan model *THE J.P. MORGAN GUIDE TO CREDIT DERIVATIVES* no date, Credit default swaps are used to make Credit Default Curves

28. J.P. Morgan is offering services in asset management, investment banking, private banking, treasury and securities services, and commercial banking.

| Period | Yield% | $DF_i$ | $PND_i$ | $\text{Annuity}_N$ | $\text{Default accrual}_N$ | $\text{Contingent leg}_N$ | $s_N$ |
|---|---|---|---|---|---|---|---|
| 0.5 | 2.33 | 0.9884 | 93.05% | 0.47 | 0.008 | 0.048 | 988 |
| 1 | 2.52 | 0.9763 | 86.56% | 0.901 | 0.016 | 0.093 | 998 |
| 1.5 | 2.87 | 0.9628 | 81.51% | 1.300 | 0.022 | 0.127 | 945 |
| 2 | 3.22 | 0.9478 | 77.30% | 1.673 | 0.028 | 0.155 | 896 |
| 2.5 | 3.52 | 0.9317 | 74.32% | 2.024 | 0.032 | 0.175 | 837 |
| 3 | 3.82 | 0.9144 | 71.45% | 2.355 | 0.036 | 0.193 | 794 |
| 3.5 | 4.02 | 0.8964 | 69.90% | 2.672 | 0.038 | 0.203 | 737 |
| 4 | 4.22 | 0.8779 | 68.37% | 2.975 | 0.040 | 0.213 | 695 |
| 4.5 | 4.37 | 0.8591 | 68.06% | 3.269 | 0.040 | 0.215 | 639 |
| 5 | 4.52 | 0.8407 | 67.76% | 3.555 | 0.040 | 0.217 | 594 |

Source : Choudhry 2004 page 83

Figure 8: An example of CDS Spread pricing premium

that are used to estimate the implied default probabilities. As for the Jarrow and Turnbull 1995 model, two states are distinguished here. The default and the no-default states for which the cashflows should be modelled to obtain the credit spreads. These are market Credit Default Swap spreads that have to be converted into default probabilities.

To do so, we have to withdraw the recovery effect, since in reality, the protection seller will disburse only (100% - R) if a credit event occurs. As shown in equation 50, this gives us a positive link between CDS spread and default probability:

$$DP = 1 - \frac{1}{[1 + [\frac{CDSs}{1-R}]^t]} \tag{50}$$

As Callen et al. 2007 point out that, although the CDS premium is linked to credit ratings issued by the rating agencies, relatively more variation in CDS spreads are noticed for entities having given ratings. In fact, CDS spreads are more responsive to fluctuations in the credit risk quality. Hull et al. 2004 join this point of view, the authors outline that since CDS are quoted directly in term of spreads on credit contract, this makes them more representative of the credit risk of these contracts. Considering these models, in this paper we investigate the determinants of CDS spreads as a proxy for credit risk. Indeed, Annaert et al. 2010, in their study of the determinants of the Euro area bank CDS spreads, confirm that the rising CDS spreads are due to increased credit risk. The empirical works to date, sustain the important impact of the structural variables on the credit spreads. Yet, other researchers argue that only a small part of the credit spreads changes can be explained by the structural variables. Alok Kumar et al. 2008 tried to model the default probabilities and credit spreads for selected Indian firms in the Merton framework (see Merton 1974). The authors found that the model spreads are small relative to the observed spreads in the secondary market for these bonds. Second, the model severely underpredicts the spreads for low leverage and low volatility firms. Collin Dufresne et al. 2001 show that these latter variables explain not more than about 25% of the global variation of the dependant variable. Bonfim 2009 illustrates that even if the firms' financial situation has a central role in explaining default probabilities, macroeconomic conditions are also very important when assessing default probabilities over time.

In this paper we try to capture other important determinants of the credit default swap spreads. In fact, we think that the variables specific to the country or to the region in which a bank is based significantly affects its credit risk. This should be all the more noteworthy that the banking group is large and active. We tend to expect bank located in uncertain area to be affected and to become riskier. Actually, the economic and financial turmoil that Greece experienced have severely affected the entire financial system of the country or even the entire Euro zone.

We witnessed serious difficulties with some Greek financial institutions that were almost dry and demanded urgently liquidity to the Greek Central Bank. If it were able to meet their requests, their situations would have improved and these institutions would not have gone bankrupt.
All this leads us to ask ourselves what are the country specific or region specific variables that affect the credit risk of the studied banking groups and to what extent their effects are Important. Castro 2013, in his study tried to examine the link between macroeconomic factors and the banking credit risk for the GIIPSI [29] countries. He concluded that this risk is significantly affected by the macroeconomic environment. He also found that the credit risk increases with an appreciation of the real exchange rate. The same finding is confirmed by Yurdakul 2014 who used a set of macroeconomic variables to model the credit risk for banks in Turkey. The author assumed that growth rate and the ISE-100 index [30] are the variables that lower, banks credit risk in the long run. However the variables that are positively linked to M2 money supply, unemployment rate, inflation rate and the interest rate. Ejsinga and Lemke 2011 in their study of the sovereigns' and banks' credit risk premiums, show that there is a considerable risk transfer in both ways between banks and governments. The authors demonstrate that bank CDS premium are sensibly reactive to changes to the sovereign credit risk mainly during financial turmoil periods. This is also confirmed by De Bruyckere et al. 2013 who tried to investigate contagion between bank and sovereign default risk in Europe over the period 2007-2012. Their analysis revealed a significant risk spread in the two directions. Aktug et al. 2013 highlight very robustly that financial sector variables are related to sovereign credit risk measured by credit ratings. This proxy for credit risk is also used by Williams et al. 2013. The authors analysed the effects of sovereign rating actions on the credit ratings of banks in emerging markets. They

29. Greece, Ireland, Portugal, Spain and Italy
30. Istanbul Stock Exchange : The country's exchange, home to 320 national companies

demonstrate that sovereign rating upgrades (downgrades) have strong effects on bank rating upgrades (downgrades). Calmess and Théoret 2014 investigate how banks, as a group, react to macroeconomic risk and uncertainty for the US and the Canadian cases. Their results confirm that banks tend to behave more homogeneously towards macroeconomic uncertainty.

To empirically investigate the long-run relationships and dynamic interactions among the variables of interest, the model has been estimated by using the bounds testing (or autoregressive distributed lag (ARDL)) cointegration procedure, developed by Pesaran 1995. This choice is maintained for the following motives . In the first place, the simplicity of the bounds test procedure. As opposed to other multivariate cointegration techniques such as Johansen and Juselius 1990 test. Once the lag order of the model is determined, we can easily conduct the cointegration relationship by OLS. Secondly, and this is particularly important when dealing with financial variables, the bounds testing procedure is less constraining regarding the stationarity since it does not necessitate the variables included in the model to be integrated of the same order unlike other techniques. It is applicable irrespective of whether the regressors in the model are purely I(0), purely I(1) or mutually cointegrated. Thirdly, the test is relatively more efficient even in small or finite sample data sizes. Note that the procedure will however crash in the presence of I(2) series.

This study empirically investigates the possible co-integration between European banking groups CDSs and their potential contextual determinants namely : the entity's equity value, the country's CDSs, the country's stock index, the country's inflation. And since all the studied entities are based in the Eurozone, we will also try to explain their CDSs by the European Stock Index, the global European inflation as well as the USD/EUR exchange rate.

The paper proceeds as follows. Section II defines methodology of the study. Section III provides data and modelling. Section IV presents results and discussions and the paper concludes with Section V.

# Autoregressive Distributed Lag - Error Correction Model

## From the traditional to the EC- ARDL model

The Autoregressive Distributed Lag Model (ARDL) is one of the main dynamic single-equation regressions. Engle and Granger 1987 proved that for the non stationary variables, the cointegration techniques is analogous to an error-correction modelling. Hassler and Wolters 2005 show that the estimation of a cointegrating vector from an ARDL specification is equivalent to that from an Error-Correction Model (ECM). Starting from the classic autoregressive distributed lag model, we'll use it to make an Error correction model. Working on the regression of a dependent variables $Y$ with two independent variables $X_1$ and $X_2$, here is the traditional ARDL modelling :

$$Y_t = \beta_0 + \sum_{p=1}^{P} \beta_p Y_{t-p} + \sum_{l=0}^{L} \alpha_l X_{1,t-l} + \sum_{j=0}^{J} \gamma_j X_{2,t-j} + \epsilon_t \tag{51}$$

The variables in question may include a mixture of stationary and non-stationary time-series.

As aforesaid, variables in the ARDL modelling may have different integration order I(0) or I(1) but not I(2). Hence, the first thing to do is to identify the order of integration of the studied variables. Here we can conduct the ADF [31] and KPSS [32]

31. Augmented Dickey-Fuller test (ADF) is a test for a unit root in a time series

32. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used for testing a null hypothesis that an observable time series is stationary around a deterministic trend

tests (see Hatanaka 1996).

After having been assured that all the variables are either I(0) or I(1), it is possible now to transform our traditional ARDL model in an error correction one (equation 52).

When dealing with non-stationary variables, an Error Correction Model (ECM) is generally used. The conventional error correction model:

$$\Delta Y_t = \beta_0 + \sum_{p=1}^{P} \beta_p \Delta Y_{t-p} + \sum_{l=0}^{L} \alpha_l \Delta X_{1,t-l} + \sum_{j=0}^{J} \gamma_j \Delta X_{2,t-j} + \phi c_{t-1} + r_t \quad (52)$$

Transforming the ARDL model (51) to an EC model is replacing the error correction term $c_{t-1}$ by the terms $Y_{t-1}$, $X_{1,t-1}$, and $X_{2,t-1}$. Where $c_t$ is the OLS estimate residuals of the regression (53) :

$$Y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + c_t \quad \Leftrightarrow \quad c_t = Y_t - \alpha_0 - \alpha_1 X_{1t} - \alpha_2 X_{2t} \quad (53)$$

Here is the new ARDL model:

$$\begin{aligned} \Delta Y_t = \beta_0 + \sum_{p=1}^{P} \beta_p \Delta Y_{t-p} + \sum_{l=0}^{L} \alpha_l \Delta X_{1,t-l} + \sum_{j=0}^{J} \gamma_j \Delta X_{2,t-j} \\ + \theta_0 Y_{t-1} + \theta_1 X_{1,t-1} + \theta_2 X_{2,t-1} + e_t \quad (54) \end{aligned}$$

The first part of the model (54),that is with the variables in first difference is used to capture the relationships of short-run, while the part with the variables in level rather serves to identify the long-run relationships.

According to Pesaran et al. 2004 equation (51) is considered as a conditional ECM. At this level, we need to verify the optimal number of lags. The use of information criteria [33] is necessary to choose the lag length (see Khim and Liew 2004). Once the lag specification is done, we can regress our variables in the conditional ECM (EC-ARDL model) using the appropriate number of lags. In order to validate this model, we have to make sure that the error terms are independent. We can't apply the bounds testing (ARDL) approach to cointegration if the independency of the residuals is not accepted.

## Long-Run Effects

To examine empirically the existence and significance of long-term relationships between the studied variables, we use the techniques of bounds tests introduced by Pesaran et al. 2001. We can then confirm or reject the correlation of the variables' long-run trends. Considering equation (54), to conduct a bound test, we have to implement an $F-test$ [34] with the absence of long-run equilibrium relationships as the null hypothesis (55). The rejection of this hypothesis means the existence of long-run equilibrium relationships which corresponds to the alternative hypothesis (56).

$$H_0 : \theta_0 = \theta_1 = \theta_2 = 0 \tag{55}$$

$$H_1 : \theta_0 \neq 0 \quad \text{and/or} \quad \theta_1 \neq 0 \quad \text{and/or} \quad \theta_2 \neq 0 \tag{56}$$

Note that F-test critical values aren't available when dealing with a mixture of integration orders (i.e I(0) and I(1)) variables. Nevertheless, Pesaran et al. 2001

33. These criteria are based on a high log-likelihood value. like AIC, HQ, BIC...
34. An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It is most often used when comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population from which the data were sampled

(page 300) provide bounds on the critical values for the asymptotic distribution of the F-statistic [35].

Suppose now that the bound tests are conclusive (cointegration is confirmed). We can then use the coefficients obtained in equation (65) to identify long-term relationships.

Note that in the long run the change quantities (equation 57) will be null.

$$\Delta Y_t = \Delta X_1 = \Delta X_2 = 0 \tag{57}$$

Thus, from the equation (54) we can derive the long-run elasticities which are $(\frac{-\theta_0}{\theta_1})$ for $X_1$ and $(\frac{-\theta_0}{\theta_2})$ for $X_2$.

# Data and Modelling

## Data

The data we used in our investigation are collected through Thomson Reuters Datastream and Thomson Reuter's Ecowin databases. We used European contextual variables to calculate their implied effects on our sample of European banks Credit Risk. The Credit risk is studied through The Credit default swap spread (5-year senior CDS). We applied the estimates on monthly frequency CDSs data over the December 2008 - September 2013 period. Lately, the Euro-zone has witnessed an important period that was rich in financial turmoil. The sample of the banking groups was chosen in this area from different countries with mixed economic situations. Below a table summarizing the data and the expected sign for

35. If the computed F-statistic falls below the lower bound we would conclude that the variables are I(0), so no cointegration is possible, by definition. If the F-statistic goes beyond upper bound, we conclude that we have cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive.

each explanatory variable. :

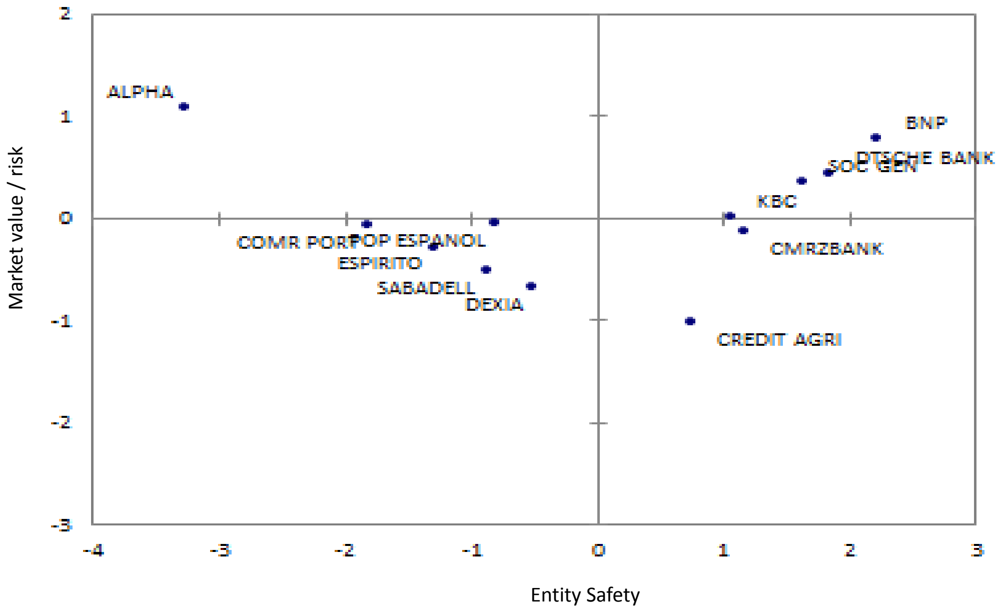
| Variables | Description | Abbreviation | Expected sign |
|---|---|---|---|
| Banks' variables | | | |
| Bank's CDSs (the dependent variable) | Credit default swap premium (spread) of the studied banking group | Entity CDSs | |
| Equity Value | The Market Value of the equity of the bank | Entity Equity | - |
| Countries' variables | | | |
| Sovereign CDSs | For each bank, its home country's credit default swap spread | CTR CDSs | + |
| Country's Stock Index | For each country a benchmark stock market index [a]. It is a capitalization-weighted measure of the most significant values among the highest market caps on the Bourse. | CTR DEX | - |
| Country inflation | The annual rate of inflation is the price of a total basket in a given month compared TO its price the same month one year before. | CTR INFL | + |
| European Variables | | | |
| Europ Stock Index | Euro Stoxx 50 : a stock index of Eurozone | EUR INDEX | - |
| European Inflation | The Harmonised Index of Consumer Prices (HICP) in the Euro area. | EUR INFL | + |
| USD/EUR Exchange rate | The rate at which one US dollar will be exchanged for the Euro. | USD/EUR | - |

a. BEL 20 for Belgian Banks, IBEX 35 for Spanish Banks, PORTUGAL PSI-20 for Portuguese Banks, FTSE MIB INDEX for Italian Banks, FRANCE CAC 40 for French Banks, and DAX 30 PERFORMANCE Index for German Banks

Table 3: Data Summary & Description of the variables

### Data Principal Component Analysis

We use the principal component analysis (PCA) to highlight similarities or contrasts between the studied entities and identify the most correlated between them. Variables close to each other are positively correlated, while remote variables are negatively correlated. With reference to the horizontal factor, we can clearly distinguish two groups, risky banks in the left side and safe ones in the right




Source: Author calculation.

Figure 9: Data Principal Component Analysis

side. The first are characterized by high Credit Default Swaps Spreads coinciding automatically with bad ratings, whereas the second have lower CDSs corresponding to banks with good ratings.

Entities having a relatively high value on the market, relative to its default risk lie above the vertical factor that is a kind of combination between the market value of the entity and its risk. The entities located below this line have a low market value relative to its risk.

Globally, The lower left square regroups banks with higher risk and a low market value relatively to its credit risk. The lower right one contains safe entities still undervalued.

Alpha Bank which lies in the upper left square is the riskiest one but overvalued in the market. In the upper right square we find the safest banks with correct market valuation.

The Principal component Analysis suggest that vertical line ie, the market value relative to its risk doesn't represent a good factor to separate the studied banks.

## Modelling

We worked on time -series Data. The very first step is to check the order of integration of the studied variables. We conducted Augmented Dickey-Fuller tests and the results show that the variables are all integrated of order 0 or 1. This allows us to apply ARDL model to verify the long-run relationships.

We assume that the banks long-run CDSs function for one entity:

$$CDSs_{it} = \alpha_{0t} + \sum_{d=1}^{D} \gamma_{it} X_{dit} + \mu_i + \epsilon_{it} \tag{58}$$

Where

– CDSs : Credit Default Swap spread

- $X_d$ : The independent variables.
- $i = 1, 2, ..., I$ : The number of the bank.
- t=1,2...T : The number of periods.

$X_d$ : The selected explanatory variables are listed above (see tale 3)
The conventional ARDL model corresponding to our regression for each bank is :

$$CDSs_t = \beta_0 + \sum_{p=1}^{P} \beta_p CDSs_{t-p} + \sum_{d=1}^{D} \sum_{l=0}^{L} \alpha_{dl} X_{d,t-l} + \epsilon_t \tag{59}$$

Where

- p..P : The autoregressive number of lags.
- d..D : The number of the explanatory variable.
- l..L : The number of the distributed lags.
- $X_d$ : The explanatory variables that could be one of the variables of the table 3.

In order to construct our Autoregressive Distributed Lag - Error Correction model (ARDL-ECM), we need to move to the variation version, as explained above, to be able to capture the long-term effects. The model 59 is then written as follows:

$$\Delta CDSs_t = \beta_0 + \sum_{p=1}^{P} \beta_p \Delta CDSs_{t-p} + \sum_{d=1}^{D} \sum_{l=0}^{L} \alpha_l \Delta X_{d,t-l} + \tag{60}$$

$$\theta_0 CDSs_{t-1} + \theta_1 EQ_{t-1} + \theta_2 CTRCDSs_{t-1} + +\theta_3 CTRDEX_{t-1} +$$

$$\theta_4 CTRINFL_{t-1} + \theta_5 EURDEX_{t-1} + \theta_6 EURINFL_{t-1} + \theta_7 XR_{t-1} + e_t$$

Where $\beta_0$ is the drift component and $e_t$ are the random errors. In the model 60, the $\theta_i$ are long-run multipliers while $\Delta$ denotes the first difference operator.

## Results

Prior to conducting the ARDL bounds test, it is necessary to compute Unit roots tests. We test the stationarity status of all variables to identify their order of integration. This is to make sure that the variables are not I(2) stationary so as to prevent spurious estimates. If it turns out that there are I(2) variables, then the computed F-statistics provided by the cointegration test are not conclusive in that the bounds test is based on the presumption, that the variables are I(0) or I(1). Hence it is indispensable to exclude the possibility that any of the series are I(2). Appendices B.1, B.2 and B.3 report the augmented Dickey-Fuller (ADF) tests' results where we tested the presence of a unit root for the variables' processes in different levels (in level to test the I(0) stationarity and in first difference to verify the I(1) stationarity). In this test the Null Hypothesis ($H_0$) is that the series has a unit root(not stationary in level). If rejected then the studied variable is stationary, else it is not integrated of order 0 and hence we have to test the stationarity in first difference and so forth (see Dickey and fuller 1979).
For all banks, the processes of the credit default swap spreads CDSs is integrated of first order I(1) except Deutsche Bank that is stationary in level at the 90 % level (and it is I(0) at the 99% confidence level). Testing the banking groups' market values, ie the equity price processes, we accepted the null hypothesis of the presence of unit root, and we rejected $H_0$ for these variables in first difference, hence they are all I(1). The countries' Credit default swap spread processes are I(1) at the risk level of 1%. The German Stock index is I(0) at the risk level of 10 % and all the others are I(1). The countries' inflation processes are stationary in difference, hence I(1). This is also true for the common European Variables.

## The ARDL -ECM results

Having done stationarity tests, we can now verify the lag order before applying the ARDL-ECM modelling on our variables. Pesaran et al. 2001 recommend to select the optimal order of lags of the model on the basis of the Schwarz-Bayesian (SBC) and Akaike Information (AIC) information criteria.. The results of the lag selection criteria[36] indicate that the optimal number of lags is two. The table 4 summarizes the computed explanatory variables' Long run incidences on the CDSs for the studied European banks. What is immediately apparent is that sovereign credit risk as measured by countries' credit default swap spreads is statistically significant for all entities except the Greek one "Alpha Bank" (For this bank, it wasn't possible to take into account since the Greek Government Credit Default Swap Spread are no more available since 2011). This allows us to confirm the effect of sovereign credit risk on banks risk of default. For these banking groups, the coefficient associated to this variable is positive and statistically significant at at least 95% (at the 90% level for "Banco Espirito Santo SA"). A deterioration in the credit quality of the country engenders the decline in credit quality of banks. Indeed, as the graphic 7 shows, banks in the Euro area hold important amounts of bonds issued by their own state. This implies that market tensions in sovereign debt can easily spread to the national banking system.

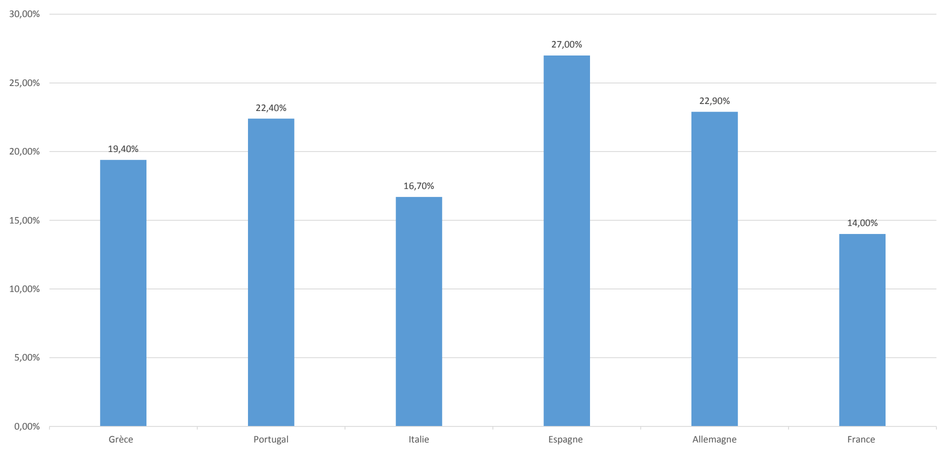
The estimates suggest that the CDSs of the considered banks (except Alpha Bank and Banco COMR Portugues) depend on inflation. They are explained either by the inflation of the home country or of the Euro area (but not both). This variable has the expected sign, ie positive. An increase in banks' credit risk is associated to a rise of the inflation. About this variable, our results confirm those of Demirguc

36. results are not reported here to conserve space and are available upon request

| Entity CDSs | Entity Equity | CTR CDSs | CTR DEX | CTR INFL | EUR INDEX | EUR INFL | USD/EUR |
|---|---|---|---|---|---|---|---|
| BNP Paribas | | 0,7149 | | 0,0713 | | | -0,0024 |
| | | (0,002) | | (0,0047) | | | (0,0412) |
| Credit Agricole | | 0,7335 | | 0,0683 | | | |
| | | (0,0016) | | (0,0089) | | | |
| Société Gńérale | -0,4492 | 0,605 | | 0,0708 | | | -0,00144 |
| | (0,0683) | (0,0003) | | (0,0022) | | | (0,0014) |
| Deutsche Bank AG | | 0,5435 | | 0,1312 | | | |
| | | (0,0066) | | (0,0397) | | | |
| Commerzbank | | 0,3627 | | | -2,7657 | 0,1113 | -0,00111 |
| | | (0,0021) | | | (0,002) | (0,0063) | (0,0036) |
| Banco de Sabadell SA | | 0,5628 | | | | 0,0872 | -0,000601 |
| | | (0,0009) | | | | (0,0097) | (0,013) |
| Banco POP Espagnol SA | | 0,5012 | | | | 0,0812 | -0,00054 |
| | | (0,0002) | | | | (0,0025) | (0,003) |
| Dexia Credit Local | | 0,43252 | | 0,00755 | | | |
| | | (0,0002) | | (0,0212) | | | |
| KBC Bank | | 1,2908 | | | -4,0469 | | -0,00061 |
| | | (0,0017) | | | (0,0109) | | (0,0012) |
| Banco COM Portugues | -0,0006 | 0,8986 | -3,0263 | | | | -0,000467 |
| | (0,0337) | (0,0278) | (0,0005) | | | | (0,0007) |
| Banco Espirito Santo SA | | 1,248 | -4,0846 | | | 0,0214 | |
| | | (0,056) | (0,0037) | | | (0,0778) | |
| Alpha Bank A,E | | | | | | | -3,92E-05 |
| | | | | | | | (0,0018) |

Source: Author calculation.
P-value are between parentheses.

Table 4: Results Summary: Explanatory variables' Long-run coefficients




Source : Pisani-Ferry (2012)

Figure 10: The share of Public Debt held by Domestic Banks in 2011

Kunt and Detragiache 1998 that argue that higher inflation is strongly significant in increasing the banking credit risk. This takes place especially through the effect of inflation on sovereign risk. Indeed, important inflation rates have a big impact on sovereign debt crises. All of the countries that experienced a default or debt restructuring in the past had swelling inflation. The negative effects of inflation involve weakening the real value of money, discouraging investment and saving.

All the parameters for the USD/EUR exchange rate have the same sign but are significant only for eight out of the twelve studied banking groups. An increase in this rate, i.e. a devaluation of the Euro, makes Euro-denominated debt less costing. Yet the coefficient associated to this variable is not high. However, it has a greater effect on the less risky entities ie those on the right side in the graph 9. The USD/EUR exchange rate reflects the competitiveness and the health of Eurozone economy. Hence an increase in this rate, ie a devaluation of the Euro reveals uncertainty in Europe as an economic union.

In the structural approach, Merton 1974 presented firm's equity as a call option on the enterprise with the strike price equal to the face value of a single payment debt issue(zero coupon debt). In this model, if at maturity $T$, the assets' value $V_T$ is insufficient to repay creditors, then the firm is in default (Note that $V_T$ is an increasing function of $E_T$ the firm's equity market price). When a company value raises, the distance-to-default of the respective entity increases. Hence the stock price is considered a significant credit risk determinant. Our results indicate that the equity price variable is not significant for most of the entities studied. As expected, it is negative for "Société Générale" et "Banco COMR Portugues". It should also be noted that for the second bank, the coefficient associated to the equity price is very low.

The relation between the stock market index and the banking credit risk as measured by the CDSs is only confirmed for the Portuguese banks. The coefficient in both cases are as predicted negative indicating that an improvement in the overall performance of a stock index enhances the perception of the safety of the registered companies and hence reduces their credit risk.

The stock market index provides information about how stocks in the index have performed. The Capital asset pricing model (CAPM) that is one of the major achievements of the financial theory stipulates that the risk of a stock index is inversely related to its market values. This model for pricing an individual security or portfolio takes into account the market risk while estimating the risk of the studied asset. The formula of this model in terms of risk premium is as follows:

$$E(R_i) - R_f = \beta_i(E(R_m) - R_f) \tag{61}$$

Where :

- $E(R_m) - R_f$ : The market premium.

- $E(R_i) - R_f$ : The asset's risk premium
- $\beta_i$ : Measures the relation of the expected return of the asset and the systematic risk, ie the sensitivity of the expected excess asset returns to the expected excess market returns.

Hence, according to this model there is a part of the risk of the asset that is explained by the market's risk. Our assessment indicates that the European Stock index "Euro Stoxx 50" is not significant for the most part of the studied banking groups. The relation is only valid for Commerzbank and KBC bank that are among the least risky entities.

## Bounds testing approach to cointegration

We opted for the bounds testing approach to cointegration in order to ascertain the existence of long-run relationship between the studied variables. The advantage of this approach other techniques for its flexibility since it allows us to test cointegration regardless the integration order of te variables (I(0)or I(1)).
The cointegration test under the bounds testing approach involves comparing the F-statistics against critical values. The calculated F-statistics, together with the critical values, are reported in table 5. As the table 5 shows, at the 5% level, the null hypothesis of no cointegration among variables for most studied European banking groups cannot be accepted, while in the "Banco Espirito Santo SA" model where calculated F-statistics are less than critical values (between the lower and the upper bounds), results are not conclusive. Hence the long-run equilibrium is rejected for the latter and accepted for the other banks of the sample at at least the 90% level of confidence.

| Entity's model | F-statistic | 0.05% F-test statistic bounds | LR evidence |
|---|---|---|---|
| BNP Paribas | 5.535527 | 3.23- 4.35 | YES** |
| Credit Agricole | 5.390232 | 3.79 - 4.85 | YES** |
| Ssociété Générale | 5.714959 | 2.86-4.01 | YES*** |
| | | (0.01% 3.74 - 5.06) | |
| Deutsche Bank AG | 5.522104 | 3.79 - 4.85 | YES** |
| Commerzbank AG | 3.727195 | 2.04 - 3.24 | YES** |
| Banco de Sabadell SA | 4.827298 | 2.45 - 3.63 | YES** |
| Banco Pop Espagnol SA | 6.085657 | 2.45 - 3.63 | YES*** |
| | | (0.01% 3.42 4.84) | |
| Dexia Credit Local | 8.723674 | 4.87 - 5.85 | YES*** |
| | | (0.01% 6.34 - 7.52) | |
| KBC Bank | 4.956741 | 4.45 -5.07 | YES* |
| | | (0.1% 3.47 - 4.45) | |
| Banco COM Portugues | 4.239751 | 2.26 -3.48 | YES** |
| Banco Espirito Santo SA | 3.262054 | 3.23 - 4.35 | NO |
| Alpha Bank A,E | 6.315583 | 6.56 - 7.30 | YES* |
| | | (0.1% 5.59 - 6.26) | |

Source: Author calculation.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Bound cointegration test

# Conclusion

This paper investigates the long-run links between European Banks CDS spreads as a proxy for credit risk with some common factors. Using the bounds testing approach to cointegration in order to analyse equilibrium relationships between the variables taken into account. We found that the home country credit risk is the most common determinant of European banks' credit risk. Inflation (whether those of countries or of the Eurozone but not both at once) also seems important in determining credit risk with a positive coefficient that means an increase in inflation is associated with the rise of credit risk. Besides, the exchange rate USD/EUR that is significant for most studied entities with a negative coefficient but not high especially for riskier banks. This means that a devaluation of the Euro (higher USD/EUR exchange rate) makes Euro-denominated debts less costing. Our results suggest that the link of the credit risk with the Market value of the equity or of the stock index in which the company is listed is becoming less essential in explaining the credit risk of the European banks. This confirms the entities' distribution found in the Principal component Analysis (18) which propounds that it is irrelevant to sort the studied entities by the factor of [Market value/ Risk].

# How does the Connectivity in the Credit Default Swap Market move?

## Introduction and Literature

This topic has not been, as far as we know, widely studied. But it has come to light since the Subprime crisis, where there was an important Domino effect that it was necessary to look into the matter. Indeed, one of the teachings of this crisis is that it is not enough to be solvent or to have creditworthy creditors to avoid default or credit risk. Financial entities are so interconnected, that when one is affected by an event, several others will be touched. As banks operate in the same market, they are continuously interrelated through exchanging securities, conducting joint operations and extending credit to each other. Besides, debts are securitized, which means they are converted into tradable shares and other credit derivates on the market. In fact, it is necessary for each bank to get protected against the credit risk through credit derivatives.
Getmansky et al. 2010 try to capture the interconnectedness among the monthly returns of hedge funds, banks, brokers, and insurance companies. The authors found that these sectors have become extremely interrelated over the past decade,

increasing the level of systemic risk.

Battiston et al. 2009 follow the evolution over time of a network of credit relations among financial agents as a system of coupled stochastic processes. They concluded that, because of the diversification of risk, a tension emerges between individual risk and systemic risk. As the number of counterparties in the credit network increases beyond a certain value, both individual and systemic default probabilities start to increase. Bowden 2010 shares this point of view and demonstrates that, in practice, in the credit default swaps market apparent risk sharing lead to a faster collapse. This opinion is also confirmed by Jorion and Zhang 2009. Working on CDS market, they suggest that counterparty risk is an important additional channel of credit risk contagion.

The special case of uniform demand of liquidity addressed to banks is treated by Allen and Carletti 2006, where they argue that credit risk transfer for the banking and insurance sector can be beneficial if this condition is respected.

The Subprime crisis [37] that occurred in 2007 is a representative example of contagion between banks and sovereigns. In fact, during and after this crisis, several banks have filed for bankruptcy and others were very close to it. Thereby, this crisis has weakened the global banking and economic systems by creating a widespread mistrust between banks and the financial system. The bankruptcy of some banks has created a snow ball effect that precipitated the economic crisis. As, on one hand, the weight of the banking system is very substantial in developed countries (the most affected by the crisis), and on the other hand, the economic sphere was critically affected, therefore the monetary authorities and governments had no choice but to intervene by setting up rescue measures. Indeed, rather than placing the entire failing financial sector under public control, governments agree to bail it out in the state. States get into debt out of proportion to rescue banks and stimu-

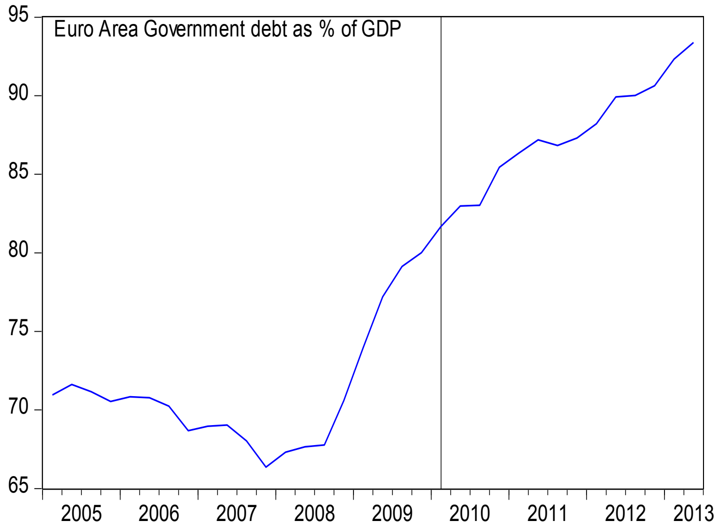
37. Patrice Fontaine, Understanding the Euro Crisis: How did the Subprime crisis become a sovereign debt crisis in Europe? Redesis, Paris North University

late the economy. The private financial crisis became a swelling of the public debt and led to a social crisis. Mody and Sandri 2011 demonstrate the emergence of financial tensions within the Eurozone. The authors show that the Subprime crisis has broken boundaries between the sovereign and the financial sector. De Bruyckere et al. 2013 investigated contagion as defined by excess correlation [38] between bank and sovereign default risk in Europe over the period 2007-2012. The authors noticed an increased correlation between sovereign and bank CDS spreads during the beginning of the recent sovereign financial crisis then the risk transfer started decreasing.

In addition to regulatory measures, governments were forced to make capital injections, liquidity provisions and vouch for some cases, to prevent the collapse of an economy battered by the Subprime crisis. For example, the French government has deployed about 428 billion euros including 360 just to rescue banks, while the German government approved a stimulus plan including bank bailout fund of 500 billion to restore confidence in the financial system.

As the graph below (11) shows, these measures led to an increase of the European governments' debt and this was felt from the beginning of 2010, when some of them began to experience difficulties in honoring their own debts. In this paper, we'll focus on the Credit Risk Transfer between European Sovereign and Corporate entities over the 2008-2013 period. Based on the phase of the crisis and the trend of CDS variation, three main sub-periods have been distinguished. This study focuses on Sovereigns and banks as they play an increasingly important role in the determination of credit risk. We opted for this choice given the different turbulence that have occurred in this area either on the bank or sovereign level. Billio et al. 2013 apply several econometric measures of connectedness using the

38. Correlation between banks and sovereigns over and above what is explained by common factors.




Source: European Central Bank.

Figure 11: Government debt evolution for the Euro Area

Merton [39] Model (contingent claims analysis Merton et al. 2007) to estimate sensibilities to external shocks on the network entities. Their findings are that the system of entities on which they worked, namely European countries, major European, U.S., Japanese banks, brokerages, and insurance companies are dynamically connected. Sovereign risk seems to become significant well before the European Sovereign crisis. They also concluded that network measures help for early warnings and the evaluation of the system complexity.

Our work falls under this approach of considering the connectedness, ie Granger causality, however we focus on three periods and we use the Credit default swap variation to show the links between the credit risk of the studied entities. Actually, Kallestrup et al. 2013 demonstrate that financial linkages across borders are priced in the CDS market beyond what can be explained by exposure to both global and

39. Robert Cox Merton is an American economist, Nobel laureate in Economics. He is known for his pioneering contributions to continuous-time finance, especially the first continuous-time option pricing model, the Black-Scholes-Merton formula.

country specific factors.

## Credit default Swaps

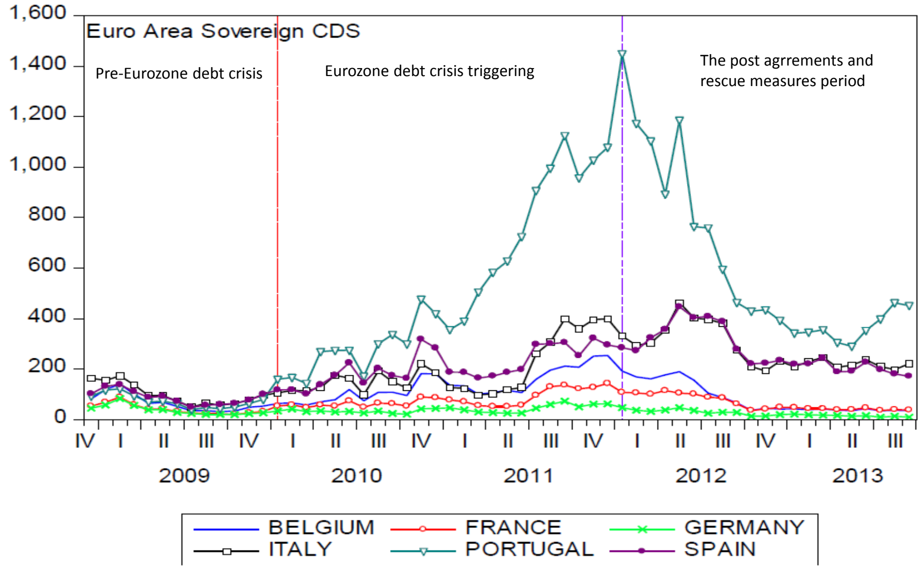
Credit Default Swaps (CDS) (see Cont 2010 ) were initially intended to be hedging and management instruments of credit risk. CDS markets now play an informative role in the credit markets, where CDS are often considered as a reflection of market consensus on the creditworthiness of the underlying entity (corporate or government). This is also confirmed through market practice of calculating the implied default probability of an entity from its CDS spreads. These probabilities are used for the valuation of credit derivatives. CDS are contracts used by their buyers to transfer the default risk of a creditor. The higher the risk involved, the greater the value of these contracts is. Thus this credit derivative is an adequate proxy for credit risk.

As shown in the figures below(12) (13), there is a correlation of changes of the European sovereigns' and banks' CDS. This makes us wonder about the links between the different entities of the two groups. We can also distinguish by the naked eye three main periods, namely:

- Until 2009: Period of implementation of the bailout following the Subprime crisis: With the introduction of governments' rescue packages for the financial system around early October 2008, the levels of sovereign issuers' CDS escalated quickly. This was commonly seen as a risk transfer from the financial to the public sector.
- 2010-2011: The bursting of the European debt crisis and first try of rescue plan: The first event is raised in 2010, with the Greek debt crisis, this period was marked by rapid increase in the CDS for both sovereigns and banks.
- 2012-2013: the post October $27^{th}$ agreement: Altera and Beyer 2014 show that the Contagion Index, measured as the average response in a spillover

matrix, fluctuates over the period October 2009-July 2012. It becomes notable following important policy events specially August 2011 and June 2012 events.

Credit default swap contracts create connections among issuers and buyers. In this sense, we assume that the CDS market can be perceived as a structure where agents are interlinked by their contracts. The best way to consider such a structure is to analyse it as a network where agents are schematized by its nodes and the credit nexus are represented by the links.

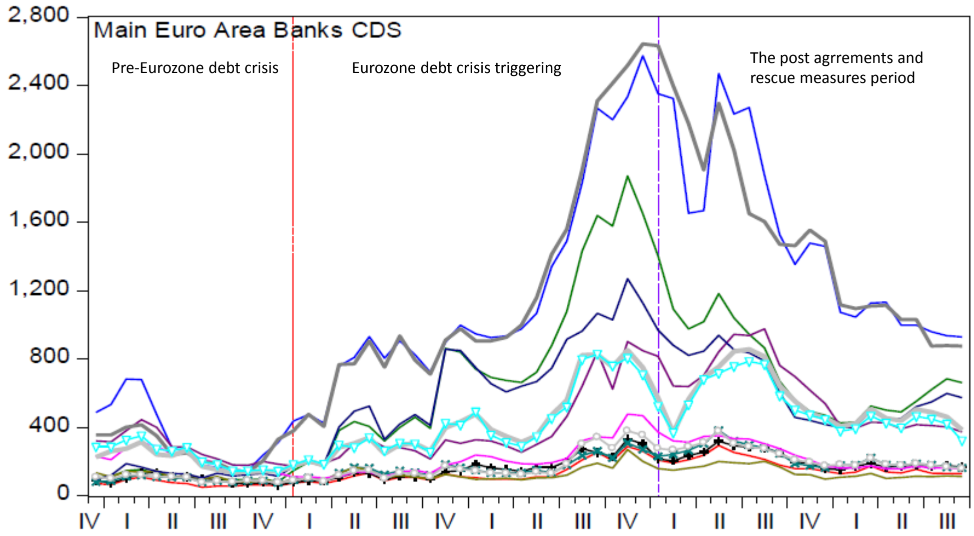



Source: Reuteurs and author calculation

Figure 12: Sovereign Euro Area CDS evolutions

This study aims to examine the unstable relationship between European countries and banks and to stress the particularities of each period for sensing what causes the increase or decrease of the links between the studied entities.

The chapter is structured in the following way: Section 3 presents the chosen methodology to measure the connectedness, in section 4 we introduce the data and the modelling. The results and the discussion are given in Section 5, while




Source: Reuteurs and author calculation

Figure 13: Main Euro Area banks CDS

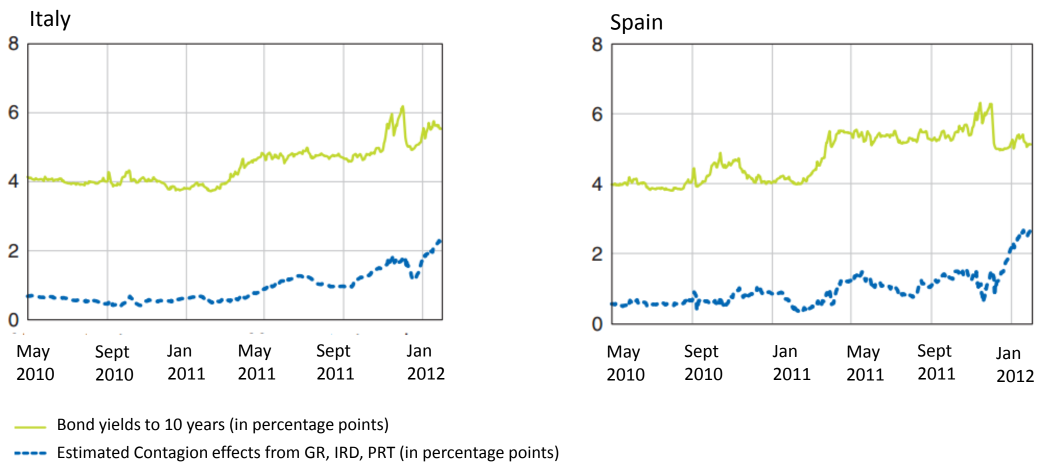
Section 6 contains the main conclusions.

# Contagion and Systemic Risk

Financial systemic risk is the risk of collapse of an entire financial system or entire market, in contrast to risk associated with any one individual entity, group or component of a system. It concerns the risks inflicted by interlinkages and interdependencies in a system or market, where the breakdown of a sole distinct entity or a group of entities can generate a cascading failure, which could potentially bankrupt or depress the entire system or market. Contagion is one of the mechanisms by which financial instability spreads to the point that crisis reaches systemic proportions. Generally we evoke contagion when turmoil in a market or institution propagates to one or more other markets or institutions.

The European sovereign debt crisis has raised requests for more general and coordinated policy interventions to refrain the crisis from expanding contagiously over countries, areas and the financial system. Indeed, during the recent financial crises that developed economies experienced and above all Europe, a succession of bank bankruptcies would have endangered the entire economy as the financial system contains a systemic component. Consequently, saving this latter became a priority for governments, that worked in concert with central banks to introduce wide-ranging financial rescue packages, involving substantial guarantees for bank liabilities. This generated pronounced contagion and risk transfer from banks to governments that can be perceived through the going up of the sovereign CDS. Remarkably, when the crisis of sovereign debt is amplified again, Moody's downgraded the rating of Portugal invoking, among other things, the situation in Greece. This is because Moody's believed that the contagion of a Greek default increased the probability that Portugal may need a second financial assistance plan. As the graph 14 shows, Castro 2013 found that the contagion from Greece, Ireland and Portugal, explains a significant proportion of the Italian and Spanish governments' bond yields. The author also noticed that changes in CDS spreads of Greece, Ireland, Portugal, Italy and France accounts for a growing proportion of the variability in CDS spreads of SociÃ©té Générale and Crédit Agricole. Hence he suggested that the sovereign debt crisis has a clear impact on the availability and cost of funding for banks in the Euro area. Gorea and Radev 2014, studying individual CDS contracts, found that financial linkages are an active contagion transmission channel only in the case of the troubled periphery Euro area economies.

This chapter aims to contribute to the techniques of measurement of what leads to systemic credit risk, ie, what are the movements in the credit market that may conduct to the risk transfer between the market agents. To do so, we will try to inspect connectivity between the studied entities.




Contagion from Greece, Ireland and Portugal to Italy and Spain

Source: 2012

Figure 14:

## Measuring connectivity

Connectivity measures are (typically bivariate) statistical measures that may be used to estimate interactions between potentially related entities. Connectivity is one of the basic concepts of graph theory.

To schematize the connectivity between the studied banks and countries we will use "entity-relationship diagram" in order to develop networks. A network is defined by the set of N nodes (or vertices) and the set of E edges (or links). The edge ij is the link that emanates from vertex i and ends in vertex j. Among a given network, two entities are considered to be connected if there is a path that binds them. We expect to obtain Many-to-Many Relationship diagram where:

Entities: Sovereigns and Banking groups

Relationship between entities: Which Entity CDS affect the other?

Attribute of entities: Changes in the Credit default swaps

For each network, it is possible to measure the level of connectivity. To do so, we use the Beta Index that it is expressed by the relationship between the number of edges (E) over the number of nodes(N) ($\beta = \frac{E}{N}$). In a network with a fixed number of nodes, the higher the number of links, the higher the number of paths possible in the network. Complex networks have a high value of Beta. More complex networks have a $\beta$ value greater than 1.

A first way to define relationships between entities is to use the pairwise correlations to determine the nodes whose movements are interrelated. Or correlation may be due to the dependence of firms and sovereigns on common economic factors. Yet, the contagion concept is associated with the local interactions between the entities themselves. R. Masson 1998 defines contagion as the effect of the residual in one market on the after, after controlling for all other forms of shock. Hence the author restricts this notion to the relationships specific to the two counterparties, eliminating external factors that can affect both of them.

## Granger Causality

Two correlated economic time series, are not necessarily linked by a causal relationship. They may have correlated tendencies changes without an economically significant link. Correlation does not evince causality. Indeed, having two correlated events $E_1$ and $E_2$, they can be caused by common factors, without causing each other, There is no connection between $E_1$ and $E_2$; the correlation is fortuitous and misleading.

Granger Causality (1969), as initially formalized by Clive Granger[40], is a statistical concept based on prediction that is used to determine whether time series $X_t$ is helpful in the foreseeing of another one $Y_t$. As defined in Liu and Taha Bahadori 2005 "X Granger causes Y if its past value can help to predict the future value of Y beyond what could have been done with the past value of Y only".

The Granger causality test is for two scalar-valued, stationary and ergodic time series $X_t$ and $Y_t$. The question we try to answer is : Does integrating the information contained in the past observations of $X_t$ improve our $Y_t$ forecasting?

Two main Granger test assumptions have to be mentioned:

- The past causes the present and/or the future but not vice versa.
- The informations about the impacts of a variable on the other, are unique and untraceable elsewhere, which allow us to identify it as a causality relationship.

The first assumption is intuitive, but it makes it impossible to take expectations into consideration. In the CDS market the risk perceptions are essentially forward

40. British economist, he taught at the University of Nottingham and at the University of California. In 2003, Granger was awarded the Nobel Memorial Prize in Economic Sciences, in recognition that he and his co-winner, Robert F. Engle, had made discoveries in the analysis of time series data that had changed fundamentally the way in which economists analyse financial and macroeconomic data.

looking which is inconsistent with this hypothesis. To use this method, we believe that although the past causes the present and future and that the opposite is not correct it makes sense to consider that past information already contain future expectations.

The second one is to say, that including the lagged observations of $X_t$ should give us informations that we cannot find in another variables' observations and that ameliorate the explanation of $Y_t$.

To answer: Does $X_t$ Granger cause $Y_t$? We assume:

- $X_t$ and $Y_t$ two scalarValued, stationary and ergodic time series.
- $I(t)$: The set of all the informations in the universe up to time t.
- $I(t)_X$: The set of all the informations in the universe except $X_t$ up to time t.
- $F(Y_t/I(t))$ : The conditional probability distribution of $Y_t$ given the set of information $I(t)$.

$X_t$ is said not to Granger cause $Y_t$, if for all $h > 0$ we have :

$$F(Y_{t+h}/I(t)) = F(Y_{t+h}/I(t)_X) \tag{62}$$

So, if the equality (62) is not accepted, then, there is a part of $Y_t$ that can be explained by $X_t$. In other words, taking into account $X_t$ improves our $Y_t$ power of prediction.

The statement that $X_t$ does Granger Cause $Y_t$ does not mean that $Y_t$ is the result of $X_t$, indeed, the Granger causality mostly measures the antecedence and the informative content.

## Modelling time series in Granger Causality test

According to Granger, the bivariate causality between two time series $X_t$ and $Y_t$ is tested through a vector autoregression model VAR. To do so, the variables have to be integrated of order 0, ie stationary, which explain the necessary condition of stationarity for the Granger test.
To test if $X_t$ Granger cause $Y_t$, we compare two models :

$$Y_t = \sum_{l=1}^{L} \alpha_l Y_{t-l} + \epsilon_t \tag{63}$$

$$Y_t = \sum_{l=1}^{L} \alpha_l Y_{t-l} + \sum_{l=1}^{L} \beta_l X_{t-l} + \epsilon_t \tag{64}$$

To choose the lag lengths, we have to resort to criteria for finding best model:

- LR: Likelihood ratio test criterion
- AIC: Akaike information criterion
- SIC: Schwarz information criterion

If the model (63) is better than the model (64), then $X_t$ does not Granger cause $Y_t$. If not, taking into account the information contained in $X_t$ improves $Y_t$ modelling, we conclude that there is a causal link in the Granger sense from $X_t$ to $Y_t$.
To choose between these two models, we use t-statistics (single coefficient), or F-test, Log-likelihood ratio-test, Wald-test (multiple coefficients).
As mentioned above, Granger is a bivariate test, that is to say, we test the causality between two variables in both directions.

$$X_t = \sum_{l=1}^{L} \sigma_l X_{t-l} + \sum_{l=1}^{L} \gamma_l Y_{t-l} + \epsilon_{1t} \tag{65}$$

$$Y_t = \sum_{l=1}^{L} \alpha_l Y_{t-l} + \sum_{l=1}^{L} \beta_l X_{t-l} + \epsilon_{2t} \tag{66}$$

Where we test both null hypothesis

- $H_0$ : Y does not Granger cause X where we test $\sum_{l=1}^{L} \gamma_l = 0$
- $H_0$ : X does not Granger cause Y where we test $\sum_{l=1}^{L} \beta_l = 0$

Hiemstra and D.Jones 1994 used Granger Causality test in the financial sector to examine the dynamic relation between daily Dow Jones stock return and percentage changes in New York stock exchange trading Volume and they concluded that bidirectional relationships exist.

## Data and Modelling

### Data

The data we used in our investigation are collected through Thomson Reuters Datastream database. We worked with weekly corporate and Sovereign CDS over the 11/28/2008 - 10/31/2013. As we have already mentioned, the period is divided into three sub-periods: (11/28/2008 - 12/25/2009), (1/01/2010 - 12/23/2011) and (1/06/2012 - 10/25/2013).

Our sample consists of two types of CDS contracts. CDS whose underlying entity is a Sovereign and CDS whose underlying entity is a Corporate precisely bank. For Sovereigns, considering data representativeness and availability, six European countries have been chosen, namely Belgium, France, Germany, Italy, Spain and Portugal. We then attempted to integrate in our sample the largest and most active European banks from different countries. Appendix C.1 summarizes the data.

## Modeling

For the empirical section of this paper, we used time series data in order to analyse the bivariate causality between Some European Sovereign and corporate CDS. In unreported results, we conducted Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) unit root tests [41] to check the stationarity of all series. Outcomes show that the null hypothesis of CDS non-stationarity can't be rejected and that these series are first order integrated.
To make it possible to compute Granger causality tests, we worked with the first differentiated series which are I(0).
Note that the VAR lag length L is always unknown and therefore has to be estimated via various lag length selection criteria such as the Aikaike's information criterion (AIC). Here the best lag length to work with is 2. We can now conduct Granger causality tests with two lags.
For any CDS series we test the causality with all the others CDS series.
We present now some Granger causality test implementations and results [42].
Working for instance, on France causality with both Spain and Portugal over the (1/06/2012 - 10/25/2013) period. We'll have to estimate 4 Var models, 2 for each bilateral relationship.

France Spain CDS Relationships :

The two VAR models corresponding to this test are:

$$France_t = \sum_{l=1}^{L} \sigma_l France_{t-l} + \sum_{l=1}^{L} \gamma_l Spain_{t-l} + \epsilon_{1t} \tag{67}$$

41. The unit root tests are available upon request
42. All Granger causality tests are available upon request

$$Spain_t = \sum_{l=1}^{L} \alpha_l Spain_{t-l} + \sum_{l=1}^{L} \beta_l France_{t-l} + \epsilon_{2t} \tag{68}$$

Where $L = 2$ and we test both null hypothesis

- $H_0$ : Spain does not Granger cause France where we test $\sum_{l=1}^{L} \gamma_l = 0$
- $H_0$ : France does not Granger cause Spain where we test $\sum_{l=1}^{L} \beta_l = 0$

| | 2009 Causality | | 2011 Causality | | 2013 Causality | |
|---|---|---|---|---|---|---|
| | F-Stat | Prob | F-Stat | Prob | F-Stat | Prob |
| Null Hypothesis | | | | | | |
| Spain does not Granger Cause France | 3.01346 | 0.0581 | 3.09600 | 0.0497 | 7.52653 | 0.0010 |
| France does not Granger Cause Spain | 0.50677 | 0.6055 | 4.03090 | 0.0208 | 0.26922 | 0.7646 |

Table 6: France - Spain Causality test

At the 95% confidence level, we confirm that an Entity-CDS Granger cause another Entity-CDS when the Pvalues are less than 0.05, then we reject the null hypothesis. For the first period we affirm that with a 5% risk, Spain-CDS do not affect France-CDS and vice versa. However, during the Eurozone debt crisis triggering period, the CDS of both countries affect each other since the Pvalues are less than 0.05. Yet, after establishing rescue plans, the relation between France-CDS and Spain CDS became asymmetrical since we validate the causality link from Spain-CDS to France-CDS but we reject it in the other direction.

France Portugal CDS Relationships :

The two VAR models corresponding to this test are:

$$France_t = \sum_{l=1}^{L} \sigma_l France_{t-l} + \sum_{l=1}^{L} \gamma_l Portugal_{t-l} + \epsilon_{1t} \tag{69}$$

$$Portugal_t = \sum_{l=1}^{L} \alpha_l Portugal_{t-l} + \sum_{l=1}^{L} \beta_l France_{t-l} + \epsilon_{2t} \tag{70}$$

Where $L = 2$ and we test both null hypothesis

- $H_0$ : Portugal does not Granger cause France where we test $\sum_{l=1}^{L} \gamma_l = 0$
- $H_0$ : France does not Granger cause Portugal where we test $\sum_{l=1}^{L} \beta_l = 0$

| | 2009 Causality | | 2011 Causality | | 2013 Causality | |
|---|---|---|---|---|---|---|
| | F-Stat | Prob | F-Stat | Prob | F-Stat | Prob |
| Null Hypothesis | | | | | | |
| Portugal does not Granger Cause France | 5.70070 | 0.0038 | 5.46726 | 0.0056 | 0.70206 | 0.4983 |
| France does not Granger Cause Portugal | 5.25359 | 0.0058 | 1.06673 | 0.3481 | 1.54315 | 0.2194 |

Table 7: France - Portugal causality test

For the first model (69) where we test the causality from Portugal to France the P-value is less than 0.05 for the two first periods, then we reject the first null hypothesis and we confirm at the 95% confidence level that Portugal-CDS Granger cause (ie affect) France-CDS. However, this relationship can't be validated during the last period.

The null hypothesis of non-causality from France to Portugal corresponds to the second model (70). It is rejected during the first period with a P-value less than 0.05. For the two other periods we can affirm that France-CDS do not Granger cause (do not affect) Portugal-CDS.

# Results

As aforesaid, the Granger causality has been tested on European sovereign and banks CDS over three consecutive periods. If we refer to figures (12) and (13), we note that the first period, which directly followed the Subprime crisis, is where the pricing of the CDS market has calmed down. In fact, prices are low for all studied entities. During this first period, comforted by the influx of public money and the stock exchanges rising, stimulated by near-zero interest rates, banks and investment funds resume their ordinary business.

During the second period, States have saved the banks without requiring counterparty. Banks turn their newfound strength against the States. Goldman Sachs has helped Greece to borrow billions of euros in secret. Then, to circumvent EU rules limiting the level of public debt, the Wall Street firm advised Athens to use clever accounting and financial tricks. The bill for these innovations then rounded the huge Greek debt. Considering support to Greece became unavoidable when the European Union governments have been already hit by their own banks bail out. The different government interventions aiming at rescuing governments and financial institutions by capital injections and guarantees increased considerably the costs of public debts. This financial turmoil has plunged the Euro-Zone in a deep debt crisis.

in the late 2011, Countries in the Euro area managed to buckle the main lines of an anti-crisis plan through a significant reduction of Greece's debt and the mobilization of 1 trillion, not to mention the international rescue plans during the same period for Ireland and Portugal in order to prevent contagion. During the following period, all these measures began to pay. As the graphs 12 and 13 show, CDS started to decline significantly for both countries and financial institutions.

Countries can be divided into two groups: countries with a stable financial posi-

tion, ie Germany, France and Belgium, and others whose credit risk is much more important, namely, Italy, Spain and Portugal. The second are part of GIIPS which are considered to be the most problematical and uncertain members in the Euro area.
As summarized in the table below (8), countries with low risk are not affected by the others during the phases of financial turmoil. These are countries whose financial and economic health is safer. The second group of countries that is more touched by the European debt crisis, is more affected during these times of hardship. It is more vulnerable and sensitive to changes occurring for other entities. Banks, however, have kept the same proportion of participation before and during the outbreak of the crisis. Their role has made a considerable jump during the later period (from 46% to 70%). Indeed, banks are more concerned by the agreements made to overcome the crisis, it is about the facilities they need to grant to entities facing problems.

| Causality From [a] | Period 1 | Period 2 | Period 3 |
|---|---|---|---|
| Germany, France, Belgium | 31 (33%) | 11 (16%) | 24 (22%) |
| Italy, Spain, Portugal | 19 (20%) | 26 (38%) | 9 (8%) |
| Banks | 44 (47%) | 32 (46%) | 75 (70%) |
| Total | 94 (100%) | 69 (100%) | 108 (100%) |

Source: Author calculation.
Percentage of the total causality relationships in parentheses

*a.* To all Network Counterparties

Table 8: Results Summary

We worked on the three above-mentioned periods. The results are presented in the form of directed networks[43]. Each node is the CDS of an entity and each link is a causal relationship. Arrows are directed from the CDS-origin to the CDS affected. Full results of the causality tests between the studied entities are shown in Appendices C.2.

$X \to Y$ Means X Granger causes Y Means X Affects Y

## The Pre-Eurozone debt crisis period

Figure (15) shows the connections between the entities of the studied sample for the first period. The 2008-2009 period is characterized by large responsibilities from states to save the banking sector following the Subprime crisis. These commitments include insurance, guarantees and particularly loans.

We found 94 causality links in the Granger sense between the 22 countries and banks.

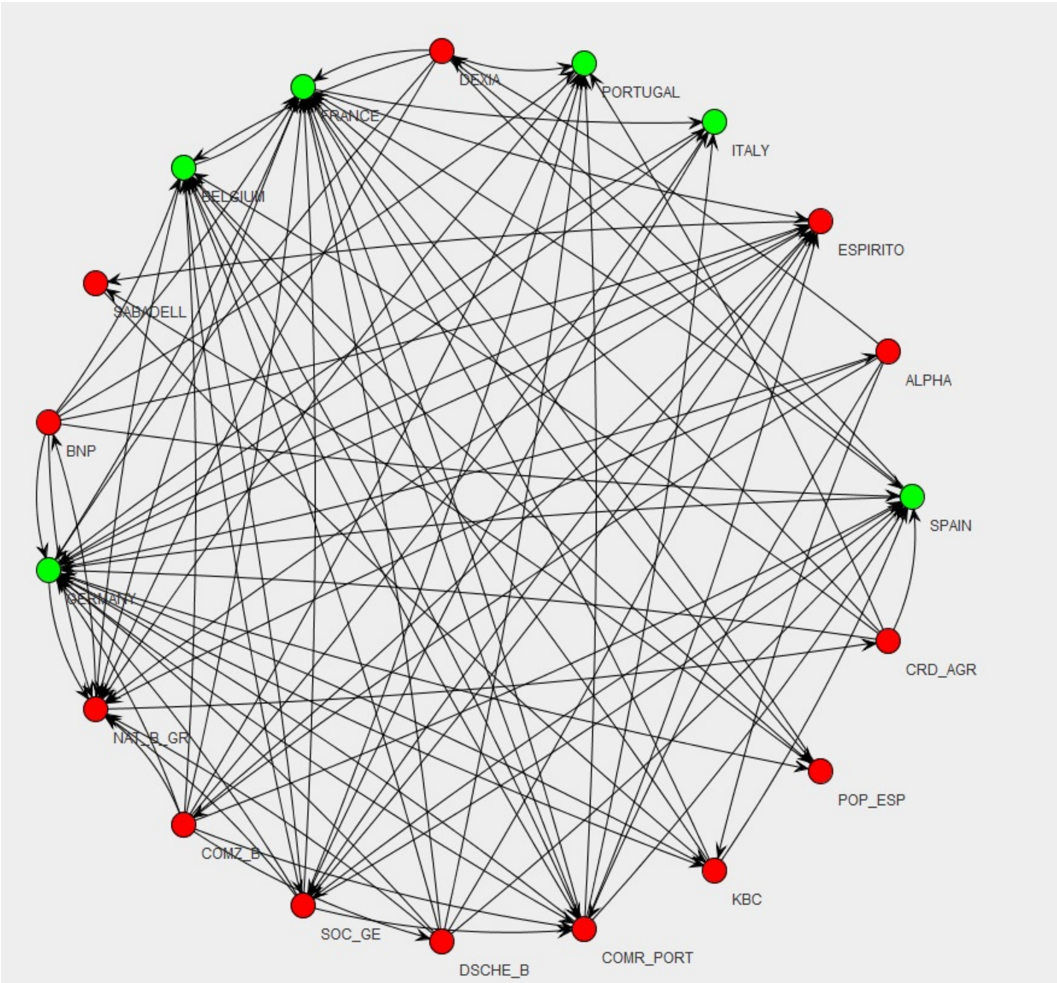
**The network topology**: The measured level of connectivity $\beta_1$ :

$$\beta_1 = \frac{E_1}{N} = \frac{94}{22} = 4,27 \tag{71}$$

A connected network with one cycle has a $\beta$ value of 1. With this fairly large $\beta$, the resulting network is quite dense. Here the impact of an entity over another arises not only from the direct link between them but also via many paths through the impact of the former on other entities to which it is connected as well as the affected one.

The first thing to note is that the relationships are not symmetrical. However, just before the European debt crisis, countries on average are more responsive to CDS changes than banks. At this point, the financial system was pointed and intensively monitored. As argues Lane 2012 "Through 2008 and 2009, there was

43. JAVA programming code is available upon request




Source: Author calculation.

Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 11/28/2008 to 12/25/2009. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

Figure 15: 2009 CDS Network

relatively little concern about European sovereign debt. Instead, the focus was on the actions of the European Central Bank to address the global financial shock".

## The Eurozone debt crisis triggering period

Figure (16) depicts the connectivities between the CDS of the same set of European sovereigns and banks during the European debt crisis triggering. Following the measures taken by the state governments of the Euro area in conjunction with central banks, financial weaknesses are propagated between the different network entities. The danger of credit risk transfer is strongly felt. The resulting network is much less dense.

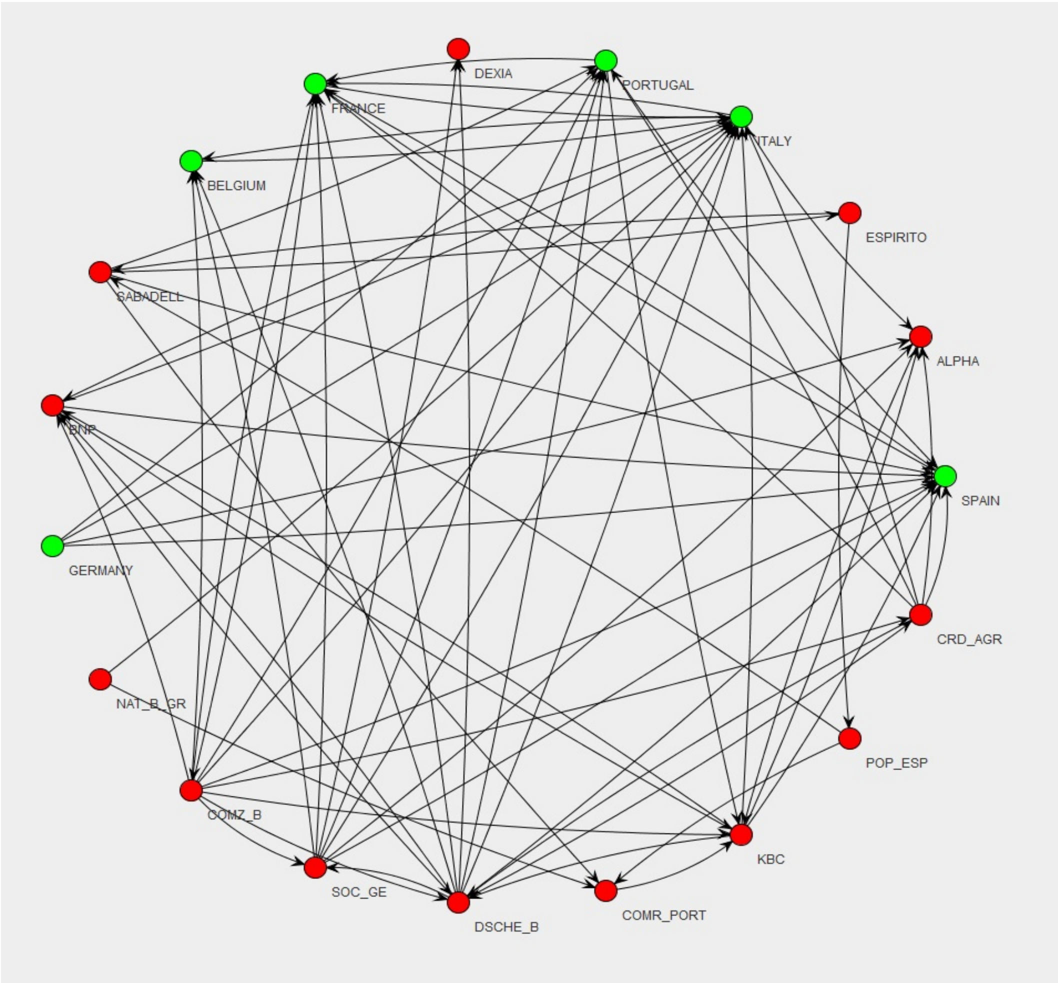
The number of causal relationships goes from 94 to 69, representing a decrease of over 25%. We found 69 causality links in the Granger sense between the 22 countries and banks.

**The network topology**: The measured level of connectivity $\beta_2$ :

$$\beta_2 = \frac{E_2}{N} = \frac{69}{22} = 3,13 \tag{72}$$

The $\beta$ dropped considerably from 4,27 to 3,13. Direct links between the entities as well as the number of cycles decreased significantly. The obtained network is less developed which reduces the contagion risk and hence the systemic risk.
After the outbreak of the Greek crisis, the countries that are part of the GIIPS [44], Italy, Spain and Portugal here, are fiscally vulnerable and became more sensitive to variations of the other entities CDS. Indeed, the financial crisis provoked a review of asset prices, growth expectations and risk levels particularly for countries manifesting macroeconomic imbalances. The other entities got less connected to the network which allows to avoid or reduce contagion.

44. Greece, Italy, Ireland, Portugal, Spain




Source: Author calculation.

Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 1/01/2010 to 12/23/2011. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

Figure 16: 2011 CDS Network

During this critical period, every transaction is uncertain and can be very risky. Combined to the fact that agents become risk averse, it is not surprising that the transactions on the financial market and thereafter CDS links drop considerably. Here, the authorities' objective is to restore trust to prevent the spread of the crisis and the collapse of the entire system.

## The Post agreements and rescue plans period

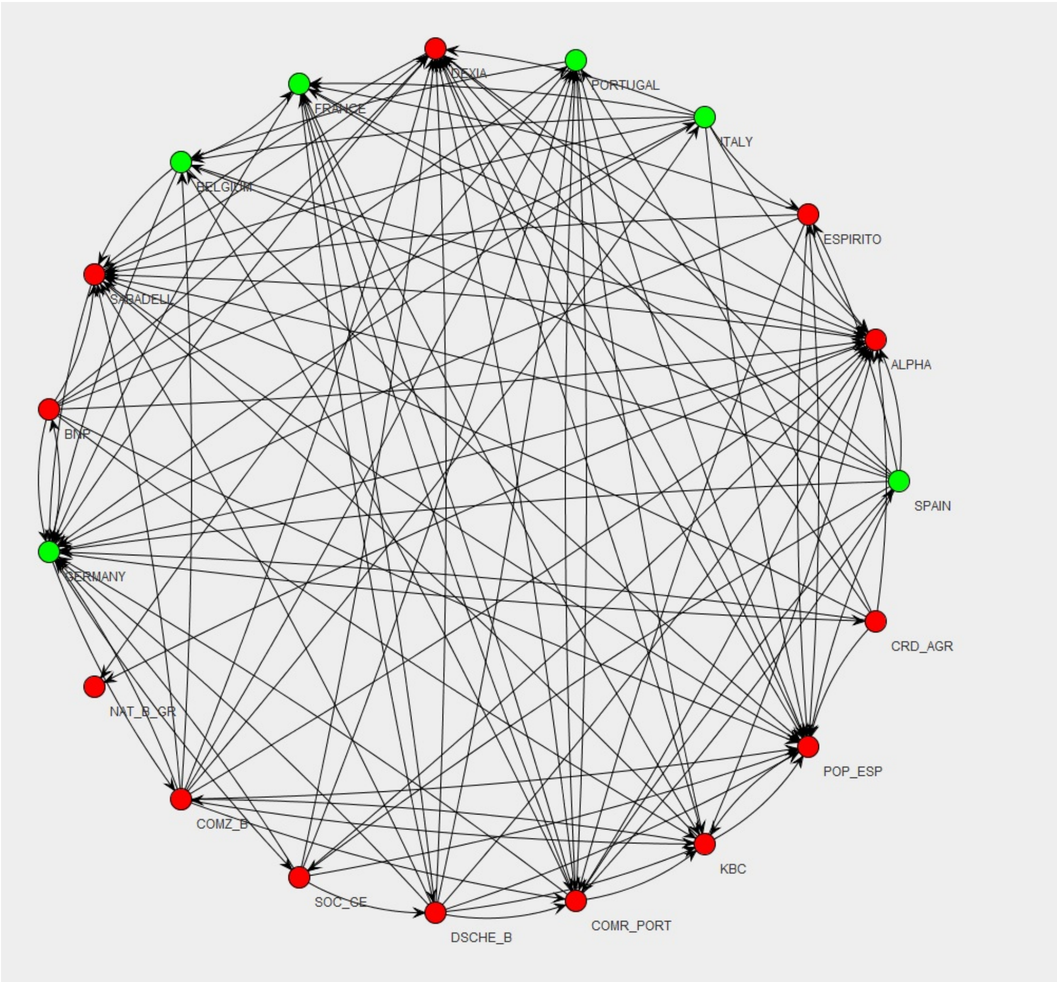
Figure (17) illustrates the connectedness among the CDS of the same set of European sovereigns and banks for the 2012-2013 period. This phase was marked by an early return of trust between agents on the financial market following agreements and rescue plans period. They cooperate to prevent the bankruptcy of entities that may eventually cause the failure of others.
Causal links moved from 69 to 108, representing a more than 56% increase.
**The network topology**: The measured level of connectivity $\beta_3$ :

$$\beta_3 = \frac{E_3}{N} = \frac{108}{22} = 4,9 \tag{73}$$

We notice a return to the increase in $\beta$. This generates a more developed and connected network with more both direct and indirect links.

The obtained network is the densest one. It seems that the measures taken jointly by the European Union and the International Monetary Fund[45] aiming to stabilize the financial system in the Euro area after the bankruptcy of Greece succeeded to restore confidence between the studied entities. The aids and relief programs implemented to avoid failure of several entities has led to the reduction of distrust and made the CDS market more energetic. This was the last and the

45. The IMF is a specialized agency of the United Nations. Through its economic surveillance, it keeps track of the economic health of its member countries, alerting them to risks on the horizon and providing policy advice. It also lends to countries in difficulty, and provides technical assistance and training.




Source: Author calculation.

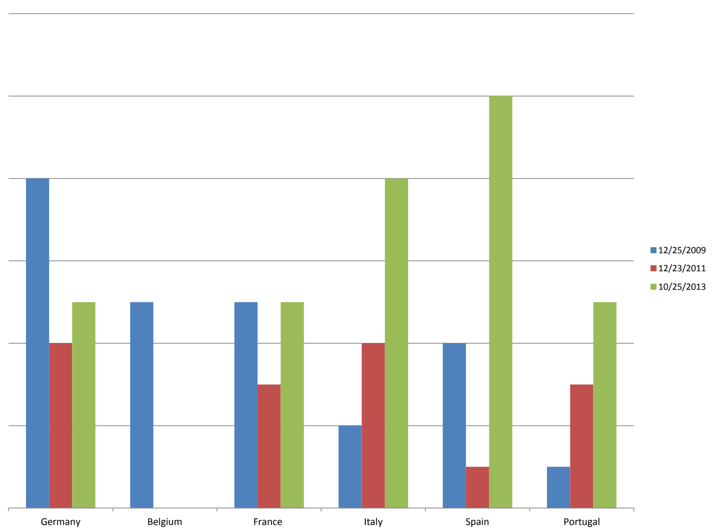
Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 1/06/2012 to 10/25/2013. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

Figure 17: 2013 CDS Network

only solution because if banks and countries refuse to lend each other and to co-operate in the market, the system dries and agents would lack cash. If this would happen, the remaining question would be who is next to file for bankruptcy. This means the collapse of the entire system.

## Contagion from and to Sovereigns

Countries are the most influential part of the studied network, they have greater weight and make decisions that affect the entire system. However, their impacts that differ according to their economic situations vary over time with the overall financial and economic condition of the monetary union. Figure 18 shows the evolution of the affected countries during the three considered periods.

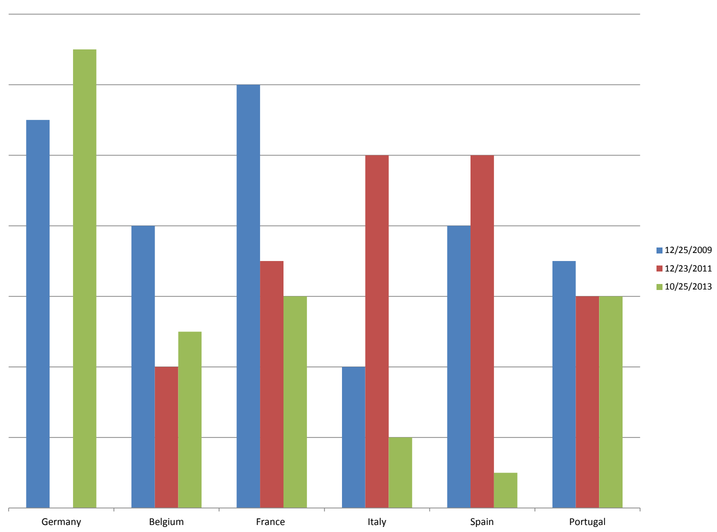



Source: Author calculation

Figure 18: Causality From Sovereigns

For strong economies, causal relationships whose source is a sovereign fall considerably during the second period; Phase of the outbreak of the European debt

crisis and vice versa for other economies (except Spain). During bad patches, economies facing problems are more vulnerable. This is why stakeholders try to help them out of their problems, otherwise the losses spread and become huge and unsustainable.
Figure 19 highlights the effects undergone by countries' CDS from the set of the network components from period to period.



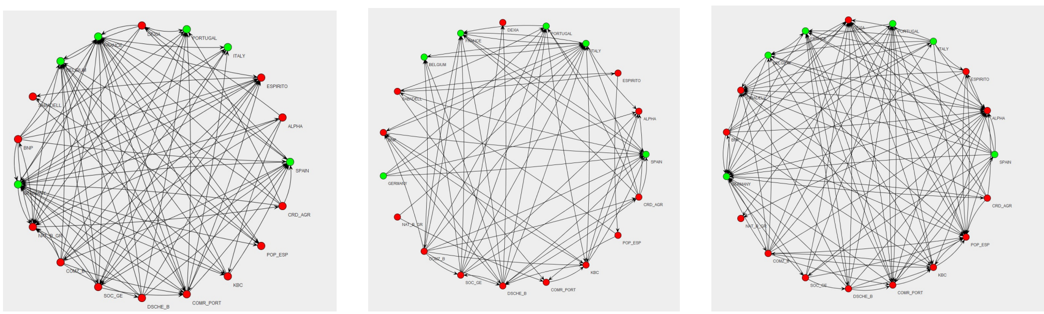

Source: Author calculation

Figure 19: Causality to Sovereigns

Causal relationships to the sovereigns decline in a remarkable way for countries with healthier economies for the (1/01/2010 - 12/23/2011) period. This is a mean of protection against the propagation of adverse effects of the debt crisis. Nevertheless, the causalities to the less powerful countries, make a major leap attesting to the vulnerability and the fragility of these economies to shocks.

# Conclusion

Using pairwise Granger causality tools and the Graph theory (see Bondy and Murty 1976), we tried to model a network of European Sovereigns and banks Credit Default Swaps. The group of the studied entities is dynamically interrelated in the sense that relationships are constantly changing from period to period. The roles of affecting and affected can be reversed. Entities can be disconneted throughout a period then they become linked.



2009 2011 2013

Source : author's calculation.

Figure 20: Networks's comparaison

During calm periods, when the system is monitored, some level of trust is established between the agents, allowing them to exchange in the financial market which increases the transfer of risk and subsequently the causal links between entities. However, during crisis, and more generally periods of financial turmoil, lack of confidence pushes agents to become more risk averse and makes everyone operate in his corner in his own interest to avoid potential contagion by less efficient agents. The mistrust makes the network sparse and agents scattered. This can be seen as beneficial in the sense that This leads to braking systemic risk.

Questions about the basics and the economic legitimacy of the establishment of the European Union with a common currency were recently raised. Joining the EU, heterogeneous countries waive their specific adjustment mechanisms including the exchange rate and they are forced to adopt the same monetary policy. However, these policies are decided at the whole union level while European aggregate data conceal significant differences at the individual country level. In addition, there is a moral hazard problem since members are able to borrow in the common currency and this raises free-rider problems as shows Buiter et al. 1993 and Lane 2012.

In forthcoming works it would be interesting to find other methods to measure entities' connectivities, since one of the principal hypothesis of Granger causality parawaise test is that the future doesn't impact the present or the past which is not realistic since the credit default swap market is not as backward looking that it is forward looking.

# Conclusion Générale

La plupart des travaux sur le risque de crédit aboutissent à une évaluation de la vraisemblance de survenance d'un évènement de crédit à savoir la non honoration des engagements de la part de l'emprunteur envers son prêteur.
Après la présentation des différentes approches du risque de crédit ainsi que des modèles fondateurs de chacune d'elles. Les principaux objectifs de cette thèse ont été de trois ordres: D'abord, nous avons cherché à étudier empiriquement le lien entre les fondamentaux macroéconomiques et le risque de crédit souverain pour certains pays de la zone euro afin de définir les déterminants de celui-ci. Ensuite, en utilisant l'approche des Bounds testing to cointegration (ARDL-ECM), nous avons examiné les relations de long terme entre les spreads des Credit Default Swap d'un échantillon de groupes bancaires Européens avec les facteurs contextuels des banques, des pays et de la zone Euro. Enfin, à travers les outils de tests de causalité au sens de Granger, nous avons construit un réseau de Credit Default Swaps reliant les entités bancaires et souveraines. Nous avons ainsi pu étudier l'évolution et l'expansion de ce réseau pour la période de l'explosion des problèmes d risque de crédit.

# Les conclusions principales

D'après la première partie proposée, trois contributions principales ont été apportées. D'abord, nous avons réussi à établir des modèles économétriques permettant de définir les déterminants macroéconomiques du risque de crédit d'un échantillon de souverains Européens. Les modèles estimés nous permettent de conclure que, le risque de crédit des pays étudiés à savoir l'Autriche, la Belgique, la France, l'Allemagne,le Luxembourg, les Pays-Bas, l'Italie, l'Espagne et le Portugal est largement dépendant des fondamentaux macroéconomiques. Le taux du chômage qui paraît être la variable macroéconomique la plus influente, a d'autant plus d'effet lorsque le pays en question traverse des conditions économiques difficiles. Les relations de long terme entre les rendements des bonds de trésors des souverains Européens avec les déterminants macroéconomiques sont plus important et plus significatifs que ceux du court terme. Les relations définies sont globalement stable à long terme (pour 7 pays sur 9).
Dans la deuxième partie, nous nous somme proposés de modéliser le risque de crédit d'un échantillon de groupes bancaires Européens en essayant de déterminer les relations de long terme entre le risque de crédit de ces derniers, en le mesurant par les spreads des contrats des Credit Default Swaps CDS, avec les facteurs propres aux banques, à leurs pays d'origine ainsi qu'à la zone Euro. Les résultats révèlent que dans le long terme, une augmentation de l'inflation et / ou le risque de crédit des pays d'origine amplifient le risque de crédit des Banques Européennes. Les estimations semblent indiquer que la dévaluation de l'euro, rend la dette libellée en euros moins coûteuse, ce qui diminue le risque de crédit des entités Européennes. Cependant, contrairement à ce qui est attendu, notre analyse montre que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la firme est inscrite deviennent insignifiants pour expliquer son risque de crédit.

Le dernier chapitre traite les liens entre le risque de crédit des entités souveraines et bancaires étudiées dans les chapitres précédents. Nous avons cherché à mettre en évidence les relations de causalité entre les Credit Default Swap des uns et des autres afin de déterminer quelles sont les entités qui affectent et quelles sont les entités affectées et ce à travers les techniques du test de causalité au sens de Granger. Nous avons constaté que les liens obtenus ne sont pas symétriques et qu'ils varient considérablement en fonction de l'état de l'économie de la région. Nous montrons aussi que juste avant les importantes phases de turbulences financières, le transfert du risque de crédit est très notable augmentant ainsi la contagion et le risque systémique, alors qu'il diminue significativement pendant les périodes d'incertitude marquées par la propagation de la méfiance. Ceci est d'autant plus important, que dans l'Union Européenne, les pays adoptent les mêmes politiques monétaires voire fiscales tout en étant hétérogènes.

## Travaux à venir

Quand bien même, les déterminants identifiés du risque de crédit sont significatifs aussi bien pour les souverains que pour les banques, il serait judicieux d'étudier d'autres facteurs susceptibles d'affecter leurs solvabilités. Des facteurs microéconomiques propres à chaque entité sont à intégrer dans des travaux futurs afin d'améliorer l'explication des probabilités de défaut. Empiriquement, il serait aussi intéressant d'essayer de trouver un autre moyen de mesure de connectivité entre les entités étudiées. Un outil qui pourrait remédier aux problèmes du test de causalité de Granger notamment la non prise en compte des prévisions sur le risque de crédit, comme ce test est plutôt forward looking.

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# Appendix A

## A.1- Data Summary & Description of the variables

| Variables | Description | Source | Expected sign |
|---|---|---|---|
| Sovereign Long Run Bond Yield (the dependent variable) | Long-Term Government Bond Yields, 10-Year, Main (including benchmark), Yield 10-year government bonds | Main Economic Indicators, copyright OECD | |
| Exports Growth rate | Exports to World: the quarterly growth rate | IMF - Direction of Trade Statistics | - |
| Unemployment rate | Unemployment to population rate, All Persons, Unemployment/population rate, all persons ratio, SA | Main Economic Indicators,copyright OECD | + |
| Gross domestic product | GDP by Expenditure, Gross domestic product, Volume index, SA, | Quarterly National Accounts,copyright OECD | - |
| Long Run government debt | Government Debt, Long-term, General government, % of GDP | Eurostat | + |

Appendix A

## A.2- Augmented Dickey-Fuller test statistic I

| | Austria | France | Belgium | Germany | Italy |
|---|---|---|---|---|---|
| LTBY | -1,131 | -1,449 | -1,470 | -1,154 | -2,602 |
| | (0,698) | (0,552) | (0,541) | (0,688) | (0,099) |
| D(LTBY) | -7,644 | -7,517 | -8,099 | -7,428 | -9,147 |
| | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) |
| GDPVOL | -1,248 | -1,394 | -1,199 | -0,781 | -1,874 |
| | (0,646) | (0,579) | (0,669) | (0,816) | (0,342) |
| D(GDPVOL) | -4,000 | -4,343 | -4,522 | -4,645 | -3,897 |
| | (0,003) | (0,001) | (0,001) | (0,000) | (0,004) |
| DEBT_GDP | -1,373 | -0,961 | -0,862 | -3,420 | -0,806 |
| | (0,589) | (0,760) | (0,793) | (0,014) | (0,810) |

| | | | | | |
|---|---|---|---|---|---|
| D(DEBT_GDP) | -4,996 | -5,656 | -5,251 | | -7,273 |
| | (0,000) | (0,000) | (0,000) | | (0,000) |
| Unemplo | -1,703 | -1,559 | -3,123 | -0,545 | -0,388 |
| | (0,424) | (0,496) | (0,031) | (0,874) | (0,904) |
| D(Unemplo) | -8,285 | -5,963 | | -4,960 | -4,149 |
| | (0,000) | (0,000) | | (0,000) | (0,002) |
| Export_growth | -3,363 | -4,045 | -6,964 | -5,411 | -3,716 |
| | (0,017) | (0,003) | (0,000) | (0,000) | (0,007) |

Null Hypothesis: Variable has a unit root.

p-value in the parentheses

# Augmented Dickey-Fuller test statistic II

| | Luxembourg | Netherlands | Portugal | Spain |
|---|---|---|---|---|
| LTBY | -1,274 | -1,206 | -2,255 | -2,218 |
| | (0,636) | (0,666) | (0,190) | (0,203) |
| D(LTBY) | -6,556 | -7,640 | -4,119 | -8,698 |
| | (0,000) | (0,000) | (0,002) | (0,000) |
| GDPVOL | -1,157 | -1,566 | -2,002 | -2,002 |
| | (0,687) | (0,493) | (0,285) | (0,285) |
| D(GDPVOL) | -7,286 | -3,972 | -5,150 | -2,022 |
| | (0,000) | (0,003) | (0,000) | (0,042) |
| DEBT_GDP | -0,612 | -1,697 | 1,441 | 0,423 |
| | (0,859) | (0,427) | (0,999) | (0,982) |

| | | | | |
|---|---|---|---|---|
| D(DEBT_GDP) | -6,950 | -5,234 | -4,441 | -7,082 |
| | (0,000) | (0,000) | (0,001) | (0,000) |
| Unemplo | -2,651 | -0,940 | -1,124 | -0,599 |
| | (0,090) | (0,768) | (0,700) | (0,862) |
| D(Unemplo) | -7,480 | -3,959 | -4,030 | -3,254 |
| | (0,000) | (0,003) | (0,003) | (0,022) |
| Export_growth | -9,636 | -5,970 | -6,610 | -3,877 |
| | (0,000) | (0,000) | (0,000) | (0,004) |

Null Hypothesis: Variable has a unit root.

p-value in the parentheses

## Appendix A

### A.3- Lag Order Selection Criteria

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| Austria | | | | | | |
| 0 | -18.71452 | NA | 0.148486 | 0.929981 | 1.119376 | 1.002354 |
| 1 | -18.55007 | 0.290195 | 0.153503 | 0.962748 | 1.190022 | 1.049596 |
| 2 | -14.76233 | 6.535717* | 0.137696* | 0.853425* | 1.118577* | 0.954747* |
| 3 | -14.60834 | 0.259666 | 0.142464 | 0.886602 | 1.189633 | 1.002399 |
| 4 | -14.54885 | 0.097983 | 0.147983 | 0.923484 | 1.264395 | 1.053756 |
| 5 | -12.47557 | 3.333505 | 0.142084 | 0.881395 | 1.260184 | 1.026142 |
| France | | | | | | |
| 0 | -17.52273 | NA | 0.149767 | 0.938447 | 1.133364 | 1.012106 |
| 1 | -16.55329 | 1.696509 | 0.150042 | 0.939721 | 1.173621 | 1.028112 |
| 2 | -11.33496 | 8.914661* | 0.125956* | 0.763957* | 1.036840* | 0.867080* |
| 3 | -11.06812 | 0.444734 | 0.129998 | 0.794505 | 1.106372 | 0.912360 |
| 4 | -10.32917 | 1.200781 | 0.131598 | 0.805382 | 1.156232 | 0.937969 |
| 5 | -8.812244 | 2.401806 | 0.129013 | 0.783843 | 1.173677 | 0.931162 |
| Belgium | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | -19.40255 | NA | 0.161970 | 1.016773 | 1.250987 | 1.090432 |
| 1 | -17.91990 | 2.594643 | 0.158833 | 0.996662 | 1.230563 | 1.085054 |
| 2 | -16.47448 | 5.484366* | 0.156034 | 0.952650* | 1.211690* | 1.081226* |
| 3 | -16.45245 | 0.036712 | 0.162694 | 1.018852 | 1.330719 | 1.136707 |
| 4 | -16.32741 | 0.203190 | 0.168962 | 1.055309 | 1.406159 | 1.187896 |
| 5 | -12.86360 | 2.469259 | 0.152737* | 0.978103 | 1.342484 | 1.099969 |
| Germany | | | | | | |
| 0 | -22.77757 | NA | 0.174134 | 1.089316 | 1.278711 | 1.161690 |
| 1 | -22.35767 | 0.740992 | 0.178224 | 1.112066 | 1.339339 | 1.198913 |
| 2 | -17.27311 | 8.773352* | 0.151943* | 0.951887* | 1.217039* | 1.053209* |
| 3 | -17.20790 | 0.109973 | 0.157754 | 0.988545 | 1.291576 | 1.104342 |
| 4 | -16.47873 | 1.200987 | 0.159617 | 0.999166 | 1.340076 | 1.129438 |
| 5 | -15.82583 | 1.049749 | 0.162033 | 1.012778 | 1.391567 | 1.157524 |
| Italy | | | | | | |
| 0 | -32.68546 | NA | 0.256819 | 1.477861 | 1.667256 | 1.550234 |
| 1 | -30.24445 | 4.307656* | 0.242821 | 1.421351 | 1.648625* | 1.508199* |
| 2 | -28.94576 | 2.240880 | 0.240149 | 1.409638 | 1.674790 | 1.510960 |
| 3 | -27.88087 | 1.795697 | 0.239747* | 1.407093* | 1.710124 | 1.522890 |
| 4 | -27.85508 | 0.042484 | 0.249363 | 1.445297 | 1.786208 | 1.575569 |
| 5 | -27.30566 | 0.883373 | 0.254167 | 1.462967 | 1.841756 | 1.607714 |
| Luxembourg | | | | | | |
| 0 | -23.53549 | NA | 0.192407 | 1.188979 | 1.383896 | 1.262638 |
| 1 | -23.52942 | 0.010626 | 0.200655 | 1.230392 | 1.464293 | 1.318784 |
| 2 | -19.46676 | 6.940370* | 0.176753* | 1.102782* | 1.375665* | 1.205905* |
| 3 | -19.45953 | 0.012060 | 0.184410 | 1.144147 | 1.456014 | 1.262002 |
| 4 | -18.29188 | 1.897426 | 0.183374 | 1.137162 | 1.488012 | 1.269748 |
| 5 | -17.89184 | 0.633402 | 0.188336 | 1.162160 | 1.551993 | 1.309478 |
| Netherlands | | | | | | |
| 0 | -19.58198 | NA | 0.156621 | 0.983279 | 1.174481* | 1.056090* |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | -19.41229 | 0.298648 | 0.161990 | 1.016492 | 1.245934 | 1.103865 |
| 2 | -16.87749 | 4.359853* | 0.152449* | 0.955100* | 1.222783 | 1.057035 |
| 3 | -16.84237 | 0.059001 | 0.158594 | 0.993695 | 1.299619 | 1.110192 |
| 4 | -16.58940 | 0.414869 | 0.163599 | 1.023576 | 1.367740 | 1.154636 |
| 5 | -15.46179 | 1.804175 | 0.163011 | 1.018472 | 1.400876 | 1.164094 |
| Portugal | | | | | | |
| 0 | -58.02458 | NA | 0.693716 | 2.471552 | 2.660947 | 2.543926 |
| 1 | -54.09969 | 6.005658* | 0.618825 | 2.325586* | 2.584124* | 2.443698* |
| 2 | -54.01026 | 0.154303 | 0.641739 | 2.392559 | 2.657712 | 2.493882 |
| 3 | -53.94873 | 0.103751 | 0.666375 | 2.429362 | 2.732394 | 2.545159 |
| 4 | -50.30244 | 6.926291 | 0.601362* | 2.356850 | 2.666496 | 2.455858 |
| 5 | -50.03589 | 0.428568 | 0.619785 | 2.354349 | 2.733138 | 2.499095 |
| Spain | | | | | | |
| 0 | -29.24892 | NA* | 0.224439 | 1.343095 | 1.532490 | 1.415468 |
| 1 | -27.22498 | 3.571661 | 0.215705* | 1.302940* | 1.530214* | 1.389788* |
| 2 | -27.19464 | 0.052348 | 0.224211 | 1.340966 | 1.606119 | 1.442289 |
| 3 | -27.09736 | 0.164042 | 0.232492 | 1.376367 | 1.679399 | 1.492164 |
| 4 | -26.91368 | 0.302539 | 0.240325 | 1.408379 | 1.749290 | 1.538651 |
| 5 | -26.39692 | 0.830867 | 0.245268 | 1.427330 | 1.806119 | 1.572077 |

# Appendix A

## A.4- Serial correlation test

| | | | |
|---|---|---|---|
| Austria | | | |
| F-statistic | 0.183870 | Prob. F(2,36) | 0.8328 |
| Obs*R-squared | 0.546033 | Prob. Chi-Square(2) | 0.7611 |

| | | | |
|---|---|---|---|
| Belgium | | | |
| F-statistic | 0.841891 | Prob. F(2,34) | 0.4397 |
| Obs*R-squared | 2.453681 | Prob. Chi-Square(2) | 0.2932 |

| | | | |
|---|---|---|---|
| France | | | |
| F-statistic | 0.198483 | Prob. F(2,35) | 0.8209 |
| Obs*R-squared | 0.581966 | Prob. Chi-Square(2) | 0.7475 |

| | | | |
|---|---|---|---|
| Netherlands | | | |
| F-statistic | 0.389249 | Prob. F(2,36) | 0.6804 |
| Obs*R-squared | 1.143029 | Prob. Chi-Square(2) | 0.5647 |

| | | | |
|---|---|---|---|
| Spain | | | |
| F-statistic | 1.572452 | Prob. F(2,42) | 0.2195 |
| Obs*R-squared | 3.831434 | Prob. Chi-Square(2) | 0.1472 |

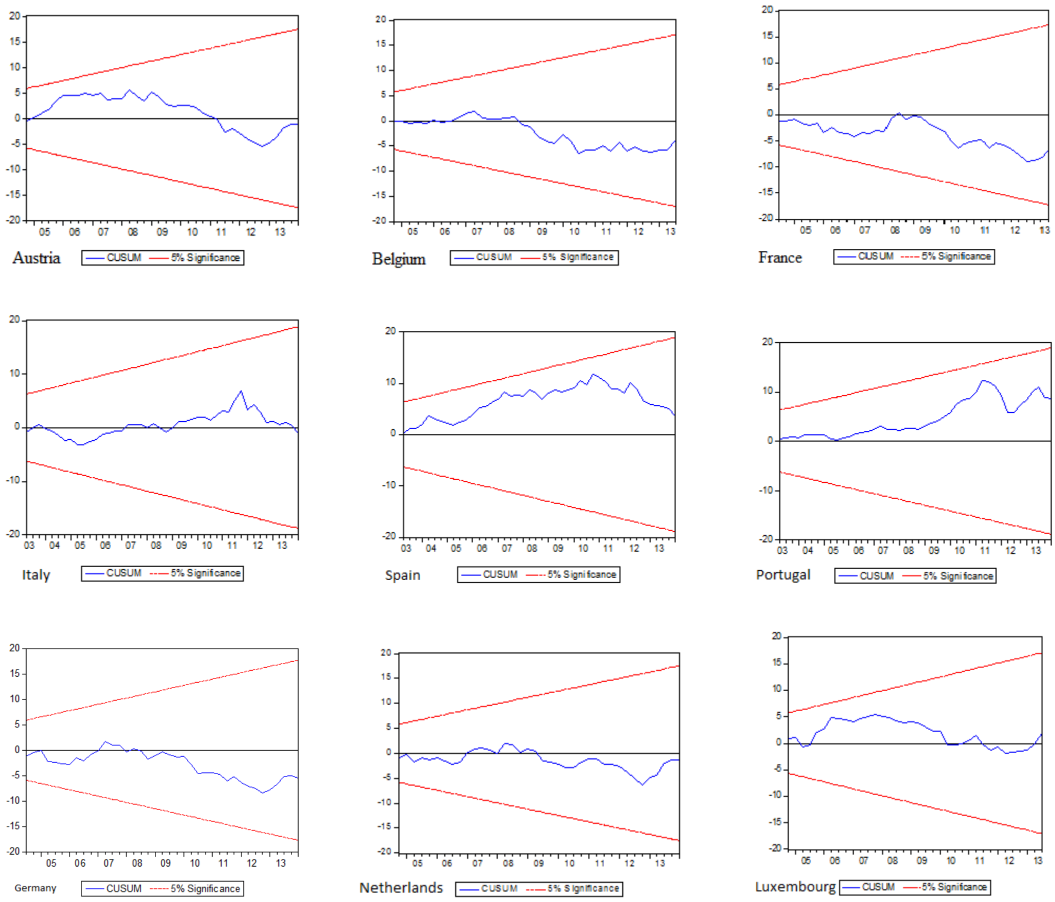
| | | | |
|---|---|---|---|
| Germany | | | |
| F-statistic | 0.061971 | Prob. F(2,36) | 0.9400 |
| Obs*R-squared | 0.185276 | Prob. Chi-Square(2) | 0.9115 |

| | | | |
|---|---|---|---|
| Italy | | | |
| F-statistic | 0.459163 | Prob. F(2,42) | 0.6349 |
| Obs*R-squared | 1.176839 | Prob. Chi-Square(2) | 0.5552 |

| | | | |
|---|---|---|---|
| Luxembourg | | | |
| F-statistic | 0.972779 | Prob. F(2,34) | 0.3883 |
| Obs*R-squared | 2.814508 | Prob. Chi-Square(2) | 0.2448 |

| | | | |
|---|---|---|---|
| Portugal | | | |
| F-statistic | 0.758435 | Prob. F(2,42) | 0.4747 |
| Obs*R-square | 1.917138 | Prob. Chi-Square(2) | 0.3834 |

# Stability test




Source : author's calculation.

# Appendix A

## A.5- Long run Relationships Evidence

| | F-statistic | Evidence for long term relationship |
|---|---|---|
| Austria | 3.582091 | Yes at 95% |
| France | 3.40313 | Yes at 90% |
| Germany | 4.235459 | Yes at 97.5% |
| Italy | 1.158257 | NO |
| Luxembourg | 1.554256 | NO |
| Netherlands | 4.976910 | Yes at 99% |
| Spain | 3.136248 | Yes at 90% |
| Portugal | 3.200856 | Yes at 90% |
| Belgium | 5.654713 | Yes at 99% |

Source : author's calculation.
Upper-Lower bounds [2.20-3.09 (0.1)] [2.56-3.49(0.05)] [2.88-3.87 (0.025)] [3.29-4.37 (0.01)]

# Appendix A

# A.6- Short Run relationships

| | | Austria | | France | | Germany | |
|---|---|---|---|---|---|---|---|
| | | (-1) | (-2) | (-1) | (-2) | (-1) | (-2) |
| Real GDP | Coefficient | 0,094 | -0,175 | 0,112 | -0,073 | -0,079 | -0,085 |
| | t-Statistic | 0,789 | -2,133 | 0,899 | -2,586 | -1,104 | -1,101 |
| | P-value | (0,43) | (0,04) | (0,37) | (0,036) | (0,27) | (0,27) |
| Exports variation | Coefficient | -0,023 | -0,021 | 0,01 | 0,014 | 0,014 | -0,02 |
| | t-Statistic | 1,936 | 2,97 | 0,776 | 1,719 | 1,175 | -2,302 |
| | P-value | (0,06) | (0,005) | (0,44) | (0,09) | (0,24) | (0,0) |
| LR Debt%GDP | Coefficient | -0,057 | 0,329 | -0,098 | -0,064 | 0,062 | 0,064 |
| | t-Statistic | -0,346 | 2,077 | -0,548 | -0,376 | 0,276 | 0,275 |
| | P-value | (0,73) | (0,04) | (0,58) | (0,7) | (0,78) | (0,78) |
| Unemployment rate | Coefficient | 0,37 | 0,294 | 0,192 | -0,125 | 1,297 | -0,147 |
| | t-Statistic | 2,22 | 0,77 | 1,996 | -0,289 | 3,373 | -0,367 |
| | P-value | (0,039) | (0,44) | (0,064) | (0,77) | (0,001) | (0,71) |
| | | Italy | | Luxembourg | | Netherlands | |
| | | (-1) | (-2) | (-1) | (-2) | (-1) | (-2) |
| Real GDP | Coefficient | 0,012 | | -0,001 | 0,017 | -0,192 | 0,135 |
| | t-Statistic | 0,101 | | -0,033 | 0,444 | 2,023 | 1,276 |
| | P-value | (0,92) | | (0,97) | (0,66) | (0,05) | (0,21) |
| Exports variation | Coefficient | -0,011 | | 0,003 | 0,007 | 0,025 | -0,027 |
| | t-Statistic | -2,048 | | 0,301 | 1,370 | 1,922 | -3,173 |
| | P-value | (0,50) | | (0,76) | (0,18) | (0,06) | (0,00) |
| LR Debt%GDP | Coefficient | -0,057 | 0,329 | -0,098 | -0,064 | 0,062 | 0,064 |
| | t-Statistic | -0,346 | 2,077 | -0,548 | -0,376 | 0,276 | 0,275 |
| | P-value | (0,73) | (0,04) | (0,58) | (0,7) | (0,78) | (0,78) |
| Unemployment rate | Coefficient | 0,37 | 0,294 | 0,192 | -0,125 | 1,297 | -0,147 |
| | t-Statistic | 2,22 | 0,77 | 1,996 | -0,289 | 3,373 | -0,367 |
| | P-value | (0,039) | (0,44) | (0,064) | (0,77) | (0,001) | (0,71) |
| | | Spain | | Portugal | | Belgium | |
| | | (-1) | (-2) | (-1) | (-2) | (-1) | (-2) |
| Real GDP | Coefficient | 0,083 | | -0,175 | | -0,047 | -0,183 |
| | t-Statistic | 0,447 | | -1,142 | | -0,430 | -0,804 |
| | P-value | (0,66) | | (0,26) | | (0,67) | (0,43) |
| Exports variation | Coefficient | -0,006 | | -0,024 | | -0,005 | 0,009 |
| | t-Statistic | -0,990 | | -1,798 | | -0,398 | 1,041 |
| | P-value | (0,33) | | (0,08) | | (0,69) | (0,30) |
| LR Debt%GDP | Coefficient | 0,051 | | 0,008 | | 0,329 | 0,183 |
| | t-Statistic | 0,588 | | 0,121 | | 1,466 | 0,804 |
| | P-value | (0,56) | | (0,90) | | (0,15) | (0,43) |
| Unemployment rate | Coefficient | -0,085 | | 0,999 | | 1,265 | 0,433 |
| | t-Statistic | -0,294 | | 2,542 | | 3,389 | 1,333 |
| | P-value | (0,77) | | (0,04) | | (0,00) | (0,19) |

Source : author's calculation.

# Annexe B

## B.1- Unit Root tests for Banks' variables

| ADF t-statistic | CDSs | | Entity Equity | |
|---|---|---|---|---|
| Entity | I(0) test | I(1) test | I(0) test | I(1) test |
| BNP PARIBAS | -1.771435 | -7.842260 | -2.053765 | -7.124459 |
| | (0.3907) | (0.0000) | (0.2638) | (0.0000) |
| CREDIT AGRICOLE | -1.871333 | -7.757161 | -1.410958 | -3.337068 |
| | (0.3432) | (0.0000) | ( 0.5703) | ( 0.0185) |
| SOCIETE GENERALE | -1.668389 | -6.052854 | -1.845042 | -6.639293 |
| | (0.4415) | (0.0000) | (0.3554) | (0.0000) |
| DEUTSCHE BANK AG | -2.799070 | -9.391924 | -2.593211 | -6.448680 |
| | (0.0647) | (0.0000) | ( 0.1003) | ( 0.0000) |
| COMZBANK AG | -1.811670 | -7.189137 | -0.329944 | -3.650863 |
| | (0.3713) | (0.0000) | ( 0.9131) | ( 0.0081) |
| BANCO DE SABADELL SA | -2.078607 | -4.623113 | -1.181306 | -5.101297 |
| | (0.2539) | (0.0004) | ( 0.6751) | ( 0.0001) |
| BANCO POP ESPANOL SA | -2.029385 | -4.745137 | -0.320933 | -9.101765 |
| | (0.2738) | (0.0003) | ( 0.9146) | ( 0.0000) |
| DEXIA CREDIT LOCAL | -1.447317 | -7.255005 | -2.119214 | -5.224437 |
| | (0.5528) | (0.0000) | ( 0.2383) | ( 0.0001) |
| KBC BANK | -1.864817 | -5.527409 | -2.204599 | -7.465465 |
| | (0.3462) | (0.0000) | ( 0.2074) | ( 0.0000) |
| BANCO COMR PORTUGUES | -1.670949 | -5.552460 | -0.976125 | -6.983254 |
| | (0.4402) | (0.0000) | ( 0.7560) | ( 0.0000) |
| BANCO ESPIRITO SANTO SA | -1.624618 | -6.971220 | -1.029023 | -6.517854 |

| | | | | |
|---|---|---|---|---|
| | (0.4636) | (0.0000) | ( 0.7371) | ( 0.0000) |
| ALPHA BANK A,E | -1.342905 | -6.640258 | -1.260728 | -3.821025 |
| | (0.6036) | (0.0000) | (0.6418) | (0.0052) |

Source: Author calculation.

P-value are between parentheses.

# Annexe B

## B.2- Unit Root tests for Countries' variables

| ADF t-statistic | CDSs | | Stock Index | | Inflation | |
|---|---|---|---|---|---|---|
| Entity | I(0) test | I(1) test | I(0) test | I(1) test | I(0) test | I(1) test |
| France | -1.786479 | -5.397507 | -2.302100 | -6.467632 | -0.725455 | -6.159238 |
| | ( 0.3833) | ( 0.0000) | ( 0.1749) | ( 0.0000) | ( 0.8316) | (0.0000) |
| Belgium | -1.445187 | -6.819215 | -1.632563 | -6.258344 | -0.296150 | -5.468373 |
| | (0.5539) | (0.0000) | (0.4596) | (0.0000) | (0.9185) | (0.0000) |
| Germany | -2.630906 | -7.131960 | -1.315451 | -6.836697 | 0.396676 | -7.359776 |
| | ( 0.0929) | (0.0000) | ( 0.6164) | ( 0.0000) | ( 0.9811) | ( 0.0000) |
| Spain | -1.888084 | -7.847726 | -2.731321 | -8.791901 | -0.368201 | -5.887593 |
| | ( 0.3355) | ( 0.0000) | ( 0.0750) | ( 0.0000) | (0.9062) | (0.0000) |
| Portugal | -2.196809 | -4.579327 | -1.230155 | -5.329766 | -0.831667 | -6.447530 |
| | ( 0.2099) | ( 0.0005) | ( 0.6553) | ( 0.0000) | ( 0.8021) | ( 0.0000) |

Source: Author calculation.

P-value are between parentheses.

# Annexe B

## B.3- Unit Root tests for Eurozone variables

| ADF t-statistic | EUR INDEX | | EUR INFL | | USD/EUR | |
|---|---|---|---|---|---|---|
| Entity | I(0) test | I(1) test | I(0) test | I(1) test | I(0) test | I(1) test |
| Eurozone | -2.104199 | -6.957278 | -0.734212 | -4.740887 | -2.731321 | -8.791901 |
| | ( 0.2439) | ( 0.0000) | ( 0.8286) | ( 0.0000) | ( 0.0750) | ( 0.0000) |

Source: Author calculation.

P-value are between parentheses.

# Annexe C

## C.1-Data Summary

| Number | Entity | Abreviation |
|---|---|---|
| 1 | FRENCH REPUBLIC | FRANCE |
| 2 | FEDERAL REP GERMANY | GERMANY |
| 3 | KINGDOM OF SPAIN | SPAIN |
| 4 | REPUBLIC OF ITALY | ITALY |
| 5 | KINGDOM OF BELGIUM | BELGIUM |
| 6 | REPUBLIC OF PORTUGAL | PORTUGAL |
| 7 | BNP PARIBAS, France | BNP |
| 10 | CREDIT AGRICOLE, France | CRD_AGR |
| 11 | SOCIETE GENERALE, France | SOC_GE |
| 12 | DEUTSCHE BANK AG, Germany | DSCHE_B |
| 13 | COMMERZBANK AG, Germany | COMZ_B |
| 14 | BANCO DE SABADELL SA, Spain | SABADELL |
| 15 | BANCO POP ESPANOL SA, Spain | POP_ESP |
| 17 | DEXIA CREDIT LOCAL, Belgium | DEXIA |
| 18 | KBC BANK, Belgium | KBC |
| 19 | BANCO COMR PORTUGUES, Portugal | COMR_PORT |
| 20 | BANCO ESPIRITO SANTO SA, Portugal | ESPIRITO |
| 21 | NATIONAL B OF GREECE SA, Greece | NAT_B_GR |
| 22 | ALPHA BANK A,E, Greece | ALPHA |

Annexe C

## C.2- 2009 Causalities

| Pairwise Granger Causality Tests | | |
|---|---|---|
| Null Hypothesis: | F-Statistic | Prob. |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL | 1.98325 | 0.1290 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM | 4.86673 | 0.0049 |
| REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL | 0.57161 | 0.6364 |
| REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY | 1.02029 | 0.3920 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL | 0.56396 | 0.6414 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN | 0.93167 | 0.4327 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL | 5.25181 | 0.0032 |
| REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY | 5.84045 | 0.0017 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.38439 | 0.0808 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 4.00914 | 0.0126 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 0.62468 | 0.6025 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 0.95589 | 0.4212 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL | 11.4696 | 9.E-06 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA | 9.44163 | 5.E-05 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL | 6.46211 | 0.0009 |
| REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL | 5.54033 | 0.0024 |
| KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL | 3.95457 | 0.0134 |
| REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK | 3.30147 | 0.0280 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL | 9.64100 | 4.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES | 4.63013 | 0.0064 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL | 6.29595 | 0.0011 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA | 1.99592 | 0.1271 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.50074 | 0.0706 |
| REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA | 8.78241 | 0.0001 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL | 1.67667 | 0.1845 |
| REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E. | 6.71379 | 0.0007 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL | 4.39858 | 0.0082 |
| REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC | 6.51356 | 0.0009 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.24651 | 0.0949 |

| | | |
|---|---|---|
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA | 4.08187 | 0.0116 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 11.0804 | 1.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG | 2.74856 | 0.0529 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 5.96837 | 0.0015 |
| REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG | 4.66619 | 0.0061 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL | 10.4174 | 2.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE | 3.87692 | 0.0146 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL | 6.42230 | 0.0010 |
| REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE | 2.41495 | 0.0780 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL | 9.12647 | 7.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS | 4.96450 | 0.0044 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM | 2.35519 | 0.0836 |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY | 1.52193 | 0.2208 |
| KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM | 2.37846 | 0.0814 |
| KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN | 1.03129 | 0.3872 |
| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM | 4.18475 | 0.0104 |
| KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY | 8.53804 | 0.0001 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 1.99228 | 0.1277 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 4.60689 | 0.0065 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 0.62110 | 0.6048 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 0.85763 | 0.4695 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM | 6.07886 | 0.0014 |
| KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA | 9.16475 | 7.E-05 |
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM | 6.92508 | 0.0006 |
| KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL | 7.92556 | 0.0002 |
| KBC BANK does not Granger Cause KINGDOM OF BELGIUM | 7.00635 | 0.0005 |
| KINGDOM OF BELGIUM does not Granger Cause KBC BANK | 4.11785 | 0.0112 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM | 11.0366 | 1.E-05 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES | 4.48396 | 0.0075 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM | 5.81874 | 0.0018 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA | 1.02595 | 0.3895 |

| | | |
|---|---|---|
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM | 0.92666 | 0.4351 |
| KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA | 10.3136 | 2.E-05 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM | 0.82582 | 0.4861 |
| KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E. | 4.84890 | 0.0050 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM | 3.29329 | 0.0283 |
| KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC | 8.21632 | 0.0002 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM | 1.32614 | 0.2768 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA | 4.16901 | 0.0106 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM | 15.7885 | 3.E-07 |
| KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG | 3.32741 | 0.0272 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM | 7.71251 | 0.0003 |
| KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG | 4.98643 | 0.0043 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM | 6.15822 | 0.0013 |
| KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE | 5.81129 | 0.0018 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM | 6.52681 | 0.0009 |
| KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE | 2.34209 | 0.0849 |
| BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM | 8.61322 | 0.0001 |
| KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS | 4.54625 | 0.0070 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY | 0.29234 | 0.8307 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN | 1.11648 | 0.3517 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY | 5.53823 | 0.0024 |
| REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY | 6.19582 | 0.0012 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 2.58654 | 0.0639 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 2.52312 | 0.0688 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 0.45782 | 0.7130 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 1.92834 | 0.1376 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY | 4.37639 | 0.0084 |
| REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA | 4.61686 | 0.0064 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY | 5.78304 | 0.0019 |
| REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL | 4.56001 | 0.0069 |
| KBC BANK does not Granger Cause REPUBLIC OF ITALY | 5.54202 | 0.0024 |

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|---|---|---|
| REPUBLIC OF ITALY does not Granger Cause KBC BANK | 1.97311 | 0.1306 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY | 5.21887 | 0.0034 |
| REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES | 1.94875 | 0.1343 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY | 3.41152 | 0.0247 |
| REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA | 0.82353 | 0.4874 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY | 3.27671 | 0.0288 |
| REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA | 5.31584 | 0.0030 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY | 3.11787 | 0.0346 |
| REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E. | 3.15327 | 0.0332 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY | 3.84542 | 0.0152 |
| REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC | 4.34841 | 0.0087 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY | 2.43664 | 0.0760 |
| REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA | 2.32973 | 0.0861 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY | 8.53811 | 0.0001 |
| REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG | 1.89425 | 0.1432 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY | 7.34636 | 0.0004 |
| REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG | 3.76151 | 0.0166 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY | 3.64265 | 0.0190 |
| REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE | 3.43648 | 0.0240 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY | 4.15531 | 0.0107 |
| REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE | 1.42851 | 0.2460 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY | 4.35126 | 0.0086 |
| REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS | 2.21962 | 0.0979 |
| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN | 2.50454 | 0.0703 |
| KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY | 6.61438 | 0.0008 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 3.15707 | 0.0331 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 5.70637 | 0.0020 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 0.40248 | 0.7519 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 0.41743 | 0.7413 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN | 7.88268 | 0.0002 |
| KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA | 7.58100 | 0.0003 |

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|---|---|---|
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN | 5.75667 | 0.0019 |
| KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL | 7.77807 | 0.0002 |
| KBC BANK does not Granger Cause KINGDOM OF SPAIN | 5.98379 | 0.0015 |
| KINGDOM OF SPAIN does not Granger Cause KBC BANK | 4.37988 | 0.0084 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN | 11.8943 | 6.E-06 |
| KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES | 5.00067 | 0.0043 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN | 5.97375 | 0.0015 |
| KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA | 1.89066 | 0.1438 |
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN | 1.21955 | 0.3128 |
| KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA | 8.25258 | 0.0002 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN | 1.71180 | 0.1771 |
| KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E. | 4.21882 | 0.0100 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN | 2.17545 | 0.1031 |
| KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC | 6.31715 | 0.0011 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN | 2.97814 | 0.0406 |
| KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA | 4.88691 | 0.0048 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN | 12.7060 | 3.E-06 |
| KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG | 4.13321 | 0.0110 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN | 6.24915 | 0.0011 |
| KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG | 5.42547 | 0.0027 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN | 6.94523 | 0.0006 |
| KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE | 6.95190 | 0.0006 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN | 6.66613 | 0.0007 |
| KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE | 2.73489 | 0.0538 |
| BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN | 7.21104 | 0.0004 |
| KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS | 6.04447 | 0.0014 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 0.58106 | 0.6303 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 4.38372 | 0.0083 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 1.79559 | 0.1606 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 1.43946 | 0.2429 |
| BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY | 3.22520 | 0.0306 |

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| FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA | 7.48517 | 0.0003 |
| DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY | 6.08010 | 0.0014 |
| FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL | 5.23995 | 0.0033 |
| KBC BANK does not Granger Cause FEDERAL REP GERMANY | 6.34912 | 0.0010 |
| FEDERAL REP GERMANY does not Granger Cause KBC BANK | 5.89419 | 0.0016 |
| BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY | 6.33824 | 0.0010 |
| FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES | 6.31368 | 0.0011 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY | 4.62145 | 0.0064 |
| FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA | 2.68352 | 0.0571 |
| NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY | 0.15851 | 0.9237 |
| FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA | 16.7736 | 1.E-07 |
| ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY | 1.42796 | 0.2462 |
| FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E. | 3.23179 | 0.0304 |
| FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY | 2.10655 | 0.1117 |
| FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC | 3.27842 | 0.0288 |
| BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY | 0.15690 | 0.9247 |
| FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA | 3.02472 | 0.0385 |
| COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY | 11.4984 | 8.E-06 |
| FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG | 3.80752 | 0.0158 |
| DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY | 4.51624 | 0.0072 |
| FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG | 3.36420 | 0.0261 |
| SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY | 4.92329 | 0.0046 |
| FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE | 3.08373 | 0.0360 |
| CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY | 5.28998 | 0.0031 |
| FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE | 2.38486 | 0.0808 |
| BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY | 6.26208 | 0.0011 |
| FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS | 5.86792 | 0.0017 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 2.30724 | 0.0884 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 1.33360 | 0.2745 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 1.09398 | 0.3608 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.09698 | 0.3595 |

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| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 0.15497 | 0.9260 |
| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 2.26395 | 0.0930 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 0.84209 | 0.4776 |
| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 4.60754 | 0.0065 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 0.24687 | 0.8632 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 0.23173 | 0.8738 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 0.75902 | 0.5226 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.81567 | 0.4915 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 0.94601 | 0.4259 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 0.40679 | 0.7488 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 2.41232 | 0.0782 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 0.40086 | 0.7530 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 4.40835 | 0.0081 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 0.95496 | 0.4217 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 2.55313 | 0.0664 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 2.66862 | 0.0581 |
| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 1.57970 | 0.2065 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 3.42720 | 0.0243 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 0.17636 | 0.9119 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 4.73515 | 0.0057 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 1.43574 | 0.2440 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 1.38694 | 0.2581 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 1.12421 | 0.3486 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 2.14778 | 0.1065 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 0.03831 | 0.9899 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 0.94233 | 0.4276 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 0.09765 | 0.9609 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.29061 | 0.2884 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 2.54984 | 0.0667 |
| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 2.20209 | 0.0999 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 3.03350 | 0.0381 |

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| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 1.61725 | 0.1977 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 1.25092 | 0.3018 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 1.17918 | 0.3275 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 1.06047 | 0.3747 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.20362 | 0.8934 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 10.3057 | 2.E-05 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 1.45015 | 0.2399 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 1.41691 | 0.2493 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 2.15875 | 0.1051 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 0.81695 | 0.4909 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 1.66144 | 0.1878 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 3.76361 | 0.0166 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 1.79084 | 0.1615 |
| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 3.75997 | 0.0167 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 1.02814 | 0.3885 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 3.91542 | 0.0140 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 2.22226 | 0.0976 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 2.57983 | 0.0644 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 1.20586 | 0.3177 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 4.66243 | 0.0061 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 0.57687 | 0.6330 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 3.81603 | 0.0157 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 1.48984 | 0.2292 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA | 3.81857 | 0.0156 |
| BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL | 4.46723 | 0.0076 |
| KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA | 3.14307 | 0.0336 |
| BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK | 2.40684 | 0.0787 |
| BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA | 2.94003 | 0.0424 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES | 3.38777 | 0.0254 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA | 2.12851 | 0.1089 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA | 3.50813 | 0.0222 |

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| NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA | 0.32078 | 0.8103 |
| BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA | 5.45144 | 0.0026 |
| ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA | 5.64366 | 0.0021 |
| BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E. | 0.95969 | 0.4194 |
| FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA | 6.30288 | 0.0011 |
| BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC | 1.98967 | 0.1281 |
| BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.67037 | 0.1858 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA | 1.60793 | 0.1998 |
| COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 9.34443 | 6.E-05 |
| BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG | 2.37470 | 0.0817 |
| DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 5.70978 | 0.0020 |
| BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG | 4.81703 | 0.0052 |
| SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA | 5.54200 | 0.0024 |
| BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE | 3.16136 | 0.0329 |
| CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA | 4.71812 | 0.0058 |
| BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE | 2.40441 | 0.0789 |
| BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA | 6.66834 | 0.0007 |
| BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS | 4.35697 | 0.0086 |
| KBC BANK does not Granger Cause DEXIA CREDIT LOCAL | 0.65014 | 0.5867 |
| DEXIA CREDIT LOCAL does not Granger Cause KBC BANK | 2.58933 | 0.0637 |
| BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL | 0.67469 | 0.5718 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES | 0.95110 | 0.4235 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL | 0.60529 | 0.6148 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA | 0.91130 | 0.4426 |
| NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL | 3.33882 | 0.0269 |
| DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA | 7.52955 | 0.0003 |
| ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL | 4.84863 | 0.0050 |
| DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E. | 3.80015 | 0.0159 |
| FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL | 6.10658 | 0.0013 |
| DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC | 6.01999 | 0.0014 |
| BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL | 2.74453 | 0.0532 |

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| DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA | 0.07749 | 0.9719 |
| COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL | 2.29006 | 0.0902 |
| DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG | 2.73317 | 0.0539 |
| DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL | 0.96994 | 0.4147 |
| DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG | 4.82516 | 0.0051 |
| SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL | 0.69847 | 0.5576 |
| DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE | 0.67665 | 0.5706 |
| CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL | 0.27158 | 0.8456 |
| DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE | 0.84833 | 0.4743 |
| BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL | 0.12819 | 0.9429 |
| DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS | 1.23576 | 0.3071 |
| BANCO COMR PORTUGUES does not Granger Cause KBC BANK | 1.45027 | 0.2399 |
| KBC BANK does not Granger Cause BANCO COMR PORTUGUES | 0.48470 | 0.6945 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK | 0.60324 | 0.6161 |
| KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA | 0.60841 | 0.6128 |
| NAT BK OF GREECE SA does not Granger Cause KBC BANK | 2.59596 | 0.0632 |
| KBC BANK does not Granger Cause NAT BK OF GREECE SA | 5.56127 | 0.0023 |
| ALPHA BANK A.E. does not Granger Cause KBC BANK | 3.26629 | 0.0292 |
| KBC BANK does not Granger Cause ALPHA BANK A.E. | 3.89342 | 0.0144 |
| FRENCH REPUBLIC does not Granger Cause KBC BANK | 4.73515 | 0.0057 |
| KBC BANK does not Granger Cause FRENCH REPUBLIC | 5.71825 | 0.0020 |
| BANCO DE SABADELL SA does not Granger Cause KBC BANK | 6.46863 | 0.0009 |
| KBC BANK does not Granger Cause BANCO DE SABADELL SA | 2.01587 | 0.1242 |
| COMMERZBANK AG does not Granger Cause KBC BANK | 2.74436 | 0.0532 |
| KBC BANK does not Granger Cause COMMERZBANK AG | 3.65870 | 0.0187 |
| DEUTSCHE BANK AG does not Granger Cause KBC BANK | 0.85050 | 0.4732 |
| KBC BANK does not Granger Cause DEUTSCHE BANK AG | 1.46042 | 0.2371 |
| SOCIETE GENERALE does not Granger Cause KBC BANK | 5.42009 | 0.0027 |
| KBC BANK does not Granger Cause SOCIETE GENERALE | 0.27652 | 0.8420 |
| CREDIT AGRICOLE does not Granger Cause KBC BANK | 0.09769 | 0.9609 |
| KBC BANK does not Granger Cause CREDIT AGRICOLE | 0.16746 | 0.9178 |

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| BNP PARIBAS does not Granger Cause KBC BANK | 0.94043 | 0.4285 |
| KBC BANK does not Granger Cause BNP PARIBAS | 0.77018 | 0.5164 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES | 1.25324 | 0.3010 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA | 1.79851 | 0.1601 |
| NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES | 1.25533 | 0.3003 |
| BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA | 1.93809 | 0.1360 |
| ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES | 3.97158 | 0.0132 |
| BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E. | 1.26195 | 0.2980 |
| FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES | 4.46822 | 0.0076 |
| BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC | 5.50114 | 0.0025 |
| BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES | 0.63145 | 0.5983 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA | 0.66467 | 0.5779 |
| COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES | 4.73452 | 0.0057 |
| BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG | 4.89894 | 0.0047 |
| DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES | 1.83189 | 0.1540 |
| BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG | 1.35261 | 0.2685 |
| SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES | 2.03506 | 0.1215 |
| BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE | 2.16006 | 0.1050 |
| CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES | 1.93026 | 0.1373 |
| BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE | 1.75386 | 0.1686 |
| BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES | 2.02028 | 0.1236 |
| BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS | 4.24679 | 0.0097 |
| NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.48062 | 0.6973 |
| BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA | 3.21322 | 0.0310 |
| ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA | 2.20905 | 0.0991 |
| BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E. | 0.82980 | 0.4840 |
| FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA | 1.80902 | 0.1581 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC | 3.64918 | 0.0189 |
| BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.67337 | 0.5726 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA | 1.71603 | 0.1762 |
| COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 3.71230 | 0.0176 |

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|---|---|---|
| BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG | 4.68227 | 0.0060 |
| DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 2.17451 | 0.1032 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG | 0.74422 | 0.5310 |
| SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA | 2.50865 | 0.0699 |
| BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE | 2.43959 | 0.0758 |
| CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA | 1.45448 | 0.2387 |
| BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE | 2.42623 | 0.0770 |
| BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA | 1.78151 | 0.1633 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS | 2.24239 | 0.0954 |
| ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA | 12.8278 | 3.E-06 |
| NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E. | 0.90450 | 0.4459 |
| FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA | 14.3732 | 8.E-07 |
| NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC | 0.28710 | 0.8345 |
| BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA | 1.36764 | 0.2639 |
| NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA | 2.53111 | 0.0681 |
| COMMERZBANK AG does not Granger Cause NAT BK OF GREECE SA | 9.51128 | 5.E-05 |
| NAT BK OF GREECE SA does not Granger Cause COMMERZBANK AG | 3.10946 | 0.0349 |
| DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA | 7.12182 | 0.0005 |
| NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG | 4.23473 | 0.0098 |
| SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA | 9.16731 | 7.E-05 |
| NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE | 1.55736 | 0.2119 |
| CREDIT AGRICOLE does not Granger Cause NAT BK OF GREECE SA | 3.04821 | 0.0375 |
| NAT BK OF GREECE SA does not Granger Cause CREDIT AGRICOLE | 3.34345 | 0.0267 |
| BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA | 2.97979 | 0.0405 |
| NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS | 5.31738 | 0.0030 |
| FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E. | 2.91362 | 0.0438 |
| ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC | 0.56557 | 0.6404 |
| BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E. | 1.00307 | 0.3996 |
| ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA | 1.72788 | 0.1738 |
| COMMERZBANK AG does not Granger Cause ALPHA BANK A.E. | 6.36488 | 0.0010 |
| ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG | 2.85085 | 0.0470 |

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|---|---|---|
| DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E. | 3.21310 | 0.0310 |
| ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG | 3.19776 | 0.0316 |
| SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E. | 0.65622 | 0.5830 |
| ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE | 1.91503 | 0.1397 |
| CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E. | 2.40548 | 0.0788 |
| ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE | 2.05246 | 0.1190 |
| BNP PARIBAS does not Granger Cause ALPHA BANK A.E. | 1.63362 | 0.1940 |
| ALPHA BANK A.E. does not Granger Cause BNP PARIBAS | 3.79702 | 0.0160 |
| BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC | 0.28611 | 0.8352 |
| FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA | 3.08608 | 0.0359 |
| COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC | 11.4650 | 9.E-06 |
| FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG | 3.00568 | 0.0394 |
| DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC | 4.72130 | 0.0058 |
| FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG | 4.29168 | 0.0092 |
| SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC | 4.72183 | 0.0057 |
| FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE | 2.81604 | 0.0490 |
| CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC | 5.15955 | 0.0036 |
| FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE | 1.71561 | 0.1763 |
| BNP PARIBAS does not Granger Cause FRENCH REPUBLIC | 6.39874 | 0.0010 |
| FRENCH REPUBLIC does not Granger Cause BNP PARIBAS | 4.24630 | 0.0097 |
| COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA | 2.71984 | 0.0547 |
| BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG | 2.66710 | 0.0582 |
| DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA | 0.94583 | 0.4260 |
| BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG | 7.62697 | 0.0003 |
| SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA | 0.50710 | 0.6792 |
| BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE | 1.47694 | 0.2326 |
| CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA | 1.00230 | 0.4000 |
| BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE | 0.80689 | 0.4963 |
| BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA | 0.92133 | 0.4377 |
| BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS | 0.54981 | 0.6507 |
| DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG | 1.58618 | 0.2049 |

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|---|---|---|
| COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG | 1.38782 | 0.2579 |
| SOCIETE GENERALE does not Granger Cause COMMERZBANK AG | 2.82296 | 0.0486 |
| COMMERZBANK AG does not Granger Cause SOCIETE GENERALE | 2.78528 | 0.0507 |
| CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG | 3.06224 | 0.0369 |
| COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE | 0.76754 | 0.5179 |
| BNP PARIBAS does not Granger Cause COMMERZBANK AG | 3.70896 | 0.0177 |
| COMMERZBANK AG does not Granger Cause BNP PARIBAS | 3.45645 | 0.0235 |
| SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG | 2.36746 | 0.0824 |
| DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE | 0.78413 | 0.5087 |
| CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG | 1.09663 | 0.3597 |
| DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE | 0.29490 | 0.8289 |
| BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG | 1.32799 | 0.2762 |
| DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS | 1.72308 | 0.1748 |
| CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE | 0.85391 | 0.4714 |
| SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE | 0.96438 | 0.4173 |
| BNP PARIBAS does not Granger Cause SOCIETE GENERALE | 0.45952 | 0.7118 |
| SOCIETE GENERALE does not Granger Cause BNP PARIBAS | 2.16885 | 0.1039 |
| BNP PARIBAS does not Granger Cause CREDIT AGRICOLE | 0.69034 | 0.5624 |
| CREDIT AGRICOLE does not Granger Cause BNP PARIBAS | 1.02665 | 0.3892 |

## 2011 Causalities

| Pairwise Granger Causality Tests | | |
|---|---|---|
| Null Hypothesis: | F-Statistic | Prob. |
| CREDIT AGRICOLE does not Granger Cause BNP PARIBAS | 1.77603 | 0.1541 |
| BNP PARIBAS does not Granger Cause CREDIT AGRICOLE | 1.90364 | 0.1313 |
| SOCIETE GENERALE does not Granger Cause BNP PARIBAS | 2.05855 | 0.1081 |
| BNP PARIBAS does not Granger Cause SOCIETE GENERALE | 1.61675 | 0.1878 |
| DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS | 6.88615 | 0.0002 |
| BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG | 4.13870 | 0.0075 |
| COMMERZBANK AG does not Granger Cause BNP PARIBAS | 9.32782 | 1.E-05 |
| BNP PARIBAS does not Granger Cause COMMERZBANK AG | 1.80555 | 0.1485 |
| BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS | 3.92227 | 0.0099 |
| BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA | 0.81266 | 0.4887 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 4.80419 | 0.0032 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 0.45995 | 0.7107 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 0.79867 | 0.4964 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 1.60884 | 0.1896 |
| BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS | 1.70378 | 0.1686 |
| BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA | 0.38125 | 0.7667 |
| DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS | 0.69254 | 0.5579 |
| BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL | 4.61105 | 0.0041 |
| KBC BANK does not Granger Cause BNP PARIBAS | 2.08122 | 0.1050 |
| BNP PARIBAS does not Granger Cause KBC BANK | 2.89794 | 0.0370 |
| BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS | 4.58108 | 0.0042 |
| BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES | 1.64754 | 0.1808 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS | 1.40085 | 0.2448 |
| BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA | 0.15357 | 0.9273 |
| NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS | 7.88505 | 6.E-05 |
| BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA | 2.06529 | 0.1072 |
| ALPHA BANK A.E. does not Granger Cause BNP PARIBAS | 4.60581 | 0.0041 |
| BNP PARIBAS does not Granger Cause ALPHA BANK A.E. | 1.63957 | 0.1826 |
| FRENCH REPUBLIC does not Granger Cause BNP PARIBAS | 2.33397 | 0.0762 |

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|---|---|---|
| BNP PARIBAS does not Granger Cause FRENCH REPUBLIC | 2.01632 | 0.1140 |
| FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS | 1.30177 | 0.2760 |
| BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY | 0.65178 | 0.5830 |
| KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS | 2.30117 | 0.0795 |
| BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN | 3.54155 | 0.0161 |
| REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS | 5.66811 | 0.0010 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY | 5.80676 | 0.0009 |
| KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS | 0.89136 | 0.4471 |
| BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM | 2.28950 | 0.0806 |
| REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS | 6.81938 | 0.0002 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL | 3.56068 | 0.0157 |
| SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE | 0.59848 | 0.6169 |
| CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE | 0.08217 | 0.9696 |
| DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE | 3.32027 | 0.0215 |
| CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG | 1.91491 | 0.1295 |
| COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE | 5.95380 | 0.0007 |
| CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG | 1.76324 | 0.1566 |
| BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE | 3.96381 | 0.0094 |
| CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA | 0.48106 | 0.6959 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 5.07848 | 0.0022 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 0.52171 | 0.6680 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 0.31624 | 0.8136 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 1.02136 | 0.3849 |
| BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE | 1.12499 | 0.3409 |
| CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA | 0.00696 | 0.9992 |
| DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE | 0.21951 | 0.8827 |
| CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL | 3.25852 | 0.0233 |
| KBC BANK does not Granger Cause CREDIT AGRICOLE | 1.47422 | 0.2238 |
| CREDIT AGRICOLE does not Granger Cause KBC BANK | 2.98212 | 0.0332 |
| BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE | 6.46362 | 0.0004 |
| CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES | 0.91921 | 0.4331 |

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|---|---|---|
| BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE | 2.59199 | 0.0548 |
| CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA | 0.43099 | 0.7311 |
| NAT BK OF GREECE SA does not Granger Cause CREDIT AGRICOLE | 8.54509 | 3.E-05 |
| CREDIT AGRICOLE does not Granger Cause NAT BK OF GREECE SA | 0.73107 | 0.5350 |
| ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE | 5.70429 | 0.0010 |
| CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E. | 1.81010 | 0.1477 |
| FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE | 3.84647 | 0.0109 |
| CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC | 3.20212 | 0.0250 |
| FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE | 0.71751 | 0.5430 |
| CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY | 0.72569 | 0.5381 |
| KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE | 4.43137 | 0.0051 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN | 5.32483 | 0.0016 |
| REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE | 3.61687 | 0.0146 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY | 6.44451 | 0.0004 |
| KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE | 2.03139 | 0.1118 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM | 2.21796 | 0.0883 |
| REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE | 6.33445 | 0.0004 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL | 5.95722 | 0.0007 |
| DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE | 7.53145 | 0.0001 |
| SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG | 3.09827 | 0.0286 |
| COMMERZBANK AG does not Granger Cause SOCIETE GENERALE | 5.95061 | 0.0007 |
| SOCIETE GENERALE does not Granger Cause COMMERZBANK AG | 0.78588 | 0.5035 |
| BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE | 5.04692 | 0.0023 |
| SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA | 0.60204 | 0.6146 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 6.01131 | 0.0007 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 0.54197 | 0.6543 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 0.33557 | 0.7996 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 1.96011 | 0.1223 |
| BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE | 0.70300 | 0.5516 |
| SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA | 0.28085 | 0.8392 |
| DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE | 0.34611 | 0.7920 |

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|---|---|---|
| SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL | 5.30945 | 0.0017 |
| KBC BANK does not Granger Cause SOCIETE GENERALE | 1.41394 | 0.2409 |
| SOCIETE GENERALE does not Granger Cause KBC BANK | 4.00517 | 0.0089 |
| BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE | 4.04197 | 0.0085 |
| SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES | 0.94760 | 0.4193 |
| BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE | 1.51421 | 0.2131 |
| SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA | 0.68767 | 0.5609 |
| NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE | 6.07137 | 0.0006 |
| SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA | 2.12368 | 0.0995 |
| ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE | 3.36131 | 0.0204 |
| SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E. | 3.14643 | 0.0269 |
| FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE | 2.50447 | 0.0613 |
| SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC | 4.31525 | 0.0059 |
| FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE | 1.05721 | 0.3692 |
| SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY | 1.80814 | 0.1480 |
| KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE | 2.60632 | 0.0538 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN | 3.70157 | 0.0131 |
| REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE | 4.59584 | 0.0041 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY | 4.63224 | 0.0039 |
| KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE | 1.22806 | 0.3015 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM | 3.24628 | 0.0236 |
| REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE | 5.27278 | 0.0017 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL | 5.77732 | 0.0009 |
| COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG | 4.11556 | 0.0077 |
| DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG | 0.97121 | 0.4080 |
| BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG | 4.23998 | 0.0065 |
| DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA | 1.62387 | 0.1862 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 3.61662 | 0.0147 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 1.57909 | 0.1967 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 0.90511 | 0.4402 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 0.62396 | 0.6006 |

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| BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG | 1.78484 | 0.1524 |
| DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 0.93798 | 0.4239 |
| DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG | 2.99677 | 0.0326 |
| DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL | 1.94301 | 0.1250 |
| KBC BANK does not Granger Cause DEUTSCHE BANK AG | 1.73592 | 0.1620 |
| DEUTSCHE BANK AG does not Granger Cause KBC BANK | 2.63617 | 0.0518 |
| BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG | 2.36956 | 0.0728 |
| DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES | 1.36977 | 0.2542 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG | 1.20287 | 0.3107 |
| DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 0.68547 | 0.5622 |
| NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG | 3.32846 | 0.0213 |
| DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA | 2.01630 | 0.1140 |
| ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG | 3.59896 | 0.0150 |
| DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E. | 1.27059 | 0.2865 |
| FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG | 7.38121 | 0.0001 |
| DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC | 8.70157 | 2.E-05 |
| FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG | 1.57714 | 0.1972 |
| DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY | 1.04332 | 0.3752 |
| KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG | 2.36705 | 0.0731 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN | 5.59487 | 0.0011 |
| REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG | 5.98540 | 0.0007 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY | 7.62522 | 9.E-05 |
| KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG | 2.82532 | 0.0406 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM | 6.57447 | 0.0003 |
| REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG | 4.67364 | 0.0037 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 5.04790 | 0.0023 |
| BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG | 4.57228 | 0.0043 |
| COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA | 1.26777 | 0.2875 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 5.90726 | 0.0008 |
| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 1.35188 | 0.2598 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 0.54562 | 0.6518 |

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| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 1.20806 | 0.3088 |
| BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG | 1.93216 | 0.1267 |
| COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 2.41425 | 0.0688 |
| DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG | 1.98288 | 0.1189 |
| COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL | 2.12691 | 0.0991 |
| KBC BANK does not Granger Cause COMMERZBANK AG | 2.35818 | 0.0739 |
| COMMERZBANK AG does not Granger Cause KBC BANK | 3.27693 | 0.0227 |
| BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG | 4.34701 | 0.0057 |
| COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES | 1.43987 | 0.2334 |
| BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG | 3.86363 | 0.0106 |
| COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 1.74704 | 0.1598 |
| NAT BK OF GREECE SA does not Granger Cause COMMERZBANK AG | 4.60871 | 0.0041 |
| COMMERZBANK AG does not Granger Cause NAT BK OF GREECE SA | 0.18330 | 0.9076 |
| ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG | 4.44901 | 0.0050 |
| COMMERZBANK AG does not Granger Cause ALPHA BANK A.E. | 1.33815 | 0.2641 |
| FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG | 6.13600 | 0.0006 |
| COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC | 11.6883 | 6.E-07 |
| FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG | 0.32874 | 0.8046 |
| COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY | 2.37030 | 0.0728 |
| KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG | 5.66413 | 0.0010 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN | 9.46188 | 9.E-06 |
| REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG | 1.96383 | 0.1218 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY | 8.56209 | 3.E-05 |
| KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG | 4.81095 | 0.0031 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM | 14.9256 | 1.E-08 |
| REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG | 6.48636 | 0.0004 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 4.50223 | 0.0047 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 6.71119 | 0.0003 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 0.01939 | 0.9963 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 0.40030 | 0.7530 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 1.57258 | 0.1983 |

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| BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA | 1.61740 | 0.1876 |
| BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA | 2.11861 | 0.1002 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA | 0.91414 | 0.4357 |
| BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL | 5.46311 | 0.0014 |
| KBC BANK does not Granger Cause BANCO DE SABADELL SA | 2.99455 | 0.0327 |
| BANCO DE SABADELL SA does not Granger Cause KBC BANK | 4.22337 | 0.0067 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA | 3.32479 | 0.0214 |
| BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES | 3.85658 | 0.0107 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA | 5.89379 | 0.0008 |
| BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 3.58655 | 0.0152 |
| NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA | 2.15546 | 0.0956 |
| BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA | 1.21324 | 0.3069 |
| ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA | 1.83800 | 0.1426 |
| BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E. | 2.19761 | 0.0906 |
| FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA | 2.55773 | 0.0573 |
| BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC | 2.17700 | 0.0930 |
| FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA | 0.44021 | 0.7246 |
| BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY | 1.72265 | 0.1647 |
| KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA | 4.96914 | 0.0026 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN | 4.12678 | 0.0076 |
| REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA | 1.89272 | 0.1332 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY | 3.31401 | 0.0217 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA | 2.60350 | 0.0540 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM | 1.72561 | 0.1641 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA | 7.88236 | 6.E-05 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL | 5.83456 | 0.0008 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 0.33419 | 0.8006 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 0.67019 | 0.5716 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 0.44823 | 0.7189 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 3.67575 | 0.0136 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 0.80670 | 0.4920 |

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| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 4.95248 | 0.0026 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 3.82275 | 0.0112 |
| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 3.45876 | 0.0180 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 3.13873 | 0.0271 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 3.49668 | 0.0171 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 5.33562 | 0.0016 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 2.02902 | 0.1122 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 2.12139 | 0.0998 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 1.09165 | 0.3545 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 2.38420 | 0.0715 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 1.92684 | 0.1276 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 0.73409 | 0.5332 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 1.88820 | 0.1339 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 0.95505 | 0.4157 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 1.22511 | 0.3026 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 4.80694 | 0.0032 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 1.06728 | 0.3648 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 1.05238 | 0.3713 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 2.05677 | 0.1083 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 1.38411 | 0.2498 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 1.67074 | 0.1757 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 8.86528 | 2.E-05 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.50672 | 0.0611 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 1.08566 | 0.3570 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 0.48488 | 0.6933 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 1.11753 | 0.3439 |
| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 0.44228 | 0.7231 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 0.34889 | 0.7900 |
| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 0.33542 | 0.7997 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 1.52976 | 0.2091 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 0.50772 | 0.6775 |

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| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 0.93120 | 0.4272 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.60798 | 0.6108 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 2.51282 | 0.0607 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 0.71679 | 0.5434 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 1.14483 | 0.3330 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 0.78196 | 0.5057 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 1.54726 | 0.2046 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 1.08447 | 0.3575 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 2.25287 | 0.0845 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 0.19015 | 0.9030 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 1.63645 | 0.1833 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 0.83992 | 0.4740 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 1.52388 | 0.2106 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 1.52437 | 0.2104 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 1.57575 | 0.1976 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 0.90599 | 0.4397 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 1.18329 | 0.3181 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 0.80542 | 0.4927 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA | 0.86080 | 0.4629 |
| BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL | 3.85177 | 0.0108 |
| KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA | 2.82511 | 0.0406 |
| BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK | 5.23253 | 0.0018 |
| BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA | 8.34181 | 4.E-05 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES | 0.89567 | 0.4449 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA | 3.05565 | 0.0302 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.39091 | 0.7597 |
| NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA | 8.93358 | 2.E-05 |
| BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA | 0.16736 | 0.9183 |
| ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA | 5.98657 | 0.0007 |
| BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E. | 2.84313 | 0.0397 |
| FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA | 2.94771 | 0.0347 |

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| BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC | 2.30619 | 0.0789 |
| FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA | 0.51285 | 0.6740 |
| BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY | 0.86984 | 0.4582 |
| KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA | 5.18725 | 0.0019 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN | 4.12517 | 0.0076 |
| REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA | 2.44058 | 0.0665 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY | 6.53408 | 0.0003 |
| KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA | 2.19826 | 0.0906 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM | 3.85478 | 0.0108 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA | 6.17126 | 0.0005 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL | 4.13713 | 0.0075 |
| KBC BANK does not Granger Cause DEXIA CREDIT LOCAL | 0.66642 | 0.5739 |
| DEXIA CREDIT LOCAL does not Granger Cause KBC BANK | 5.40093 | 0.0015 |
| BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL | 3.39801 | 0.0194 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES | 1.26986 | 0.2868 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL | 2.87289 | 0.0382 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA | 0.80177 | 0.4947 |
| NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL | 3.71882 | 0.0128 |
| DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA | 0.71043 | 0.5472 |
| ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL | 3.96138 | 0.0094 |
| DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E. | 0.89864 | 0.4434 |
| FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL | 4.04181 | 0.0085 |
| DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC | 0.08096 | 0.9703 |
| FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL | 0.82602 | 0.4814 |
| DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY | 0.65387 | 0.5817 |
| KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL | 4.73678 | 0.0035 |
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN | 1.84419 | 0.1415 |
| REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL | 6.98079 | 0.0002 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY | 0.85098 | 0.4681 |
| KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL | 5.25606 | 0.0018 |
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM | 0.67659 | 0.5676 |

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| REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL | 4.83913 | 0.0030 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL | 2.24375 | 0.0855 |
| BANCO COMR PORTUGUES does not Granger Cause KBC BANK | 4.46569 | 0.0049 |
| KBC BANK does not Granger Cause BANCO COMR PORTUGUES | 1.94339 | 0.1249 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK | 2.26323 | 0.0834 |
| KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA | 1.65800 | 0.1784 |
| NAT BK OF GREECE SA does not Granger Cause KBC BANK | 2.96257 | 0.0341 |
| KBC BANK does not Granger Cause NAT BK OF GREECE SA | 1.28890 | 0.2803 |
| ALPHA BANK A.E. does not Granger Cause KBC BANK | 4.99328 | 0.0025 |
| KBC BANK does not Granger Cause ALPHA BANK A.E. | 1.50142 | 0.2165 |
| FRENCH REPUBLIC does not Granger Cause KBC BANK | 3.96700 | 0.0093 |
| KBC BANK does not Granger Cause FRENCH REPUBLIC | 2.38117 | 0.0718 |
| FEDERAL REP GERMANY does not Granger Cause KBC BANK | 3.50802 | 0.0169 |
| KBC BANK does not Granger Cause FEDERAL REP GERMANY | 0.51595 | 0.6719 |
| KINGDOM OF SPAIN does not Granger Cause KBC BANK | 3.80884 | 0.0114 |
| KBC BANK does not Granger Cause KINGDOM OF SPAIN | 5.20443 | 0.0019 |
| REPUBLIC OF ITALY does not Granger Cause KBC BANK | 5.16782 | 0.0020 |
| KBC BANK does not Granger Cause REPUBLIC OF ITALY | 3.76829 | 0.0120 |
| KINGDOM OF BELGIUM does not Granger Cause KBC BANK | 5.35177 | 0.0016 |
| KBC BANK does not Granger Cause KINGDOM OF BELGIUM | 4.03212 | 0.0086 |
| REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK | 4.02027 | 0.0087 |
| KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL | 1.35963 | 0.2573 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES | 0.07552 | 0.9731 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA | 0.59612 | 0.6185 |
| NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES | 3.39457 | 0.0195 |
| BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA | 2.47270 | 0.0638 |
| ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES | 0.30693 | 0.8204 |
| BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E. | 1.68873 | 0.1718 |
| FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES | 2.44771 | 0.0659 |
| BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC | 3.82089 | 0.0113 |
| FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES | 0.92760 | 0.4290 |

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| BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY | 1.05316 | 0.3709 |
| KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES | 0.43020 | 0.7317 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN | 2.27547 | 0.0821 |
| REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES | 0.13169 | 0.9411 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY | 4.28754 | 0.0062 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES | 0.91549 | 0.4350 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM | 5.15442 | 0.0020 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES | 4.53341 | 0.0045 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL | 0.80215 | 0.4945 |
| NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA | 2.09292 | 0.1035 |
| BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA | 0.77703 | 0.5085 |
| ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA | 0.63560 | 0.5932 |
| BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E. | 0.44232 | 0.7231 |
| FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA | 0.31628 | 0.8136 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC | 1.68809 | 0.1719 |
| FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA | 1.94858 | 0.1241 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY | 0.73507 | 0.5326 |
| KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA | 0.62452 | 0.6002 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN | 1.00285 | 0.3933 |
| REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA | 0.05544 | 0.9828 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY | 1.49704 | 0.2176 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA | 0.27151 | 0.8459 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM | 2.06050 | 0.1078 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA | 3.27782 | 0.0227 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL | 0.47405 | 0.7008 |
| ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA | 4.74654 | 0.0034 |
| NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E. | 4.04107 | 0.0085 |
| FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA | 4.40499 | 0.0053 |
| NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC | 4.57380 | 0.0043 |
| FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA | 3.21881 | 0.0245 |
| NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY | 2.23835 | 0.0861 |

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| KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA | 1.58783 | 0.1946 |
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN | 2.07656 | 0.1056 |
| REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA | 0.94111 | 0.4224 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY | 5.62506 | 0.0011 |
| KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA | 2.46117 | 0.0648 |
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM | 4.76046 | 0.0033 |
| REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA | 5.26589 | 0.0017 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.40327 | 0.0698 |
| FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E. | 1.14799 | 0.3317 |
| ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC | 2.73418 | 0.0457 |
| FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E. | 3.53360 | 0.0163 |
| ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY | 2.36671 | 0.0731 |
| KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E. | 1.69414 | 0.1706 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN | 1.04358 | 0.3751 |
| REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E. | 1.69705 | 0.1700 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY | 2.86880 | 0.0384 |
| KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E. | 0.97059 | 0.4083 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM | 3.97131 | 0.0093 |
| REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E. | 4.75179 | 0.0034 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL | 1.19884 | 0.3122 |
| FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC | 4.08211 | 0.0080 |
| FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY | 1.34997 | 0.2604 |
| KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC | 4.43411 | 0.0051 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN | 3.87354 | 0.0105 |
| REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC | 5.48454 | 0.0013 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY | 3.18958 | 0.0254 |
| KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC | 0.43265 | 0.7299 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM | 1.06873 | 0.3642 |
| REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC | 8.83676 | 2.E-05 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL | 1.91808 | 0.1290 |
| KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY | 1.82393 | 0.1451 |

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|---|---|---|
| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN | 4.09354 | 0.0079 |
| REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY | 1.98570 | 0.1185 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY | 4.66926 | 0.0038 |
| KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY | 1.46995 | 0.2250 |
| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM | 3.07392 | 0.0295 |
| REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY | 3.33480 | 0.0211 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL | 3.22853 | 0.0242 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN | 0.15178 | 0.9284 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY | 2.18228 | 0.0924 |
| KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN | 3.29822 | 0.0221 |
| KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM | 5.41894 | 0.0014 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN | 5.43510 | 0.0014 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL | 1.61275 | 0.1887 |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY | 4.64513 | 0.0039 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM | 3.94625 | 0.0096 |
| REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY | 7.33022 | 0.0001 |
| REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL | 2.97507 | 0.0335 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM | 6.70750 | 0.0003 |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL | 2.73905 | 0.0454 |

## 20013 Causalities

| Pairwise Granger Causality Tests | | |
|---|---|---|
| Null Hypothesis: | F-Statistic | Prob. |
| CREDIT AGRICOLE does not Granger Cause BNP PARIBAS | 0.83785 | 0.4742 |
| BNP PARIBAS does not Granger Cause CREDIT AGRICOLE | 0.97237 | 0.4064 |
| SOCIETE GENERALE does not Granger Cause BNP PARIBAS | 1.52639 | 0.2082 |
| BNP PARIBAS does not Granger Cause SOCIETE GENERALE | 0.60756 | 0.6107 |
| DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS | 5.02884 | 0.0021 |
| BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG | 2.88749 | 0.0362 |
| COMMERZBANK AG does not Granger Cause BNP PARIBAS | 5.29032 | 0.0015 |
| BNP PARIBAS does not Granger Cause COMMERZBANK AG | 1.96952 | 0.1191 |
| BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS | 3.12080 | 0.0266 |
| BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA | 2.55914 | 0.0556 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 2.85322 | 0.0379 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 2.47605 | 0.0620 |
| BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS | 0.78290 | 0.5045 |
| BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA | 1.24299 | 0.2947 |
| BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS | 1.27300 | 0.2842 |
| BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA | 0.99381 | 0.3963 |
| DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS | 1.71716 | 0.1640 |
| BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL | 13.3371 | 4.E-08 |
| KBC BANK does not Granger Cause BNP PARIBAS | 1.78116 | 0.1513 |
| BNP PARIBAS does not Granger Cause KBC BANK | 1.78307 | 0.1509 |
| BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS | 5.12460 | 0.0019 |
| BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES | 2.37252 | 0.0709 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS | 2.12493 | 0.0976 |
| BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA | 1.00574 | 0.3908 |
| NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS | 5.50168 | 0.0011 |
| BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA | 2.76339 | 0.0426 |
| ALPHA BANK A.E. does not Granger Cause BNP PARIBAS | 0.79120 | 0.4998 |
| BNP PARIBAS does not Granger Cause ALPHA BANK A.E. | 11.6931 | 3.E-07 |
| FRENCH REPUBLIC does not Granger Cause BNP PARIBAS | 2.77521 | 0.0420 |

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|---|---|---|
| BNP PARIBAS does not Granger Cause FRENCH REPUBLIC | 1.45506 | 0.2274 |
| FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS | 1.14847 | 0.3301 |
| BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY | 0.59185 | 0.6209 |
| KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS | 1.81581 | 0.1448 |
| BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN | 1.62457 | 0.1842 |
| REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS | 1.65745 | 0.1768 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY | 4.02740 | 0.0080 |
| KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS | 1.98811 | 0.1163 |
| BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM | 2.51638 | 0.0588 |
| REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS | 7.17614 | 0.0001 |
| BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL | 7.32237 | 0.0001 |
| SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE | 0.96230 | 0.4111 |
| CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE | 0.84119 | 0.4724 |
| DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE | 3.48689 | 0.0164 |
| CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG | 1.09048 | 0.3537 |
| COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE | 3.78000 | 0.0111 |
| CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG | 1.76603 | 0.1542 |
| BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE | 2.02570 | 0.1108 |
| CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA | 2.14191 | 0.0955 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 1.93203 | 0.1249 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 2.38767 | 0.0695 |
| BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE | 0.35235 | 0.7875 |
| CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA | 0.80437 | 0.4925 |
| BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE | 0.55079 | 0.6481 |
| CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA | 1.21786 | 0.3038 |
| DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE | 0.41419 | 0.7430 |
| CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL | 10.0209 | 3.E-06 |
| KBC BANK does not Granger Cause CREDIT AGRICOLE | 1.91317 | 0.1280 |
| CREDIT AGRICOLE does not Granger Cause KBC BANK | 1.33068 | 0.2649 |
| BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE | 4.26395 | 0.0059 |
| CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES | 1.18059 | 0.3177 |

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|---|---|---|
| BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE | 2.21204 | 0.0872 |
| CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA | 0.90365 | 0.4399 |
| NAT BK OF GREECE SA does not Granger Cause CREDIT AGRICOLE | 3.94349 | 0.0090 |
| CREDIT AGRICOLE does not Granger Cause NAT BK OF GREECE SA | 0.61626 | 0.6051 |
| ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE | 1.69010 | 0.1697 |
| CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E. | 7.54488 | 8.E-05 |
| FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE | 2.54110 | 0.0570 |
| CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC | 2.36990 | 0.0711 |
| FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE | 0.63753 | 0.5915 |
| CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY | 0.83087 | 0.4780 |
| KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE | 3.72551 | 0.0120 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN | 1.59515 | 0.1911 |
| REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE | 1.79353 | 0.1489 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY | 3.06694 | 0.0286 |
| KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE | 2.29170 | 0.0787 |
| CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM | 3.21168 | 0.0236 |
| REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE | 6.49911 | 0.0003 |
| CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL | 9.40851 | 7.E-06 |
| DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE | 4.18133 | 0.0065 |
| SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG | 1.76701 | 0.1540 |
| COMMERZBANK AG does not Granger Cause SOCIETE GENERALE | 2.32789 | 0.0751 |
| SOCIETE GENERALE does not Granger Cause COMMERZBANK AG | 0.93100 | 0.4263 |
| BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE | 3.33104 | 0.0202 |
| SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA | 1.24221 | 0.2950 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 2.62248 | 0.0512 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 1.53346 | 0.2064 |
| BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE | 0.46653 | 0.7059 |
| SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA | 1.76953 | 0.1535 |
| BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE | 0.53443 | 0.6591 |
| SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA | 1.29634 | 0.2762 |
| DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE | 0.68524 | 0.5618 |

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|---|---|---|
| SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL | 10.2991 | 2.E-06 |
| KBC BANK does not Granger Cause SOCIETE GENERALE | 1.25933 | 0.2889 |
| SOCIETE GENERALE does not Granger Cause KBC BANK | 2.47393 | 0.0622 |
| BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE | 5.42336 | 0.0013 |
| SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES | 1.22422 | 0.3014 |
| BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE | 2.50446 | 0.0597 |
| SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA | 1.06619 | 0.3640 |
| NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE | 4.95604 | 0.0023 |
| SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA | 3.18347 | 0.0245 |
| ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE | 1.33508 | 0.2635 |
| SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E. | 11.0398 | 8.E-07 |
| FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE | 2.12201 | 0.0980 |
| SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC | 3.37523 | 0.0190 |
| FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE | 0.95155 | 0.4163 |
| SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY | 1.75904 | 0.1556 |
| KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE | 2.81569 | 0.0398 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN | 2.11716 | 0.0986 |
| REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE | 2.63705 | 0.0503 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY | 4.36852 | 0.0051 |
| KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE | 1.80905 | 0.1460 |
| SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM | 3.78897 | 0.0110 |
| REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE | 5.89562 | 0.0007 |
| SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL | 8.59115 | 2.E-05 |
| COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG | 1.72903 | 0.1616 |
| DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG | 0.62181 | 0.6015 |
| BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG | 3.61235 | 0.0139 |
| DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA | 1.52276 | 0.2091 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 2.56951 | 0.0549 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 0.99518 | 0.3957 |
| BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG | 0.74698 | 0.5250 |
| DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA | 0.48387 | 0.6938 |

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|---|---|---|
| BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG | 0.75672 | 0.5194 |
| DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 0.93566 | 0.4240 |
| DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG | 1.61628 | 0.1861 |
| DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL | 6.46456 | 0.0003 |
| KBC BANK does not Granger Cause DEUTSCHE BANK AG | 3.09866 | 0.0274 |
| DEUTSCHE BANK AG does not Granger Cause KBC BANK | 3.93846 | 0.0090 |
| BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG | 2.85604 | 0.0377 |
| DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES | 2.66607 | 0.0484 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG | 1.82836 | 0.1425 |
| DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 1.30178 | 0.2744 |
| NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG | 2.91926 | 0.0347 |
| DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA | 1.43733 | 0.2324 |
| ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG | 2.14333 | 0.0953 |
| DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E. | 4.60765 | 0.0037 |
| FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG | 7.30656 | 0.0001 |
| DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC | 6.60133 | 0.0003 |
| FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG | 1.96005 | 0.1205 |
| DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY | 0.83348 | 0.4766 |
| KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG | 2.93936 | 0.0338 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN | 4.19127 | 0.0065 |
| REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG | 3.47655 | 0.0167 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY | 5.56570 | 0.0010 |
| KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG | 3.45285 | 0.0172 |
| DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM | 7.30302 | 0.0001 |
| REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG | 6.01597 | 0.0006 |
| DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 9.84883 | 4.E-06 |
| BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG | 3.88191 | 0.0097 |
| COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA | 2.87570 | 0.0368 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 4.72115 | 0.0032 |
| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 2.03366 | 0.1097 |
| BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG | 0.34789 | 0.7907 |

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|---|---|---|
| COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA | 0.63461 | 0.5933 |
| BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG | 0.39490 | 0.7568 |
| COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA | 1.76469 | 0.1545 |
| DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG | 0.91814 | 0.4327 |
| COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL | 8.61558 | 2.E-05 |
| KBC BANK does not Granger Cause COMMERZBANK AG | 1.13924 | 0.3338 |
| COMMERZBANK AG does not Granger Cause KBC BANK | 3.49418 | 0.0163 |
| BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG | 4.32174 | 0.0054 |
| COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES | 2.38531 | 0.0697 |
| BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG | 5.04785 | 0.0021 |
| COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA | 2.37545 | 0.0706 |
| NAT BK OF GREECE SA does not Granger Cause COMMERZBANK AG | 3.65013 | 0.0132 |
| COMMERZBANK AG does not Granger Cause NAT BK OF GREECE SA | 1.28588 | 0.2798 |
| ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG | 2.52172 | 0.0584 |
| COMMERZBANK AG does not Granger Cause ALPHA BANK A.E. | 8.82850 | 1.E-05 |
| FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG | 4.04477 | 0.0078 |
| COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC | 4.67587 | 0.0034 |
| FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG | 0.73386 | 0.5327 |
| COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY | 0.55218 | 0.6471 |
| KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG | 7.02702 | 0.0001 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN | 4.34767 | 0.0052 |
| REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG | 2.60141 | 0.0527 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY | 5.61070 | 0.0010 |
| KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG | 2.80469 | 0.0404 |
| COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM | 8.01899 | 4.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG | 7.66471 | 6.E-05 |
| COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL | 10.2500 | 2.E-06 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 2.81184 | 0.0400 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 2.10212 | 0.1005 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA | 0.58827 | 0.6232 |
| BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA | 1.88272 | 0.1330 |

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|---|---|---|
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA | 5.63394 | 0.0009 |
| BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.27592 | 0.2832 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA | 2.45877 | 0.0634 |
| BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL | 9.45543 | 6.E-06 |
| KBC BANK does not Granger Cause BANCO DE SABADELL SA | 3.24784 | 0.0225 |
| BANCO DE SABADELL SA does not Granger Cause KBC BANK | 3.89494 | 0.0096 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA | 2.77718 | 0.0418 |
| BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES | 2.66138 | 0.0487 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA | 8.26021 | 3.E-05 |
| BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 4.69131 | 0.0033 |
| NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA | 1.74369 | 0.1586 |
| BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA | 2.98515 | 0.0319 |
| ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA | 1.90026 | 0.1301 |
| BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E. | 5.49541 | 0.0011 |
| FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA | 3.38029 | 0.0189 |
| BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC | 1.39237 | 0.2457 |
| FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA | 0.00691 | 0.9992 |
| BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY | 1.56123 | 0.1994 |
| KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA | 9.84652 | 4.E-06 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN | 2.74319 | 0.0437 |
| REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA | 5.03783 | 0.0021 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY | 3.19603 | 0.0241 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA | 3.72582 | 0.0120 |
| BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM | 1.27815 | 0.2824 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA | 7.92025 | 5.E-05 |
| BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL | 7.76071 | 6.E-05 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 0.46155 | 0.7094 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA | 0.99476 | 0.3959 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 4.79238 | 0.0029 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.05429 | 0.3692 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 3.03767 | 0.0297 |

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| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 9.08040 | 1.E-05 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 3.75914 | 0.0115 |
| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 2.73664 | 0.0441 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 2.85534 | 0.0378 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 1.56424 | 0.1986 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 9.41082 | 7.E-06 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 3.39908 | 0.0185 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 1.49848 | 0.2155 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 3.55490 | 0.0150 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 1.75877 | 0.1556 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 6.08238 | 0.0005 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 2.20284 | 0.0883 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 0.62903 | 0.5969 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 0.36023 | 0.7818 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 0.84576 | 0.4700 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 12.0501 | 2.E-07 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 1.22519 | 0.3011 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 5.32542 | 0.0014 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 2.46840 | 0.0626 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 2.85254 | 0.0379 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 0.71962 | 0.5411 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 7.61198 | 7.E-05 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 2.97905 | 0.0321 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA | 0.88392 | 0.4500 |
| BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA | 0.55718 | 0.6438 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA | 1.38936 | 0.2466 |
| BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL | 0.19114 | 0.9024 |
| KBC BANK does not Granger Cause BANCO POP ESPANOL SA | 0.14553 | 0.9325 |
| BANCO POP ESPANOL SA does not Granger Cause KBC BANK | 0.38138 | 0.7665 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA | 2.02144 | 0.1114 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES | 0.85249 | 0.4664 |

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| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA | 1.38104 | 0.2491 |
| BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA | 1.03464 | 0.3778 |
| NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA | 1.37260 | 0.2517 |
| BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA | 0.94678 | 0.4186 |
| ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA | 0.97467 | 0.4053 |
| BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E. | 2.04056 | 0.1088 |
| FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA | 1.67788 | 0.1723 |
| BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC | 0.90432 | 0.4396 |
| FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA | 2.25706 | 0.0823 |
| BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY | 0.37849 | 0.7686 |
| KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA | 1.67840 | 0.1722 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN | 0.81087 | 0.4889 |
| REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA | 1.65084 | 0.1782 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY | 1.24389 | 0.2944 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA | 1.41435 | 0.2391 |
| BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM | 0.81716 | 0.4854 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA | 1.15946 | 0.3258 |
| BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL | 1.33764 | 0.2627 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA | 0.20311 | 0.8942 |
| BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL | 7.82142 | 5.E-05 |
| KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA | 0.84321 | 0.4713 |
| BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK | 1.93651 | 0.1242 |
| BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA | 1.30930 | 0.2719 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES | 1.43854 | 0.2321 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.24712 | 0.2932 |
| BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA | 1.77736 | 0.1520 |
| NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA | 1.46453 | 0.2248 |
| BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA | 0.74871 | 0.5240 |
| ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA | 1.91779 | 0.1272 |
| BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E. | 6.45815 | 0.0003 |
| FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA | 2.12159 | 0.0980 |

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| BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC | 1.42236 | 0.2368 |
| FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA | 1.44604 | 0.2299 |
| BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY | 1.18206 | 0.3171 |
| KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA | 3.11689 | 0.0268 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN | 1.91273 | 0.1280 |
| REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA | 1.34195 | 0.2613 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY | 2.92322 | 0.0346 |
| KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA | 2.38399 | 0.0699 |
| BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM | 1.69899 | 0.1678 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA | 2.79408 | 0.0409 |
| BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL | 4.86146 | 0.0026 |
| KBC BANK does not Granger Cause DEXIA CREDIT LOCAL | 1.54001 | 0.2047 |
| DEXIA CREDIT LOCAL does not Granger Cause KBC BANK | 2.71343 | 0.0455 |
| BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL | 5.59420 | 0.0010 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES | 3.94194 | 0.0090 |
| BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL | 4.63569 | 0.0036 |
| DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA | 2.83079 | 0.0390 |
| NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL | 4.77195 | 0.0030 |
| DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA | 4.07882 | 0.0075 |
| ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL | 4.08342 | 0.0074 |
| DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E. | 7.43452 | 9.E-05 |
| FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL | 6.43920 | 0.0003 |
| DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC | 1.10091 | 0.3494 |
| FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL | 1.44304 | 0.2308 |
| DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY | 0.70900 | 0.5474 |
| KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL | 14.2638 | 1.E-08 |
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN | 2.53714 | 0.0573 |
| REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL | 16.8551 | 5.E-10 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY | 1.61414 | 0.1866 |
| KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL | 6.08091 | 0.0005 |
| DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM | 2.64280 | 0.0499 |

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| REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL | 5.95641 | 0.0006 |
| DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL | 3.55040 | 0.0151 |
| BANCO COMR PORTUGUES does not Granger Cause KBC BANK | 4.70846 | 0.0032 |
| KBC BANK does not Granger Cause BANCO COMR PORTUGUES | 3.05464 | 0.0291 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK | 2.69310 | 0.0467 |
| KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA | 2.16619 | 0.0926 |
| NAT BK OF GREECE SA does not Granger Cause KBC BANK | 1.58991 | 0.1923 |
| KBC BANK does not Granger Cause NAT BK OF GREECE SA | 0.95001 | 0.4170 |
| ALPHA BANK A.E. does not Granger Cause KBC BANK | 1.23672 | 0.2969 |
| KBC BANK does not Granger Cause ALPHA BANK A.E. | 4.14001 | 0.0069 |
| FRENCH REPUBLIC does not Granger Cause KBC BANK | 6.01452 | 0.0006 |
| KBC BANK does not Granger Cause FRENCH REPUBLIC | 3.93884 | 0.0090 |
| FEDERAL REP GERMANY does not Granger Cause KBC BANK | 4.30625 | 0.0055 |
| KBC BANK does not Granger Cause FEDERAL REP GERMANY | 1.01820 | 0.3852 |
| KINGDOM OF SPAIN does not Granger Cause KBC BANK | 1.68721 | 0.1703 |
| KBC BANK does not Granger Cause KINGDOM OF SPAIN | 3.11471 | 0.0269 |
| REPUBLIC OF ITALY does not Granger Cause KBC BANK | 1.90665 | 0.1290 |
| KBC BANK does not Granger Cause REPUBLIC OF ITALY | 1.74093 | 0.1592 |
| KINGDOM OF BELGIUM does not Granger Cause KBC BANK | 6.86117 | 0.0002 |
| KBC BANK does not Granger Cause KINGDOM OF BELGIUM | 5.76469 | 0.0008 |
| REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK | 5.27955 | 0.0015 |
| KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL | 1.77269 | 0.1529 |
| BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES | 0.72948 | 0.5353 |
| BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA | 0.44727 | 0.7194 |
| NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES | 3.36689 | 0.0193 |
| BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA | 10.8775 | 1.E-06 |
| ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES | 1.97936 | 0.1176 |
| BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E. | 13.0179 | 6.E-08 |
| FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES | 1.94381 | 0.1231 |
| BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC | 6.89773 | 0.0002 |
| FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES | 0.06907 | 0.9764 |

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| BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY | 1.42120 | 0.2371 |
| KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES | 1.00947 | 0.3891 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN | 2.52609 | 0.0581 |
| REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES | 1.17559 | 0.3196 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY | 6.92956 | 0.0002 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES | 0.85322 | 0.4660 |
| BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM | 7.42547 | 9.E-05 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES | 0.79559 | 0.4973 |
| BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL | 5.33149 | 0.0014 |
| NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA | 0.80468 | 0.4923 |
| BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA | 5.46179 | 0.0012 |
| ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA | 0.66686 | 0.5731 |
| BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E. | 9.60810 | 5.E-06 |
| FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA | 0.01904 | 0.9964 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC | 3.07853 | 0.0282 |
| FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA | 1.40670 | 0.2414 |
| BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY | 0.84399 | 0.4709 |
| KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA | 0.53090 | 0.6615 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN | 1.51030 | 0.2124 |
| REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA | 0.44838 | 0.7187 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY | 2.65950 | 0.0488 |
| KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA | 0.33546 | 0.7997 |
| BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM | 1.31859 | 0.2689 |
| REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA | 1.14460 | 0.3317 |
| BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL | 4.07639 | 0.0075 |
| ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA | 10.3430 | 2.E-06 |
| NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E. | 14.5007 | 1.E-08 |
| FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA | 4.80005 | 0.0029 |
| NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC | 2.05543 | 0.1067 |
| FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA | 3.04125 | 0.0296 |
| NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY | 2.71773 | 0.0452 |

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| KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA | 1.09320 | 0.3526 |
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN | 3.92373 | 0.0092 |
| REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA | 1.02294 | 0.3831 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY | 6.55137 | 0.0003 |
| KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA | 6.58101 | 0.0003 |
| NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM | 1.92105 | 0.1267 |
| REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA | 11.2047 | 6.E-07 |
| NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL | 1.34237 | 0.2612 |
| FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E. | 5.80675 | 0.0008 |
| ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC | 0.78514 | 0.5032 |
| FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E. | 2.74608 | 0.0436 |
| ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY | 0.13208 | 0.9409 |
| KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E. | 6.85213 | 0.0002 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN | 1.11701 | 0.3428 |
| REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E. | 6.94310 | 0.0002 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY | 1.60137 | 0.1896 |
| KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E. | 6.00345 | 0.0006 |
| ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM | 0.35190 | 0.7878 |
| REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E. | 7.00593 | 0.0002 |
| ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL | 0.77735 | 0.5076 |
| FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC | 1.75293 | 0.1568 |
| FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY | 1.05117 | 0.3705 |
| KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC | 0.79939 | 0.4952 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN | 1.92604 | 0.1259 |
| REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC | 1.62308 | 0.1845 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY | 2.81289 | 0.0399 |
| KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC | 1.20981 | 0.3067 |
| FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM | 0.12621 | 0.9445 |
| REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC | 5.22739 | 0.0016 |
| FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL | 3.92211 | 0.0092 |
| KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY | 0.67741 | 0.5666 |

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| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN | 2.49307 | 0.0606 |
| REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY | 0.33777 | 0.7980 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY | 3.13782 | 0.0261 |
| KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY | 1.13082 | 0.3372 |
| FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM | 2.86539 | 0.0373 |
| REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY | 0.90855 | 0.4375 |
| FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL | 3.87753 | 0.0098 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN | 0.19914 | 0.8969 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY | 1.65352 | 0.1776 |
| KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN | 3.21849 | 0.0234 |
| KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM | 1.64506 | 0.1795 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN | 6.73411 | 0.0002 |
| KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL | 5.15193 | 0.0018 |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY | 5.79628 | 0.0008 |
| REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM | 2.63183 | 0.0506 |
| REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY | 7.40328 | 9.E-05 |
| REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL | 4.99411 | 0.0022 |
| REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM | 1.85602 | 0.1376 |
| KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL | 3.59864 | 0.0142 |