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Entrepreneurial ecosystems structure, a measurement framework and first findings in african low income countries

Grégory Guéneau

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UNIVERSITÉ PARIS I - PANTHÉON SORBONNE
Institut d'Administration des Entreprises de Paris
Ecole doctorale de Management Panthéon-Sorbonne - ED 559
Equipe de Recherche GREGOR - EA 2474

**Entrepreneurial Ecosystems structure,
a network measurement framework and first findings
in African low income countries**

THESE

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en vue de l'obtention du

DOCTORAT EN SCIENCES DE GESTION

par

Grégory Guéneau

JURY

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“L’université de PARIS I – Panthéon Sorbonne n’entend donner aucune approbation ni improbation aux opinions émises dans les thèses ; ces opinions doivent être considérées comme propres à leurs auteurs”

A mon père, universel inspirateur
A ma mère, nourricière éternelle
A mes enfants, à qui j'ai pris tant de temps
A mon épouse adorée, soutien indéfectible

Abstract FR

Un des importants facteurs de stimulation du Bien-Être et du Développement Économique sur un territoire est l'Entrepreneuriat. Le milieu dans lequel il émerge est l'Écosystème Entrepreneurial. Dès lors, la compréhension de sa structure et de sa configuration est essentielle pour bâtir des stratégies de stimulation. Cependant, son modèle structurel et configurationnel est actuellement méconnu, du fait notamment de la confusion théorique entre sa compréhension économique et une explication organisationnelle de sa structure et de ses processus. Il en résulte une grande dispersion des cadres conceptuels dans une littérature abondante centrée sur un cadre théorique économique, limitant l'émergence de théories organisationnelles convaincantes, comme le remarquent de nombreux chercheurs de référence. Tout au long de ce travail de doctorat, nous nous efforçons de rassembler ce qui est éparé, ce qui conduit à proposer une méthode de mesure originale. En nous appuyant sur une orientation méthodologique quantitative, nous sommes amenés à découvrir les prémices d'un modèle structurel, basé sur la mobilisation de la théorie des réseaux appliquée aux écosystèmes entrepreneuriaux. Cette thèse par articles présente cinq articles complémentaires, étudiant systématiquement l'application de cette méthode en Afrique, fournissant des résultats intéressants sur l'impact des écosystèmes entrepreneuriaux sur la dynamique entrepreneuriale. Nous avons découvert à quel point les facteurs de diffusion de l'information et de proximité dans les écosystèmes entrepreneuriaux sont corrélés à une forte dynamique entrepreneuriale, et identifié un facteur de distribution des ressources pour les entrepreneurs. Nous constatons que lorsque ces attributs de l'Écosystème Entrepreneurial sont faibles, un processus de discontinuité se produit dans la distribution des ressources aux entrepreneurs, conduisant à une diminution de la dynamique entrepreneuriale associée. Plus qu'une thèse, ce travail constitue les premières étapes d'un programme de recherche visant à mieux comprendre comment un Écosystème Entrepreneurial peut être plus propice à la dynamique entrepreneuriale qu'un autre.

Mots Clefs : Écosystèmes, Entrepreneuriat, Réseaux, Quantitatif, Afrique

Abstract EN

One of the most important factors for stimulating well-being and economic development in a territory is entrepreneurship. The environment in which it emerges is the Entrepreneurial Ecosystem. Therefore, the understanding of its structure and configuration is essential to build stimulation strategies. However, its structural and configurational model is currently misunderstood, mainly because of the theoretical confusion between its economic understanding and an organizational explanation of its structure and processes. The result is a wide dispersion of conceptual frameworks in an abundant literature centered on an economic theoretical theory, limiting the emergence of convincing organizational theories, as noted by many leading researchers. Throughout this doctoral journey, we strive to bring together what is scattered, leading to the proposal of an original measurement method. Based on a quantitative methodological orientation, we are led to discover clues of a structural model, based on the mobilization of network theory applied to entrepreneurial ecosystems. This article-based thesis presents five complementary articles, systematically studying the application of this method in Africa, providing interesting results on the impact of entrepreneurial ecosystems on entrepreneurial dynamics. We find how information diffusion and proximity factors in entrepreneurial ecosystems are correlated with strong entrepreneurial dynamics, and identify a resource distribution factor for entrepreneurs. We find that when these Entrepreneurial Ecosystem attributes are weak, a process of discontinuity occurs in the distribution of resources to entrepreneurs, leading to a decrease in the associated entrepreneurial dynamics. More than a thesis, this work constitutes the first steps of a research program aimed at better understanding how one Entrepreneurial Ecosystem can be more conducive to entrepreneurial dynamics than another.

Key words : Ecosystems, Entrepreneurship, Network, Quantitative, Africa

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Mener à son terme une Thèse de Doctorat, qui plus est à cinquante ans, ne se fait pas sans devoir dépasser de multiples obstacles et relever de multiples challenges. Pour un doctorat, la qualité de l'entourage, tout comme pour un entrepreneur la qualité de son écosystème entrepreneurial, est un facteur de réussite de son processus de recherche, car il vous soutient et vous nourrit.

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Liste des Articles de la Thèse

Article 1 (Chapitre 1) : **Guéneau G.**, Chabaud D., Chalus Sauvannet M-C., ‘*How Entrepreneurial Ecosystem Actors Ties Can Undermine Entrepreneurial Efforts: An Exploratory Study from Morocco*’ in P. Rippa, M. Raffa, C. Ben-Hafaïedh, A. Kurczewska, M. Xenheti (eds.), *2020 RENT Anthology*

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Article 2 (Chapitre 2) : **Guéneau G.**, Chabaud D., Chalus Sauvannet M-C., ‘*Opening entrepreneurial ecosystem’s black box: the power of networks in African low income countries*’, International Entrepreneurship and Management Journal, 2022, <https://doi.org/10.1007/s11365-021-00775-1> [CNRS cat. 4, FNEGE cat 3, HCERES cat. B]

Une version précédente a été présentée dans : Conférence ACIEK 2021, SORBONNE VIRTUAL, 14-16 Juin 2021, ‘*Opening entrepreneurial ecosystem’s black box: the power of networks in African low income countries*’ avec D. Chabaud et MC. Chalus Sauvannet

Ce papier a reçu un **Best Paper Award**

Article 3 (Chapitre 2) : **Guéneau G.**, Chabaud D., Chalus Sauvannet M-C., ‘*Entrepreneurial Ecosystems Power of Networks : central role impact in low income countries*’, Academy of Management Proceedings, 2021, <https://doi.org/10.5465/AMBPP.2021.13891abstract>

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Article 4 (Chapitre 3) : **Guéneau G.**, Chabaud D., Chalus Sauvannet M-C., ‘*Quest for structural inter-organizational configurations in Entrepreneurial Ecosystems*’, Conférence ACIEK 2022, Séville

Ce papier a reçu un **Best Paper Award**

Papier destiné à être soumis à Technological Forecasting and Social Change Journal (in review)

[CNRS cat. 2, FNEGE cat 2, HCERES cat. A]

Article 5 (Chapitre 3) : **Guéneau G.**, Chabaud D., Chalus Sauvannet M-C., ‘Goats and Crocodiles : African Entrepreneurial Ecosystems Network Archetypes, the cases of Madagascar, Morocco, Senegal and Tunisia’, Conférence R&D Management 2022, Trento

Une version a été présentée dans : BCERC 2022, Waco, Guéneau G., Chabaud D., Chalus Sauvannet M-C., ‘Goats and Crocodiles : African Entrepreneurial Ecosystems Network Archetypes, the cases of Madagascar, Morocco, Senegal and Tunisia’, 2022, June 3rd

Papier destiné à être soumis à R&D Management Journal

[CNRS cat. 3, FNEGE cat 2, HCERES cat. A]

ANNEXE

Article Annexe : **Guéneau G.**, Chalus Sauvannet M-C., ‘*Structural and Processual Approach of Entrepreneurial Ecosystems, the case of Lyon Area*’, Revue de l’Entrepreneuriat (in review)
[CNRS cat. 4, FNEGE cat 2, HCERES cat. A]

Une version a été présentée dans : Conférence AEI, Online, 2021, Guéneau G., Chalus Sauvannet M-C., ‘Processual Approach of Entrepreneurial Ecosystems, the case of Lyon Area’ [10/2021]

Travaux liés à la thèse

- Organisation et Direction Scientifique de la conférence internationale pour l'innovation et l'entrepreneuriat en Afrique, INNODAYS de 2016 à ce jour
 - GUENEAU, G. (2016), INNODAYS 2016 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat , 27 Septembre 2016, Casablanca, Maroc.
 - GUENEAU, G. (2017), INNODAYS 2017 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat , 10-11 Octobre 2017, Casablanca, Maroc.
 - GUENEAU, G. (2019), INNODAYS 2019 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat , 13 Février 2019, Casablanca, Maroc.
 - GUENEAU, G. (2020), INNODAYS 2020 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat , 7 juillet 2020, Casablanca, Maroc.
 - GUENEAU, G. (2021), INNODAYS 2021 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat “Leadership Entrepreneurial en Afrique pour une Reprise Historique”, Jeudi 28 Octobre 2021, Casablanca, Maroc.
 - GUENEAU, G. (2022), INNODAYS 2022 - Conférence Internationale pour l'Innovation et l'Entrepreneuriat “Innovation et Entrepreneuriat, le Futur de l'Afrique”, 5 au 8 Novembre 2022, Casablanca, Maroc.
- Création et animation de l'Observatoire des Soutiens à l'Entrepreneuriat au Maroc (2019)
- Création et animation de l'Observatoire des Soutiens à l'Entrepreneuriat en Afrique (2022)
- Guéneau G., Chabaud D., Chalus Sauvannet M-C. (2021b), *Entrepreneurial Ecosystems Spillovers : power of networks and central actor in low income countries, an exploratory study*, Pre-conference Workshop BCERC 2021 Entrepreneurial Ecosystems and Territories, Online, June 9th 2021
- Guéneau G., Chabaud D., Chalus Sauvannet M-C. *Goats and Crocodiles : network processes in African Entrepreneurial Ecosystems, cases of Madagascar, Morocco, Senegal and Tunisia*, Conférence BCERC 2022, organisé par Babson College, Waco
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- Reviewer dans la revue Small Business Economics (2022)
- Reviewer pour la conférence ACIEK - 2021 et 2022
- Chair Session Management - Conférence AOM - 2021

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Résumé Français

L'esprit d'entreprise est un élément crucial du développement économique, en particulier dans les pays à faible revenu (Acs, 2006), où plus de 300 millions de petites et moyennes entreprises (PME) contribuent jusqu'à 40 % du produit national brut de développement (PNB). Par conséquent, la compréhension approfondie des facteurs influençant la dynamique de l'émergence entrepreneuriale est un domaine de recherche essentiel (Gartner et al., 2004). Ces dynamiques sont profondément liées à leur environnement (Van De Ven, 1993). Introduits en 2010 (Isenberg, 2010) sur la base de l'observation de lieux de réussite entrepreneuriale tels que la Silicon Valley, les écosystèmes entrepreneuriaux (EE) sont définis comme "un ensemble d'acteurs et de facteurs interdépendants qui sont gouvernés de telle manière qu'ils permettent un entrepreneuriat productif sur un territoire particulier" (Leendertse, Schrijvers et Stam, 2021). Mais le manque de recherches rigoureuses orientées vers les sciences sociales dans ce domaine (Audretsch et al., 2018 ; Cao et Shi, 2020) suggère que la recherche sur les écosystèmes entrepreneuriaux ne fournit pas réellement de théories et de stratégies accessibles, complètes et exploitables pour stimuler l'entrepreneuriat. Comme nous comprenons que l'écosystème entrepreneurial influence l'entrepreneuriat, et que les effets causaux sont en fait principalement inconnus, il est alors approprié d'ouvrir de nouvelles perspectives de recherche, en particulier liées aux endroits les plus faibles qui reposent sur leur dynamique entrepreneuriale. Pour ouvrir cette perspective, dite "Boîte noire de l'écosystème entrepreneurial", notre programme de recherche consiste à proposer une méthode de mesure de la structure des écosystèmes entrepreneuriaux. Ce faisant, nous sommes amenés à explorer comment la configuration structurelle des écosystèmes entrepreneuriaux (Rocha et Audretsch, 2022) peut être une condition causale de la dynamique entrepreneuriale dans un territoire donné, et à formuler des premières propositions basées sur cette nouvelle méthode.

Questions et intérêts du sujet

Les décideurs politiques du monde entier reconnaissent l'importance de stimuler l'entrepreneuriat dans leurs juridictions en créant et en gérant des écosystèmes entrepreneuriaux efficaces (Buffart et al., 2020). Le cadre disponible est basé sur l'héritage de la recherche de Daniel Isenberg, les dix éléments de l'écosystème entrepreneurial, qui fournit une compréhension globale des forces économiques en jeu, conduisant à des stratégies de stimulation à moyen et long terme. Mais il manque un chaînon qui peut leur permettre de piloter des stratégies à plus court terme, au niveau de l'organisation de ces écosystèmes, pour les rendre

plus efficaces (Audretsch et al., 2018). Cette recherche consiste donc à proposer une approche organisationnelle, en proposant un nouveau cadre de mesure des écosystèmes entrepreneuriaux, permettant la construction de telles stratégies. Cela soulève un certain nombre de défis managériaux, théoriques et méthodologiques intéressants.

Intérêt managérial

Stimulation du processus entrepreneurial

La reconnaissance des opportunités et la création de la spécificité entrepreneuriale dans la création de nouvelles entreprises (Bhave, 1994) s'appuie notamment sur les ressources environnantes telles que les connaissances, le capital social (Fayolle et al., 2016), les marchés, les compétences. Le processus entrepreneurial est connu, objet d'une littérature abondante (Gartner et al., 2004). Il est compris comme reposant sur l'entrepreneur lui-même (Hui-Chen, Kuen-Hung et Chen-Yi, 2014), d'une manière qui peut être soutenue par des organisations dédiées telles que les incubateurs (Peters, Rice et Sundararajan, 2004) ou les accélérateurs. La création de la nouvelle entreprise génère également une quête souvent difficile de ressources appropriées (Brush, Greene et Hart, 2001). Si le soutien à l'entrepreneuriat est connu sur le plan théorique et managérial au niveau individuel, il en est autrement lorsqu'il s'agit de soutenir un groupe de nouvelles entreprises à l'échelle d'un territoire.

Conscients de ces contraintes, les décideurs politiques désireux de stimuler - sur un territoire donné - la dynamique entrepreneuriale, tendent à mettre en place des stratégies pour fournir des ressources de manière globale. Le succès de certains lieux dynamiques tels que la Silicon Valley, Boulder Colorado ou la Route 126, connus sous le nom d'écosystèmes entrepreneuriaux, les inspire dans une tentative de réplique de leurs attributs et stratégies visibles. Mais les tentatives de réplique ne sont pas aussi simples qu'il n'y paraît (Maroufkhani, Wagner et Wan Ismail, 2018), et les connaissances actuelles sur les écosystèmes entrepreneuriaux présentent diverses faiblesses. La plupart des recherches qualitatives sont effectuées autour des facultés d'entrepreneuriat, et dans des zones assez abondantes en termes de ressources entrepreneuriales. Même si elles sont intéressantes, ces recherches présentent peu de variations en termes de contexte. Elles observent des phénomènes de niveau micro. La duplicabilité de ces recherches ne peut se faire par elle-même, en raison de la nature profonde de la recherche qualitative, et des résultats réels qui ne peuvent être généralisés, ni faire l'objet de propositions théoriques substantielles. En outre, la plupart des recherches quantitatives s'appuient sur des données économiques et macroéconomiques. Nous sommes confrontés à des

chaînon manquant en termes de recherche structurelle et processuelle à l'échelle locale ou nationale, probablement en raison de limites méthodologiques réelles.

Gouvernance et gestion de l'écosystème entrepreneurial

En conséquence, la nécessité de stimuler l'esprit d'entreprise soulève des préoccupations sur la gouvernance de l'écosystème entrepreneurial (Colombo et al., 2019), compte tenu de la complexité de coordonner les efforts d'acteurs multiples et indépendants, dans une stratégie complexe multi-agents (Cunningham, Menter et Wirsching, 2019) et multi-principes. La conséquence de la recherche actuelle est à la fois une compréhension au niveau macro de l'écosystème entrepreneurial, alimentée par l'analyse des données économiques, en tirant parti des éléments communs de l'EE (Stam et van de Ven, 2019), et une analyse au niveau micro des phénomènes locaux. Les moyens de gouvernance de l'écosystème entrepreneurial ne sont pas clairement définis aujourd'hui et devraient reposer sur la compréhension managériale et organisationnelle de l'écosystème entrepreneurial. Cependant, ces perspectives restent inexplorées en raison d'un manque de connaissances sur l'analyse structurelle et processuelle.

Intérêt théorique

La plupart des recherches sur les écosystèmes entrepreneuriaux sont orientées vers les données économétriques et l'observation qualitative (Theodoraki et al., 2022), ce qui en soi n'est pas suffisant pour susciter une analyse théorique intéressante (Sutton et Staw, 1995). Les critiques dans ce domaine de recherche visent à considérer que les objectifs des chercheurs pour observer ce phénomène sont soit trop larges, soit trop étroits pour analyser les écosystèmes entrepreneuriaux de manière managériale.

Ainsi, une bonne compréhension managériale de l'écosystème entrepreneurial conduirait les chercheurs à ouvrir des perspectives structurelles, car elles ont un fort potentiel théorique. Dans ce sens, nous pouvons déjà prévoir que l'écosystème entrepreneurial comprend un réseau de ressources qui a une influence sur ses résultats (Boje et Whetten, 1981). Une telle recherche nous permettrait alors de proposer des modèles sur la manière dont, à travers des configurations structurelles spécifiques, un Ecosystème Entrepreneurial stimule, plus ou moins, l'entrepreneuriat productif.

Sous cet angle, nous sommes amenés à comprendre quels sont les cadres organisationnels qui composent un Ecosystème Entrepreneurial. La recherche reconnaît généralement que les

écosystèmes entrepreneuriaux proposent, à travers diverses organisations telles que des incubateurs, des accélérateurs, des institutions et des acteurs dédiés, diverses ressources et services pour soutenir les entrepreneurs dans leurs efforts. Par conséquent, nous sommes amenés à observer les écosystèmes entrepreneuriaux dans une perspective interorganisationnelle (Galaskiewicz, 1985). Cette perspective offre un certain nombre de possibilités pour comprendre la structure de l'écosystème entrepreneurial.

L'analyse de la configuration structurelle de l'écosystème entrepreneurial ouvre également une autre perspective : la topologie (Bechky, 2020). La topologie, c'est-à-dire la manière dont les parties d'un écosystème entrepreneurial sont reliées entre elles ou disposées, peut ouvrir la voie à une analyse descriptive très intéressante et à une théorie de la topologie de l'écosystème entrepreneurial, en tant qu'effet des mesures économétriques de niveau macro ou en tant que cause des dynamiques entrepreneuriales connexes. Une telle recherche repose sur une bonne compréhension de ses composantes.

Au-delà de l'observation et de la description avec des lentilles renouvelées permises par une analyse configurationnelle et topologique appropriée, la perspective la plus attendue qui a le potentiel théorique et managérial de fournir les réponses attendues est une approche processuelle des écosystèmes entrepreneuriaux. Les tentatives effectivement proposées (Spigel et Harrison, 2018b), basées sur les éléments de l'écosystème entrepreneurial, n'ont pas encore fourni les résultats attendus. Par conséquent, un programme de recherche complet devrait être entrepris pour ouvrir cette perspective.

Comme le suggèrent les recherches précédentes sur la structure sociale et la forme interorganisationnelle (Tatarynowicz, Sytch et Gulati, 2016), l'approche que nous proposons dans la recherche sur l'écosystème entrepreneurial a le potentiel de fournir une structure archétypale très intéressante et une analyse de la dynamique des écosystèmes entrepreneuriaux. L'obtention d'une telle compréhension théorique de l'écosystème entrepreneurial permettrait de fournir des informations intéressantes sur les théories de l'encastrement, de l'écosystème et de l'entrepreneuriat, et permettrait de proposer une proposition théorique des sciences sociales sur les écosystèmes entrepreneuriaux, qui pourrait alimenter des propositions managériales.

Intérêt méthodologique

Comme nous l'avons présenté précédemment, les méthodes et théories actuelles de la recherche sur l'écosystème entrepreneurial présentent des limites. Afin de briser ce plafond de verre, nous proposons d'adopter une nouvelle approche de recherche, avec ses limites spécifiques. Cette recherche vise à ouvrir la boîte noire de l'analyse structurelle et processuelle de l'écosystème entrepreneurial, en adoptant une perspective relationnelle. Nous avons choisi de nous appuyer sur la théorie des réseaux, qui a le pouvoir de révéler les modèles structurels et processuels de l'écosystème entrepreneurial. Ce choix soulève de nombreux défis méthodologiques, et des questions de validité, en termes d'unité d'analyse, de variables et de mécanismes à observer, de source de données et de méthodes de mesure.

Unité d'analyse

Inspirée par les recherches récentes sur le cadre de recherche des réseaux et des écosystèmes (Shipilov et Gawer, 2020), la recherche orientée vers les sciences sociales sur l'écosystème entrepreneurial devrait adopter une analyse à grande échelle des écosystèmes entrepreneuriaux, par l'observation des organisations et des relations entre les personnes. Une telle recherche devrait clarifier les attributs de chaque composant observé, et la nature exacte de leurs relations. A notre connaissance, de telles analyses n'ont jamais été menées dans la recherche sur les écosystèmes entrepreneuriaux.

Variables et mécanismes

Sur la base de ces unités d'analyse, nous espérons ouvrir une recherche très intéressante sur les dépendances, complémentarités et goulots d'étranglement multilatéraux et multi-niveaux complexes qui se produisent dans les écosystèmes entrepreneuriaux, et dans quelle mesure ils sont liés aux résultats de l'EE. Cela ouvrirait également la voie à une analyse très intéressante de la structure de la collaboration, afin de comprendre les niveaux de coopération et de concurrence, et leur dynamique, en relation avec l'efficacité de leur influence sur les résultats de l'EE, et par exemple le retard observé entre les causes et les effets sur l'entrepreneuriat productif, et la satisfaction des entrepreneurs eux-mêmes. L'observation des mécanismes qui se produisent dans l'écosystème entrepreneurial a le potentiel de comprendre comment la gouvernance affecte les écosystèmes entrepreneuriaux, quelle est son évolution structurelle, quelle configuration est corrélée à quelle cause ou quel effet, tout ceci et au-delà ayant un intérêt important en ce qui concerne la contribution managériale de cette recherche.

Données et mesures

Une des dimensions les plus exigeantes de cette recherche est probablement la compréhension de la manière de mesurer la configuration structurelle, la topologie et la forme archétypale de l'écosystème entrepreneurial. La recherche suggère d'utiliser des référentiels d'acteurs de

l'écosystème entrepreneurial, ou de les créer s'ils n'existent pas. Et de fait, nous observons que peu de ces référentiels existent, ou sont loin d'être exhaustifs. Nous devrions également être amenés à réaliser des analyses de documents afin d'identifier les relations, ainsi que des entretiens avec des experts de l'écosystème entrepreneurial. La source de données de l'identification des relations n'est pas une tâche facile, car nous observons que la plupart des documents disponibles ne retracent pas suffisamment la quantité totale de relations entre les acteurs de l'EE. L'analyse basée sur les médias sociaux pourrait être intéressante, mais les liens qu'ils intègrent sont interpersonnels et sans signification. Nous devons identifier un moyen approprié pour détecter les liens inter-organisationnels entre les acteurs de l'écosystème entrepreneurial.

Naissance de la thèse et du programme de recherche

En 2018, le Global Entrepreneurship Monitor (GEM) a publié son rapport annuel marocain. À l'époque, et cela n'a pas beaucoup changé depuis, le Maroc présentait l'activité entrepreneuriale totale au stade précoce la plus faible de tout le continent africain (figure 2). En raison de l'importance de l'entreprenariat pour générer de la croissance (Carre et Thurik, 2003 ; Acs, 2006 ; Audretsch et al., 2006), une attention particulière est requise pour comprendre ce fait. Mais l'analyse et les explications de ce phénomène n'étaient pas vraiment convaincantes, et l'associé a recommandé une feuille de route qui n'est ni accessible pour un pays à faible revenu, ni susceptible de produire des résultats à court ou même à moyen terme. Et le Maroc n'est pas le seul pays, ni le seul territoire, dans le monde qui a besoin d'une stimulation entrepreneuriale, en particulier dans les endroits où le PIB par habitant est le plus bas.

Vivant au Maroc depuis 4 ans à l'époque, et connaissant la volonté des marocains de performer dans ce domaine, j'étais perplexe par ce manque de performance entrepreneuriale, et j'ai commencé à essayer de comprendre le "pourquoi" en confrontant les niveaux d'AET aux facteurs environnementaux du GEM publiés dans son profil pays. Une surprise est apparue en comparant ces niveaux à d'autres profils de pays africains : les facteurs environnementaux présentés à l'époque n'avaient pas de pouvoir explicatif en ce qui concerne l'activité entrepreneuriale initiale totale (TEA) du Maroc, ni ses niveaux de performances économiques (PIB par habitant), par rapport à d'autres pays africains. Il n'y avait aucune corrélation apparente entre toutes ces mesures. Apparemment, aucune analyse causale n'a pu être menée. Une question s'est alors posée avec force, et a initié mon parcours doctoral : "pourquoi (et comment) un territoire donné est plus propice à la dynamique entrepreneuriale qu'un autre ?".

Ayant cela en tête, la plongée profonde dans les rapports et articles scientifiques n'a pas éteint ma soif, mais la lecture d'un intéressant appel à contribution (Audretsch et al., 2018) m'a apporté la ferme conviction que cette question était largement ouverte et devait être approfondie. Sans ébranler la robustesse de la compréhension économique des écosystèmes entrepreneuriaux qui émergeait à l'époque (Stam et Spigel, 2016), il y a peut-être d'autres lentilles à adopter pour avoir une compréhension plus claire et plus directe des écosystèmes entrepreneuriaux. Leurs comportements, afin de pouvoir voir différemment ce qui est la cause et ce qui est la conséquence concernant le phénomène de l'Ecosystème Entrepreneurial, devraient être analysés. À cette époque, la littérature sur le sujet était en plein essor et entrainait en phase d'expansion (Theodoraki, Dana et Caputo, 2022). Les articles publiés sont principalement des articles théoriques, des revues de littérature, des articles qualitatifs, des articles à méthodes mixtes pour un total de 72,2% des articles les plus cités. Les articles quantitatifs (26,1%) présentent principalement des données économétriques utilisant les bases de données GEM, GEI ou WorldBank. Presque aucun article n'a présenté d'articles quantitatifs orientés vers les sciences sociales, et ceux-là observaient principalement les startups et pas vraiment l'écosystème entrepreneurial lui-même. En outre, à cette époque, la recherche a reconnu que ce domaine de recherche nécessitait de nouvelles méthodologies pour explorer l'écosystème entrepreneurial en tant qu'ensemble organisationnel (Carayannis, Provan et Grigoroudis, 2016 ; Erina, Shatrevich et Gaile-Sarkane, 2017).

Adoptant un point de vue réaliste (Kuhn, 1957), et en raison de sa nature inter-organisationnelle et évolutive, l'EE peut être observé - en sciences sociales - sous diverses perspectives de théorie organisationnelle, telles que l'agence, le néo-institutionnel ou le réseau. En considérant la nécessité de parcimonie scientifique, en tenant compte de l'affirmation du scolar majeur que les écosystèmes entrepreneuriaux sont un ensemble relationnel (Spigel, 2017b), et après des débats riches et stimulants avec des spécialistes connus comme Frederic Delmar, la théorie des réseaux est identifiée comme l'angle le plus précis pour éclairer le phénomène de l'EE, offrant de nombreuses possibilités pour les recherches futures. C'est ici que ma thèse prenait forme, en plus d'une autre perspective à considérer : la modularité (Baldwin et Clark, 2000) proposée par mon directeur de recherche, Didier Chabaud.

Les entrepreneurs sont des joueurs de Lego, ouvrant une perspective de modularité

La grande idée pour soutenir cette compréhension de l'EE est que les entrepreneurs sont des joueurs de Lego. Ils ont besoin de "pièces" pertinentes pour construire leurs projets. Les acteurs de l'ERE sont les fournisseurs de ces pièces, offrant une forme d'"externalisation des processus d'entreprise" aux entrepreneurs de diverses manières et sous diverses formes. En ce sens, certains auteurs évoquent le concept d'affordance locale qui souligne cette perspective (Autio et al., 2018). En prenant au sérieux la métaphore de l'écologie dans la recherche sur l'écosystème entrepreneurial (Auerswald, 2015), notre hypothèse est que la précision, la diversité, la quantité et la disponibilité de ces pièces permises par une configuration de réseau appropriée est un facteur clé pour stimuler la dynamique entrepreneuriale dans un territoire donné. Ces pièces, que nous nommerons " Composantes de l'entretien entrepreneurial " (ENC), qui ne devraient pas être nommées " éléments " car ce terme désigne la compréhension des composantes économétriques des EE (Stam et van de Ven, 2019), ne sont pas réellement définies, mais sont décrites par parties dans divers articles.

Par conséquent, comment pourrions-nous définir la nature de ces composantes d'encouragement à l'entrepreneuriat ? Tout d'abord, nous devons nous rappeler que les entrepreneurs sont constamment à la recherche de ressources pour atteindre leurs objectifs, soit pour traverser la vallée de la mort entrepreneuriale, soit pour construire leurs entreprises par divers moyens (Spigel, 2017a). Ils seront bien sûr en quête de fonds financiers supplémentaires, mais pas seulement. Au-delà de leur rôle financier, on ne sait pas exactement quelle valeur ajoutée les acteurs de l'EE apportent aux entrepreneurs (Theodoraki et Messeghem, 2017). Mais diverses recherches soulignent que les entrepreneurs ont recours à des services de conseil ou d'accompagnement pour finaliser leur plan d'affaires, leur modèle économique, leur stratégie d'entreprise ou de marketing. Ils ont soit besoin de compléter leur processus d'innovation, d'organiser leur organisation et d'accéder aux bonnes ressources humaines. Ils ont aussi souvent besoin d'un soutien juridique et en matière de propriété intellectuelle - ce qui peut constituer un goulot d'étranglement - ou d'un accès à des installations et à des compétences de prototypage, pour tester leur premier produit ou service, ou - enfin - pour accéder à des opportunités commerciales et de vente. Pour tout cela, les jeunes entrepreneurs peuvent bénéficier de programmes de soutien (Buffart et al., 2020) proposés par des acteurs publics et internationaux, ou des consortiums d'intérêts (Theodoraki et Messeghem, 2015 ; Messeghem et al., 2020). Pour élaborer leurs projets entrepreneuriaux, les entrepreneurs utilisent la plupart du temps des techniques de bricolage (Baker et Nelson, 2005), en utilisant et en exploitant les ressources disponibles dans leur environnement. Par conséquent, le rôle de fournisseur de ressources des

acteurs de l'EE est un attribut essentiel de l'EE (Ratinho et al., 2020). Cela signifie également que l'abondance des ressources disponibles dans l'environnement général des entrepreneurs, indépendamment de l'EE, les rend moins dépendants d'une performance d'EE donnée.

Le portefeuille de l'étendue et de la profondeur des composantes de l'entretien entrepreneurial est une perspective peu explorée dans la littérature sur l'écosystème entrepreneurial, car les chercheurs se concentrent davantage sur la recherche aux niveaux macro et micro. Néanmoins, nous avons des preuves que le processus entrepreneurial lui-même dépend des affordances locales, de quelque nature qu'elles soient. Ils soulignent le rôle critique des technologies de pointe et des connaissances disponibles en tant que composantes de qualité pour atteindre la compétitivité entrepreneuriale dans un territoire donné (Autio et al., 2018 ; Song et al., 2022). Cela dit, la disponibilité des ressources pour les Entrepreneurs à travers les EE peut également être explorée dans une perspective de Resource Based View (RBV) (Freiling et Baron, 2017). Cette posture de recherche peut conduire à des résultats et des contributions théoriques et managériales intéressantes. La perspective RBV nécessite une meilleure compréhension de la ressource concernée, ainsi que des méthodes appropriées pour mesurer leur quantité disponible respective et leur utilisation dans une EE donnée.

La disponibilité des composantes du développement de l'esprit d'entreprise est également une perspective sous-explorée. Elle pourrait conduire à une perspective de capacités dynamiques (Bhattacharyya et Jha, 2015) qui pourrait être d'un certain intérêt pour les acteurs académiques et managériaux. En effet, les ressources disponibles, ou le stock de ressources, sont cruciales pour planifier une stratégie de soutien à l'entrepreneuriat. Il est particulièrement important et essentiel pour toute forme de stratégie de croissance et d'internationalisation (Harima, Harima et Freiling, 2020). Cette preuve est liée à la théorie de la complexité économique (Hidalgo et Hausmann, 2009) qui prend ses racines dans la capacité locale d'excellence, vue sous un angle international. Par conséquent, la disponibilité générale des CEN est essentielle pour soutenir l'esprit d'entreprise, mais au cœur d'une telle stratégie devrait se trouver la recherche de l'excellence territoriale afin - pour un écosystème entrepreneurial - d'être compétitif au niveau international.

Ces perspectives soulignent le rôle critique de la qualité, de la quantité et de la disponibilité de la composante de soutien à l'entrepreneuriat sur un territoire donné. Mais cela soulève la question de savoir comment de tels composants devraient être créés, générés et distribués.

Les acteurs de l'écosystème entrepreneurial fournissent des "composantes de soutien à l'entrepreneuriat".

La métaphore du joueur de lego est intéressante mais par nature incomplète. Cette métaphore suggère que le projet entrepreneurial peut être construit avec des "briques", ce qui - si l'on considère par exemple la perspective de la chaîne de valeur ou de la modularité - est un concept pertinent. Mais dans le cas d'un projet entrepreneurial, ces briques peuvent servir à construire les entrepreneurs eux-mêmes, leur équipe et leurs compétences, leur innovation, leur modèle économique, leur produit ou service, le financement de leur projet, et leur organisation elle-même. C'est ici qu'apparaissent l'importance et la pertinence de la recherche sur l'écosystème entrepreneurial, en tant que fournisseur de composantes de soutien à l'entrepreneuriat. Mais pas seulement.

La recherche sur l'écosystème entrepreneurial en bref

Le concept d'écosystème entrepreneurial trouve ses racines historiques dans l'approche schumpétérienne liée à l'entrepreneuriat et à son soutien (Henrekson et Sanandaji, 2019). Il est intéressant de noter que l'approche schumpétérienne souligne la sélection naturelle dans la population des nouvelles entreprises, faisant un lien naturel avec l'approche écologique des Ecosystèmes Entrepreneuriaux. L'infrastructure pour l'entrepreneuriat, ancêtre du concept d'écosystème entrepreneurial, est née avec le travail séminal de Van de Ven (Van De Ven, 1993). Van de Ven souligne les lentilles de macro-niveau utilisées pour cette observation, et diverses propositions intéressantes liées au processus entrepreneurial et aux dépendances latérales. Plus tard, d'intéressantes perspectives connexes sont apparues, telles que les clusters, les districts industriels, les écosystèmes innovants, les écosystèmes commerciaux (Digiovanna, 1996) qui, paradoxalement, par rapport à la façon dont l'EE est considérée comme un concept distinct, fait en fait partie d'un courant général de recherche visant à observer et à expliquer comment les territoires excellent de diverses manières, avec une hypothèse de dépendance multilatérale. Plus récemment, l'écosystème entrepreneurial a émergé par lui-même dans une tentative de comprendre comment lancer une révolution entrepreneuriale (Isenberg, 2010).

Cette approche a d'abord suscité des doutes quant au cadre conceptuel de l'EE, mais elle a progressivement été acceptée par la communauté scientifique, avec un nombre croissant d'articles publiés dans des revues scientifiques de premier plan (Theodoraki, Dana et Caputo, 2022). Néanmoins, au sein de la communauté des chercheurs en EE, des critiques sont

apparues, pointant du doigt un courant de recherche théorique émergent mais sous-développé (Spigel, 2017b ; Wurth, Stam et Spigel, 2021). Depuis 2017, la recherche en EE est désormais considérée comme étant dans sa phase d'expansion rencontrant l'acceptation de la communauté académique. Mais l'efficacité de l'EE n'est pas réellement prouvée (Theodoraki, Messeghem et Audretsch, 2020) et soulève des préoccupations majeures dans la recherche.

Les concepts d'EE prennent leur place dans une autre façon de voir le monde, les métiers et les affaires (Moore, 1996) dans une manière multilatérale et écosystémique de faire des affaires. Les interdépendances profondes sont désormais considérées, que ce soit sous l'angle économique, international ou managérial. En ce sens, les écosystèmes sont des éléments d'une économie libérale, constituée de réseaux interorganisationnels (Benson, 1975) qui soutiennent les efforts entrepreneuriaux. Il souligne l'importance des échanges multilatéraux entre les organisations de l'EE pour soutenir l'esprit d'entreprise. L'objet de ces échanges étant les composantes du développement de l'esprit d'entreprise et leur élaboration. Sous ces angles, les chercheurs sont amenés à plonger dans les perspectives des sciences sociales afin de mieux comprendre les acteurs de l'ERE, leurs relations et leurs transactions.

Définition floue des acteurs de l'EE

Selon cette perspective, une meilleure compréhension de qui appartient à un écosystème entrepreneurial, comment et pourquoi, est essentielle pour l'observation scientifique. Tout d'abord, la recherche reconnaît que ces acteurs font partie d'un écosystème (Adner, 2017), qui est une Structure par elle-même, une structure inter-organisationnelle et inter-personnelle. Nous savons également que les EE et leurs acteurs sont ancrés dans des lieux et des territoires particuliers (Boutillier, Carré et Levratto, 2016), ce qui est lié aux perspectives d'affordances spatiales des EE (O'Connor et al., 2018).

Nous savons également, en particulier, que les incubateurs et les accélérateurs sont des acteurs clés de l'EE (Goswami, Mitchell et Bhagavatula, 2018), et que leur rôle est essentiel pour soutenir l'entrepreneuriat. Leur rôle est partiellement dévoilé par la recherche (Purbasari, Wijaya et Rahayu, 2020b) avec la première tentative de mobiliser les méthodes de réseau dans la recherche en EE. Cependant, les attributs des acteurs de l'EE ne sont pas encore clairs au-delà de leur soutien financier ou non financier aux efforts entrepreneuriaux.

Proposition de valeur des acteurs de l'EE

Pour mieux comprendre le rôle des acteurs de l'EE, nous sommes amenés à mieux comprendre leur proposition de valeur.

Tout d'abord, qui est en fait une perspective historique dans la recherche en EE, la perspective de la triple hélice souligne le rôle des acteurs éducatifs pour soutenir l'entrepreneuriat dans une EE (Guerrero et Urbano, 2017 ; Purbasari, Wijaya et Rahayu, 2020a). Cette perspective, alignée sur la perspective relationnelle des EE, tend à étudier l'efficacité de l'activité et de la collaboration des Universités ou des Écoles pour stimuler la dynamique entrepreneuriale des étudiants (Brem et Radziwon, 2017), plaçant l'Éducation comme pilier de la recherche en EE, adossée au courant et au cadre de recherche dominant en EE, pour irriguer l'EE en Connaissances.

Le renforcement des capacités est également fréquemment mentionné dans la littérature sur l'entrepreneuriat (Nwazor, 2012 ; Karmokar, 2019 ; Towers et al., 2020) mais étonnamment rarement évoqué dans la littérature sur l'EE elle-même. Néanmoins, certaines recherches ciblées sur les acteurs de l'ERE, tels que les incubateurs, en tant que fournisseurs de renforcement des capacités (Theodoraki, Messeghem et Audretsch, 2020) soulèvent diverses questions intéressantes telles que leur rôle précis dans le processus entrepreneurial (Peters, Rice et Sundararajan, 2004). Le renforcement des capacités est également considéré comme le rôle des programmes de soutien à l'entrepreneuriat principalement proposés par les programmes gouvernementaux et les institutions locales. Le renforcement des capacités intervient principalement dans les phases de naissance de l'entreprise.

Les articles qualitatifs soulignent également que le capital social (Light et Dana, 2013) est une ressource essentielle pour les entrepreneurs. Il est également évoqué dans la littérature sur les EE (Theodoraki, Messeghem et Rice, 2018) comme une composante importante pour soutenir la dynamique entrepreneuriale. Le capital social est connu pour être un atout essentiel pour les entrepreneurs, et la recherche reconnaît que les acteurs financiers dans les EE se considèrent comme des fournisseurs de capital social plutôt que des fournisseurs de financement. Il en va de même pour les accélérateurs, qui utilisent leur capital social pour ouvrir des perspectives de marché aux nouvelles entreprises.

Les acteurs du soutien pratique tels que les fablabs (Osunyomi et al., 2016), les espaces de coworking (Gauger, Strych et Pfnür, 2021), et plus généralement les organisations de soutien à

la culture entrepreneuriale (Audretsch, 2020 ; Donaldson, 2021), comme les événements, les médias, les tiers lieux, les pépinières, les lieux dédiés, sont également considérés comme des acteurs de l'EE. En fait, ils fournissent des composantes intéressantes de développement de l'esprit d'entreprise. Les acteurs qui délivrent ces composantes sont la plupart du temps des organisations distinctes et spécialisées dans les EE.

Mis bout à bout, les types de composantes que sont la connaissance, le renforcement des capacités, le capital social et le soutien pratique, chacune étant fournie de préférence par un type d'acteur, peuvent nous permettre de proposer une compréhension structurelle synthétique des écosystèmes entrepreneuriaux (Fig. 3), qui est cohérente avec la proposition initiale de Van de Ven, et complémentaire avec la compréhension économique des EE qui domine depuis Isenberg.

Distribution des "Entrepreneurial Nurturing Components" (ENC)

Maintenant que les composantes de l'encouragement à l'entrepreneuriat sont comprises et que leurs principaux fournisseurs ont été désignés, un nouveau défi de recherche se pose : comment ces composantes sont-elles fournies aux entrepreneurs ? C'est également une perspective peu explorée dans la recherche sur l'EE qui nous amène à soulever des préoccupations théoriques (Nayak, 2008). En raison de la nature des EE, de leur échelle, de la diversité de leurs acteurs et de leurs composantes, l'élaboration d'un cadre théorique applicable nécessite de s'appuyer sur la théorie de la complexité (Larsen-Freeman, 2012), qui utilise des représentations symboliques pour mieux comprendre le phénomène complexe que nous tentons de saisir.

Dans notre compréhension du phénomène de l'écosystème entrepreneurial, la création de connaissances (Bathelt, Malmberg et Maskell, 2004) est considérée comme un fondement de la dynamique entrepreneuriale. Cette perspective fait référence aux capacités de transfert de connaissances sur un territoire donné et à la diffusion effective de ces connaissances opérée par les acteurs intégrés dans les EE. Ce processus est essentiel dans la recherche sur l'EE car les chercheurs reconnaissent, à travers la perspective de la construction créative (Agarwal, Audretsch et Sarkar, 2007), que l'entrepreneuriat nécessite une circulation active des connaissances.

Les acteurs essentiels de l'écosystème entrepreneurial, tels que les incubateurs, jouent un rôle central dans le processus entrepreneurial (Peters, Rice et Sundararajan, 2004), mais ne sont

qu'une partie de l'ensemble du système qui soutient l'entrepreneuriat sur un territoire donné. Néanmoins, ils sont connus pour être un relais de transfert de connaissances, ainsi que de renforcement des capacités, ayant un impact mesurable sur le parcours entrepreneurial des nouvelles entreprises qu'ils soutiennent, à travers les services qu'ils fournissent en termes de coaching et de formation. Mais une telle recherche en profondeur sur les attributs réels de chaque type d'acteurs dans l'écosystème entrepreneurial n'est pas encore explorée, et devrait d'abord nécessiter une compréhension plus profonde de la configuration de l'écosystème entrepreneurial avant d'étudier les attributs des acteurs de l'écosystème entrepreneurial.

Structure de l'écosystème entrepreneurial

Les recherches précédentes suggèrent la nature relationnelle des écosystèmes entrepreneuriaux (Spigel, 2017), mais étant donné cette hypothèse, que nous dit la recherche sur sa nature relationnelle structurelle ? À notre connaissance, et au vu des dernières revues de la littérature (Theodoraki et al., 2022), la recherche ne fournit pas de réponses directes à cette question. La recherche interorganisationnelle suggère une structure basée sur la communauté ou sur la distance. Dans le cas de l'écosystème entrepreneurial, sa structure est par définition liée à un territoire particulier, ce qui rend sa structure orientée vers la communauté. La littérature sur les clusters, tels que les clusters d'innovation, même si ces clusters ne sont pas principalement basés sur le lieu, mais sur la spécialité ou la fonction, suggère des types d'organisation basés sur leurs complémentarités pour élaborer des chaînes de valeur spécifiques. Les approches portériennes sur la chaîne de valeur ont également été appliquées à la recherche interorganisationnelle sur l'innovation ouverte, ce qui confirme cette complémentarité des fonctions détenues par les collaborations interorganisationnelles. Des résultats similaires sont trouvés dans la recherche sur les districts industriels. Appliqué à l'écosystème entrepreneurial, nous sommes amenés à comprendre sa structure par des liens interorganisationnels orientés vers les fonctions.

Dans les écosystèmes entrepreneuriaux, nous pouvons trouver des organisations, des acteurs, qui ont des fonctions archétypales, telles que les fonds d'investissement, les incubateurs, les accélérateurs, les universités entrepreneuriales, les espaces de co-working, les pépinières de startups, les business angels, etc. On pourrait dire que certains acteurs proposent diverses fonctions, et certaines d'entre elles en dehors de leur mission principale. Par exemple, certains fonds d'investissement proposent des services d'accélération. Néanmoins, chaque type d'acteur assure avant tout sa mission principale. Cela signifie que pour observer correctement la structure et la configuration structurelle de l'écosystème entrepreneurial, nous devons à la fois

répertorier les organisations de l'écosystème entrepreneurial et vérifier leurs fonctions. Pour suivre le cadre proposé précédemment (Figure 3), le chercheur doit vérifier la distribution verticale des fonctions entre les incubateurs et les accélérateurs, les institutions publiques dédiées et les organismes de financement privés ; et la distribution horizontale des fonctions entre les incubateurs et les institutions publiques dédiées, les accélérateurs et les organismes de financement privés.

La compréhension des relations inter-organisationnelles et des complémentarités de fonctions qui forment la structure des écosystèmes entrepreneuriaux, une structure permettant une distribution efficace des ressources disponibles aux entrepreneurs, doit inclure une liste détaillée des acteurs, de leurs attributs en termes de fonctions, et de leurs liens afin d'analyser leurs relations, leurs communautés, leurs complémentarités et leurs interdépendances. Cette approche s'éloigne du cadre de recherche de référence actuel, héritage de la proposition d'Isenberg.

Configurations structurelles de l'écosystème entrepreneurial

Les différentes formes de configurations de l'EE n'ont que récemment attiré l'attention des chercheurs, mais restent pour la plupart peu explorées. De telles observations pourraient, par exemple, éclairer les causes des capacités d'innovation dans des territoires donnés (Khedhaouria et Thurik, 2017). Seules quelques recherches évoquent les configurations d'EE, soulignant le tropisme de la recherche sur les lieux pratiques, et l'intérêt d'une compréhension configurationnelle de l'EE qui permettrait - avec suffisamment de données - de proposer un cadre théorique de sciences sociales des EE (Alves et al., 2019). Ce courant de recherche suggère également une relation réelle entre la structure configurationnelle de l'EE et l'efficacité de ses retombées en termes de dynamique entrepreneuriale (Cherubini Alves, Fischer et Vonortas, 2021).

Théorisation des configurations structurelles de l'écosystème entrepreneurial

A chaque étape de notre présentation de la recherche sur l'écosystème entrepreneurial, nous sommes confrontés à des perspectives sous-explorées. Certaines sont des débats ouverts au sein de la communauté de recherche sur l'EE, comme ceux qui ont eu lieu pendant l'école d'hiver de l'Université d'Utrecht en janvier 2022, au cours desquels les chercheurs ont voté de manière consensuelle en faveur d'un approfondissement de la recherche configurationnelle, en réseau ou longitudinale dans le domaine de la recherche sur l'EE.

Les chercheurs s'intéressent en fait à l'observation des causes de la réussite des EE, ainsi qu'aux processus ayant un impact sur les retombées de l'EE. Ils s'intéressent particulièrement à la configuration qui est plus bénéfique à un résultat d'EE donné qu'à un autre, ainsi qu'à la compréhension de la gouvernance / des causes institutionnelles de ces configurations, notamment dans une perspective relationnelle.

La perspective des réseaux retient également l'attention des chercheurs, ainsi que les processus connexes qui se produisent dans les écosystèmes entrepreneuriaux. Ils reconnaissent également la porosité des EE et s'interrogent sur la manière dont un EE attire les talents et la mobilité des personnes entre les EE. En mesurant le réseau, on s'interroge sur sa santé, sa robustesse et sa maturité, en observant les communautés, les modalités de collaboration, la formation des liens et leur force. Les EE étant ancrées dans des lieux particuliers, les configurations spatiales retiennent également l'attention. Les liens et les transactions entre les EE, ainsi que les interactions entre les sous-écosystèmes, sont la première perspective à se dessiner. La localisation des acteurs, des activités et des retombées est également en question afin de plonger dans les affordances spatiales et leurs retombées, ouvrant ainsi la voie à une perspective topologique.

Le temps est également considéré comme un facteur clé dans la recherche sur l'EE. Le plus grand intérêt est de trouver des moyens de recherche appropriés pour mesurer l'évolution des interactions au sein des EE et comprendre la dynamique structurelle des EE. D'autres perspectives sont ouvertes, comme la compréhension de l'impact dans le temps des politiques d'EE. D'autres perspectives liées au temps, telles que la mesure des variations des délais du processus entrepreneurial, la croissance d'une EE, la persistance des liens dans les EE et la rapidité du capital social dans les EE, attirent l'attention des chercheurs. Une perspective évolutionniste de l'EE se pose avec des préoccupations sur les étapes de l'évolution de l'EE, les interactions à plusieurs niveaux, ainsi que les dynamiques et les relations inter-écosystèmes et intra-écosystèmes.

La gouvernance est également une préoccupation centrale, en particulier dans la compréhension des différents types de gouvernance et de leur impact, dans le cadre de différents sous-flux de recherche : la mesure de l'impact des politiques, l'impact des politiques d'investissement, et toute autre perspective longitudinale concernant la gouvernance et la politique d'EE. La

structure du pouvoir est également prise en compte ainsi que son impact, le niveau de démocratie, les communautés, les leaders et leur centralité.

De nombreuses autres préoccupations existent dans la recherche sur l'EE, telles que l'impact de la politique d'EE sur sa configuration, une perspective d'"échec" pour comprendre les causes des échecs, trouver des mesures et des données appropriées pour mesurer l'EE et les retombées à différents niveaux, le leadership dans les EE.

Une perspective configurationnelle des écosystèmes entrepreneuriaux mobilisant la théorie des réseaux

Nous savons maintenant que l'EE est une structure relationnelle sous-explorée (Spigel, 2017b), qui attire l'attention des chercheurs actuels. En conséquence, nous sommes amenés à mobiliser la théorie des réseaux comme une perspective centrale pour observer et analyser les EE.

L'héritage de la théorie des réseaux

La théorie des réseaux (Borgatti et Haglin, 2011) et la perspective connexe de l'intégration (Uzzi, 1997) sont apparues il y a 25 ans, produisant des recherches intéressantes dans le domaine des réseaux sociaux et - plus près de notre sujet - dans la perspective des réseaux inter-organisationnels (Evan, 1965 ; Benson, 1975 ; Wooten et Sacco, 2017). La recherche reconnaît que la structure, la configuration et les attributs des réseaux et sous-réseaux, les clusters, les trous structurels et de nombreux autres attributs des réseaux, par l'observation des liens et des associations dyadiques (Dahlander et McFarland, 2013), ont un impact mesurable sur les résultats et les retombées des réseaux.

La théorie des réseaux est également intéressante en ce qui concerne la perspective du capital social intégrée dans le cadre de recherche de l'écosystème entrepreneurial. Au-delà de la compréhension structurelle de l'EE, la théorie des réseaux peut également être mobilisée pour mieux comprendre les relations causales avec le processus entrepreneurial lui-même, en tirant parti des attributs du capital social, liés aux capacités des réseaux de l'EE.

Un écosystème entrepreneurial est une structure inter-organisationnelle.

En suivant le cadre de recherche de la théorie des réseaux (Shipilov et Gawer, 2020), nous devons mieux comprendre les composants du réseau de l'EE. Nous pouvons définir comme nœuds de réseau les individus ou les organisations (ou les deux), et considérer les différentes couches de réseaux présents dans les EE. En ce qui concerne l'objet transactionnel - les composantes du développement entrepreneurial - nous prévoyons que le niveau de réseau le

plus précis et le plus important dans les écosystèmes entrepreneuriaux est son réseau inter-organisationnel. A partir de ce point de départ, nous comprenons que les écosystèmes entrepreneuriaux sont des structures inter-organisationnelles. Chaque organisation au sein de l'écosystème entrepreneurial peut être considérée comme un nœud, leurs relations comme des sommets. Les organisations de l'écosystème entrepreneurial établissent diverses formes de liens, formels et informels, sous forme de collaborations variées pour soutenir les entrepreneurs ou les nouvelles entreprises.

Cette compréhension de l'écosystème entrepreneurial sous l'angle du réseau ouvre la voie à de nombreux moyens d'observation et de mesures intéressants, tels que les attributs de base du réseau : la densité, la centralité (et ses nombreuses sous-mesures), les mesures de distance moyenne, les mesures de regroupement, les mesures de poids moyen, et bien d'autres encore. Des mesures longitudinales de l'écosystème entrepreneurial ouvrant des perspectives écologiques. Toutes ces perspectives n'ont pas été étudiées avant que nous ne commencions notre courant de recherche.

Une perspective de modularité dans la recherche sur les écosystèmes entrepreneuriaux

En sciences sociales, les attributs et la dynamique des réseaux sont liés à des attributs intéressants en termes de connaissances, de collaboration, de mobilité, d'accessibilité de diverses ressources disponibles dans une structure donnée. Ces ressources, les composantes de l'épanouissement entrepreneurial, sont mises à la disposition des entrepreneurs par le biais des attributs de réseau de l'EE. Pourquoi est-ce important ?

Configurations uniques des Entrepreneurial Nurturing Components : L'unicité entrepreneuriale

La recherche reconnaît que la différenciation est un facteur clé de la performance des startups (Jalali, Jaafar et Ramayah, 2014). Cette différenciation est atteinte par une proposition de valeur unique pour le consommateur final, qui peut être trouvée avec une combinaison appropriée d'innovation, de chaîne de valeur et de modèle économique. Ce caractère unique est élaboré la plupart du temps par le biais du bricolage (Ghezzi, 2019) en utilisant des ressources saisies par les entrepreneurs principalement dans leur environnement direct, et au-delà. En conséquence, ces configurations uniques de ressources forment la différenciation de l'entreprise sur le marché. La capacité des entrepreneurs à se différencier dépend de leur propre projet, mais elle est soutenue par la qualité, la quantité et la disponibilité de ces ressources : Les composantes de l'entretien entrepreneurial.

Dans une perspective de capacités dynamiques, la combinaison, la configuration et l'utilisation uniques des ressources disponibles permettent à une organisation d'obtenir un avantage concurrentiel (Teece, 2007). Comme les nouvelles entreprises sont des organisations internes naissantes, leur quête de différenciation repose en grande partie sur des ressources externes de différents types, mises à disposition par et à travers le réseau inter-organisationnel de l'écosystème entrepreneurial.

Composantes du développement entrepreneurial, écosystèmes entrepreneuriaux et modularité
La modularité a été soulevée en relation avec l'orientation entrepreneuriale (Bouncken, Lehmann et Fellnhofner, 2016), démontrant comment les composantes de l'entrepreneuriat soutiennent la fonction essentielle pour soutenir la proposition de valeur globale d'une nouvelle entreprise donnée. Ce faisant, l'entreprise finale est une combinaison optimale de ces composantes, produisant une valeur ajoutée.

La perspective de la modularité indique que les "modules" disponibles doivent être standard, seule une combinaison unique et spécifique de ces modules crée de la valeur pour le consommateur final. Pour créer une nouvelle entreprise performante, c'est une combinaison unique des composantes de l'incubation entrepreneuriale qui crée la valeur de l'entreprise. Ces composants doivent être standardisés, seule une combinaison spécifique et unique de ceux-ci crée la différenciation.

Par conséquent, le dynamisme de l'environnement entrepreneurial, par le biais de l'écosystème entrepreneurial, permet de fournir un portefeuille suffisant de composantes de développement entrepreneurial, sous forme de "modules" standard, pour permettre aux entrepreneurs d'élaborer des nouvelles entreprises uniques et distinctives. La disponibilité de ces composants, rendue possible par une configuration optimale de l'écosystème entrepreneurial ou une abondance particulière de ressources, est propice à la dynamique entrepreneuriale.

Enfin, la compétitivité mondiale des nouvelles entreprises émergeant d'un écosystème entrepreneurial donné dépend de son portefeuille de composantes de soutien à l'entrepreneuriat, de sa disponibilité, de sa diversité et de sa qualité. Et en raison de la nécessité de s'adapter et d'être agile dans un environnement compétitif mondial, la capacité de l'écosystème entrepreneurial à fournir un portefeuille large et profond d'ENCs permet aux nouvelles entreprises de s'adapter plus rapidement et plus précisément.

Les nouvelles entreprises en tant que résultats des écosystèmes entrepreneuriaux

Le plus souvent, l'écosystème entrepreneurial est défini comme "un ensemble d'acteurs et de facteurs interdépendants qui sont régis de telle manière qu'ils permettent un entrepreneuriat productif sur un territoire donné" (Leendertse, Schrijvers et Stam, 2021). Les nouvelles entreprises, et en particulier les entreprises productives, sont le résultat des écosystèmes entrepreneuriaux et sont alimentées par les ressources mises à disposition par les EE : Entrepreneurial Nurturing Components.

Le pouvoir explicatif de cette approche

L'intérêt de cette approche repose sur son pouvoir explicatif. La théorie des réseaux, même dans une perspective inter-organisationnelle, est une approche théorique parcimonieuse et puissante ; combinée à la perspective de la modularité, elle permet à la fois d'observer et d'analyser les configurations des EE. Grâce à la modularité, nous pouvons également comprendre l'impact de l'EE sur l'entrepreneuriat productif. Cette perspective correspond à la compréhension relationnelle réelle des écosystèmes entrepreneuriaux et à l'analyse des processus entrepreneuriaux. Elle permet également d'élaborer des études longitudinales pour une perspective évolutive. Grâce à la compréhension des ENC, il est possible de soulever la RBV appliquée au processus entrepreneurial. Tout cela combiné ouvre des perspectives intéressantes dans la recherche sur l'EE.

Qu'est-ce qui est cause, qu'est-ce qui est effet dans notre compréhension de la recherche sur l'écosystème entrepreneurial ?

Les retombées de l'écosystème entrepreneurial sont une variable dépendante.

Le résultat de l'EE est, au premier stade, l'entrepreneuriat productif et, indirectement, le bien-être (Wurth, Stam et Spigel, 2021). La plupart du temps, les chercheurs se concentrent sur l'entrepreneuriat productif pour mesurer les retombées de l'écosystème entrepreneurial. Et ces retombées peuvent être de différents types : connaissance, croissance, bien-être, création d'emplois, création de nouvelles entreprises, etc.

La dynamique entrepreneuriale (Gartner et al., 2004) est une approche processuelle de la création de nouvelles entreprises, dirigée par des entrepreneurs. Au-delà des différents aspects de la dynamique entrepreneuriale, il existe une relation étroite entre la dynamique entrepreneuriale et l'écosystème entrepreneurial dans lequel elle s'inscrit. Les EE sont des

facilitateurs, des stimulateurs, des générateurs de la dynamique entrepreneuriale, utilisant toutes sortes de moyens pour atteindre cet objectif, la dynamique entrepreneuriale est une retombée des écosystèmes entrepreneuriaux.

Mesurer la dynamique entrepreneuriale

Les chercheurs utilisent actuellement différents ensembles de données et mesures pour évaluer la dynamique entrepreneuriale sur un territoire donné. La mesure la plus couramment acceptée et la plus pertinente dans la communauté des chercheurs est l'activité entrepreneuriale totale au stade initial (Peris-Ortiz, Ferreira et Fernandes, 2018), avec la mesure complémentaire de l'entrepreneuriat induit par les opportunités (Nicotra et al., 2018), parmi d'autres, comme l'indice de développement mondial de la Banque mondiale, le Forum économique mondial, l'indice mondial de l'entrepreneuriat et du développement, les indicateurs de l'OCDE, la base de données Eurostat, la base de données Espon ou l'indice de compétitivité régionale de l'UE.

Paradoxes de la dynamique entrepreneuriale et des mesures de l'écosystème

Mais une surprise surgit ici : la dynamique et les écosystèmes entrepreneuriaux sont des phénomènes locaux qui peuvent être observés à l'échelle d'une ville ou d'une région, comme la Silicon Valley, Boulder Colorado ou la Route 126. Les mesures disponibles, en fait, sont proposées au niveau national. Cela représente un goulot d'étranglement pour la recherche sur l'EE, qui peut être résolu en localisant les mesures de type TEA, avec des approches par ensembles de données orientées NUTS (Leendertse, Schrijvers et Stam, 2021).

L'écosystème entrepreneurial comme cause des niveaux de dynamique entrepreneuriale

Néanmoins, l'écosystème entrepreneurial, en tant que structure globale, est une cause de la dynamique entrepreneuriale, car les EE fournissent un soutien et des ressources pour soutenir le processus et l'activité entrepreneuriale sur leur territoire. D'autres facteurs environnementaux peuvent être impliqués, mais l'EE a un impact direct et un effet mesurable sur la dynamique entrepreneuriale.

Mesurer un écosystème entrepreneurial dans son ensemble

Pourtant, seules des mesures économétriques sont proposées pour mesurer un écosystème entrepreneurial dans son ensemble. Ces mesures sont fournies par le programme central actuel de recherche sur l'EE (Fig. 4) qui suggère que dix éléments (Stam et van de Ven, 2019) sont constitutifs de l'écosystème entrepreneurial : les réseaux, le leadership, les finances, le talent, les connaissances, les services de soutien / intermédiaires, les institutions formelles, la culture et les institutions formelles. Cette conception des écosystèmes entrepreneuriaux, comme mentionné précédemment, prend ses racines dans la proposition séminale d'Isenerg.

Attributs des écosystèmes entrepreneuriaux

Les mesures proposées dans la Théorie des Réseaux, telles que présentées précédemment, sont connues, et leur signification dans la recherche inter-organisationnelle, définie (Shipilov et Gawer, 2020). Nous proposons trois ensembles de mesures, chacune ayant un pouvoir explicatif spécifique.

Tout d'abord, nous proposons le facteur de diffusion de l'information et des connaissances dans l'écosystème entrepreneurial (Purbasari, Wijaya et Rahayu, 2020b) comme mesure clé pour comprendre le degré de connaissance de l'entrepreneur des ressources disponibles existant dans un écosystème entrepreneurial donné. Il s'agit d'un attribut fondamental car il constitue le fondement de la capacité de modularité d'un écosystème entrepreneurial. On sait également que l'information et la connaissance sont liées à la capacité d'innovation et de productivité d'un écosystème entrepreneurial (Agarwal, Audretsch et Sarkar, 2007 ; Kuebart et Ibert, 2019 ; Audretsch et Belitski, 2020). Ce facteur peut être mesuré en utilisant à la fois des mesures de centralité et de densité du réseau qui peuvent être fusionnées dans un facteur de Cohésion.

Deuxièmement, la modularité requiert l'accessibilité de ses composants (Camarinha-Matos et Afsarmanesh, 2018). L'accessibilité arrive en deuxième position car les entrepreneurs n'économisent pas leurs efforts ou leur énergie pour acquérir une ressource critique, mais un faible niveau d'accessibilité peut représenter un obstacle à la réalisation des objectifs entrepreneuriaux. Cette mesure d'accessibilité peut être atteinte par la mesure du poids moyen d'un réseau, qui peut être associée à son niveau d'interconnectivité.

Enfin, un écosystème entrepreneurial bien organisé peut être mesuré par l'intensité de la collaboration entre ses acteurs (Xu, Yan et Xiong, 2019). Il s'agit également d'une mesure importante car elle révèle la culture de collaboration ou de coopération par rapport à la compétition qui se produit dans un Écosystème entrepreneurial. De faibles niveaux de collaboration peuvent avoir un impact négatif sur la dynamique entrepreneuriale. La collaboration peut être évaluée par des mesures de distance, telles que le chemin le plus court moyen, le coefficient de regroupement ou la distance moyenne.

Ces trois ensembles de mesures sont destinés à ouvrir cette perspective de la modularité des réseaux, car la théorie des réseaux intègre un nombre impressionnant de méthodes, d'outils et de méthodes analytiques qui peuvent être exploités dans ce domaine de recherche.

Comparer l'écosystème entrepreneurial : un défi

Un seul écosystème entrepreneurial peut être difficile à mesurer, car la théorie des réseaux exigerait alors d'identifier correctement chacun de ses acteurs (nœuds) et de ses liens inter-organisationnels (vecteurs). Mais un autre défi, qui est en fait connu dans la recherche actuelle sur l'écosystème entrepreneurial au niveau macro, est la comparabilité entre les écosystèmes.

Tout d'abord, la collecte de données est judicieuse. Chaque zone géographique, chaque culture, chaque système local a sa propre compréhension d'une donnée donnée. Deuxièmement, si les biais peuvent être homogènes au sein d'un territoire donné, il est peu probable que ce soit le cas entre différents territoires. Troisièmement, chaque configuration d'écosystème entrepreneurial a ses propres spécificités structurelles, en fonction de son histoire, de sa culture de collaboration, de sa gouvernance et de son pouvoir, et de ses attributs spécifiques de dynamique entrepreneuriale.

En conséquence, toute conception de recherche visant à comparer les écosystèmes entrepreneuriaux afin d'être en mesure de les comparer quantitativement, ou en utilisant des méthodes de cas, devrait fortement inclure une approche de réduction des biais, afin de sélectionner initialement les territoires les plus comparables, ou de réduire a posteriori l'hétérogénéité des données.

Un champ de recherche basé sur le lieu

L'écosystème entrepreneurial est un phénomène lié au lieu (Maroufkhani, Wagner et Wan Ismail, 2018) dans lequel la distance joue contre la dynamique entrepreneuriale car elle est liée au coût de l'entrepreneuriat (Roundy et Fayard, 2020). La densité spatiale est, par conséquent, un attribut essentiel de l'écosystème entrepreneurial. Cela souligne également qu'en raison de son attribut géographique, chaque écosystème entrepreneurial est unique (Cowell, Lyon-Hill et Tate, 2018) et ne peut être reproduit tel quel. La portée géographique de la recherche sur l'écosystème entrepreneurial est par conséquent très spécifique pour comprendre sa performance (Feldman, 2014).

En plus de l'observation inter-écosystème entrepreneurial mentionnée précédemment, il y a sa portée géographique, afin de comparer ce qui peut être comparé. Il devrait être tout à fait accessible de comparer l'écosystème entrepreneurial au niveau national, lorsque nous rencontrons un écosystème entrepreneurial unique et centralisé, mais ne doit pas être proposé

dans les pays développés ou les vastes zones géographiques, où vous trouvez de multiples écosystèmes entrepreneuriaux, et seulement des mesures au niveau national. La recherche sur l'écosystème entrepreneurial devrait être ciblée au niveau local, qui est plus pertinent par rapport aux niveaux nationaux, mais plus difficile à réduire les biais locaux liés à la taille et à la géographie de l'EE.

Rôle de l'écosystème entrepreneurial lorsque les niveaux de dynamique entrepreneuriale sont faibles

De nombreux chercheurs soulignent l'obsession de la recherche et des décideurs politiques pour les lieux de réussite entrepreneuriale, qui génèrent des niveaux importants d'entrepreneuriat productif. Mais comme ils sont limités en nombre, spécifiques en termes de géographie et d'autres attributs configurationnels. Par conséquent, il est hasardeux de les prendre en considération pour toute tentative de généralisation théorique.

Les lieux à faible dynamique entrepreneuriale sont en plus grand nombre, et sont le plus souvent liés à des lieux faibles qui peuvent être comparés par divers moyens. Mais en réalité, ces territoires attirent moins l'attention des chercheurs, car les articles qui s'y rapportent ont un potentiel de publication plus faible en termes de classement des revues ou de citations.

Néanmoins, les lieux à faible niveau de dynamique entrepreneuriale présentent un intérêt scientifique substantiel. Les faibles niveaux de dynamique entrepreneuriale sont le plus souvent rencontrés dans des environnements à faibles ressources, tels que les pays ou régions à faible revenu. Des ressources moins abondantes dans l'environnement sont liées à une plus faible dynamique entrepreneuriale. Mais dans ces territoires, avec - par exemple - des niveaux de PIB par habitant comparables, la dynamique entrepreneuriale mesurée par les niveaux de TEA, par exemple, peut combler des lacunes intéressantes. Dans ces endroits, des mesures systématiques de l'écosystème entrepreneurial ont le potentiel de révéler ce qui affecte les niveaux de dynamique entrepreneuriale et comment ils sont affectés.

Pour relever le défi de cette recherche, nous nous sommes lancés dans un programme de recherche, dont 5 des 13 premiers papiers sont présentés ci-après et fondent une approche originale de la mesure des écosystèmes entrepreneuriaux, fournissant ainsi des analyses nouvelles et originales susceptibles d'ouvrir d'intéressantes nouvelles perspectives au sein de ce champ de recherche.

General Introduction

Entrepreneurship is a crucial element for economic development, especially in low-income countries (Acs, 2006), where more than 300 million small and mid-sized enterprises (SMEs) contribute up to 40% of national Gross Development Product (GDP). As a consequence, the profound understanding of factors influencing the dynamics of entrepreneurial emergence is a key field of research (Gartner *et al.*, 2004). Those dynamics are deeply related to their environment (Van De Ven, 1993). Introduced in 2010 (Isenberg, 2010) based on the observation of Entrepreneurial successful places such as Silicon Valley, Entrepreneurial Ecosystems (EE) are defined as *'a set of interdependent actors and factors that are governed in such a way that they enable productive entrepreneurship within a particular territory'* (Leendertse, Schrijvers and Stam, 2021). But lack of rigorous social science oriented research in that area (Audretsch *et al.*, 2018; Cao and Shi, 2020) suggests Entrepreneurial Ecosystem research does not actually provide accessible, comprehensive and actionnable theories and strategies to stimulate entrepreneurship. As we understand Entrepreneurial Ecosystem influences Entrepreneurship, and causal effects are actually mainly unknown, it is then appropriate to open new research perspectives, especially related to the weakest places which rely on their entrepreneurial dynamics. To open this perspective, so called "Entrepreneurial Ecosystem Black Box" our research program consists in proposing a method to measure the structure of entrepreneurial ecosystems. In doing so, we are led to explore how Entrepreneurial Ecosystem structural configuration (Rocha and Audretsch, 2022) can be a causal condition of the entrepreneurial dynamics in a given territory, and to formulate first proposals based on this new method.

1) Issues and interests of the subject

Policymakers around the world recognize the importance of stimulating entrepreneurship in their jurisdictions by creating and managing effective entrepreneurial ecosystems (Buffart *et al.*, 2020). The framework available is based on the legacy of Daniel Isenberg's research, the Ten Elements of the Entrepreneurial Ecosystem, which provides a comprehensive understanding of the economic forces at play, leading to medium and long-term stimulation strategies. But there is a missing link that can enable them to drive shorter-term strategies, at the level of the organization of these ecosystems, to make them more efficient (Audretsch *et al.*, 2018). This research therefore consists in proposing an organizational approach, by

proposing a new measurement framework of entrepreneurial ecosystems, allowing the construction of such strategies. This raises a number of interesting managerial, theoretical and methodological challenges.

a) Managerial interest

i) Entrepreneurial Process stimulation

Recognition of opportunities and the creation of entrepreneurial distinctiveness in new venture creation (Bhave, 1994) notably relies on surrounding resources such as knowledge, social capital (Fayolle *et al.*, 2016), markets, skills. Entrepreneurial process is known, object of an abundant literature (Gartner *et al.*, 2004). It is understood as relying on the entrepreneur himself (Hui-Chen, Kuen-Hung and Chen-Yi, 2014), in a way that can be supported by dedicated organizations such as incubators (Peters, Rice and Sundararajan, 2004) or accelerators. The new venture's creation also generates an often difficult quest for appropriate resources (Brush, Greene and Hart, 2001). If the support of entrepreneurship is known on a theoretical and managerial level at the individual level, it is different when it comes to the support of a group of new ventures at a territorial scale.

Knowing of those constraints, policy makers willing to stimulate -in a given territory- entrepreneurial dynamics, tend to set up strategies to provide resources in a comprehensive manner. The success of some vibrant places such as Silicon Valley, Boulder Colorado, or Route 126, known as Entrepreneurial Ecosystems, inspire them in an attempt to replicate their visible attributes and strategies. But replicate attempts aren't as simple as it means (Maroufkhani, Wagner and Wan Ismail, 2018), but Entrepreneurial Ecosystem actual knowledge presents various weaknesses. Most qualitative research is made around entrepreneurial faculties, and in quite abundant areas in terms of entrepreneurial resources. Even if interesting, those research present few variances in terms of context. They observe micro-level phenomenons. Duplicability of those research can not be done by itself, due to the profound nature of qualitative research, and actual results that can not be generalized, neither be the object of substantial theoretical propositions. In addition, most quantitative research leverages economic and macro-level data. We face missing links in terms of structural and processual local or national scale research, probably due to actual methodological limits.

ii) Entrepreneurial Ecosystem governance and management

Accordingly, the necessity to stimulate entrepreneurship raises concerns on Entrepreneurial Ecosystem governance (Colombo *et al.*, 2019), taking into account the complexity to coordinate efforts of multiple and independent actors, in a multi-agent (Cunningham, Menter and Wirsching, 2019) and multi-principle complex strategy. The consequence of actual research is both a macro-level understanding of Entrepreneurial Ecosystem, feeded by economic data analysis, leveraging the common EE elements (Stam and van de Ven, 2019), and micro-level analysis of local phenomenons. Entrepreneurial Ecosystem Governance means aren't clearly defined today, and should rely on Entrepreneurial Ecosystems managerial, organizational understanding. Though, those perspectives remain unexplored due to a lack of knowledge on structural and processual analysis.

b) Theoretical interest

Most of Entrepreneurial Ecosystem research is econometric data and qualitative observation oriented (Theodoraki *et al.*, 2022), which in itself is not sufficient to raise interesting theoretical analysis (Sutton and Staw, 1995). Critics in this field of research aim to consider that scholar's lenses to observe this phenomenon are either too large, or too narrow in order to managerially analyze Entrepreneurial Ecosystems.

Thus, a proper managerial understanding of Entrepreneurial Ecosystem would conduct scholars to open structural perspectives, as they have a strong theoretical potential. In that sense, we can already project that the Entrepreneurial Ecosystem embeds a network of resources which has influence on its outcomes (Boje and Whetten, 1981). Such research would then allow us to propose patterns of how, through specific structural configurations, an Entrepreneurial Ecosystem stimulate, more or less, productive entrepreneurship.

Under this angle, we are led to understand which are the organizational settings composing an Entrepreneurial Ecosystem. Research usually acknowledges that Entrepreneurial Ecosystems propose, through various organizations such as incubators, accelerators, dedicated institutions and actors, various resources and services to support entrepreneurs in their efforts. As a consequence, we are conducted to observe Entrepreneurial Ecosystems under an interorganizational perspective (Galaskiewicz, 1985). This perspective provides a number of possibilities to understand Entrepreneurial Ecosystem structure.

Entrepreneurial Ecosystem structural configuration analysis also opens another perspective : topology (Bechky, 2020). Topology, the way in which an Entrepreneurial Ecosystem parts are interrelated or arranged, can open very interesting descriptive analysis, and conduct to a theory of Entrepreneurial Ecosystem topology, as an effect of econometric macro-level measures, or as a cause of related entrepreneurial dynamics. Such research relies on a proper understanding of its components.

Beyond observation and description with renewed lenses allowed by a proper configurational and topology analysis, the most expected perspective which has the theoretical and managerial potential to provide the expected answers is a processual approach of Entrepreneurial Ecosystems. Attempts actually proposed (Spigel and Harrison, 2018b), based on Entrepreneurial Ecosystem elements, did not yet provide expected results. Therefore, a comprehensive research program should be undertaken to open up this perspective.

As suggested by previous social structure and interorganizational form research (Tatarynowicz, Sytch and Gulati, 2016), the approach we propose in Entrepreneurial Ecosystem research has the potential to provide very interesting archetypal structure and dynamics analysis of Entrepreneurial Ecosystems. Achieving such theoretical understanding of Entrepreneurial Ecosystem would either provide interesting insights in embeddedness, ecosystem, entrepreneurship theories, and shall allow to propose a social science theoretical proposition of Entrepreneurial Ecosystems, which has the potential to feed managerial propositions.

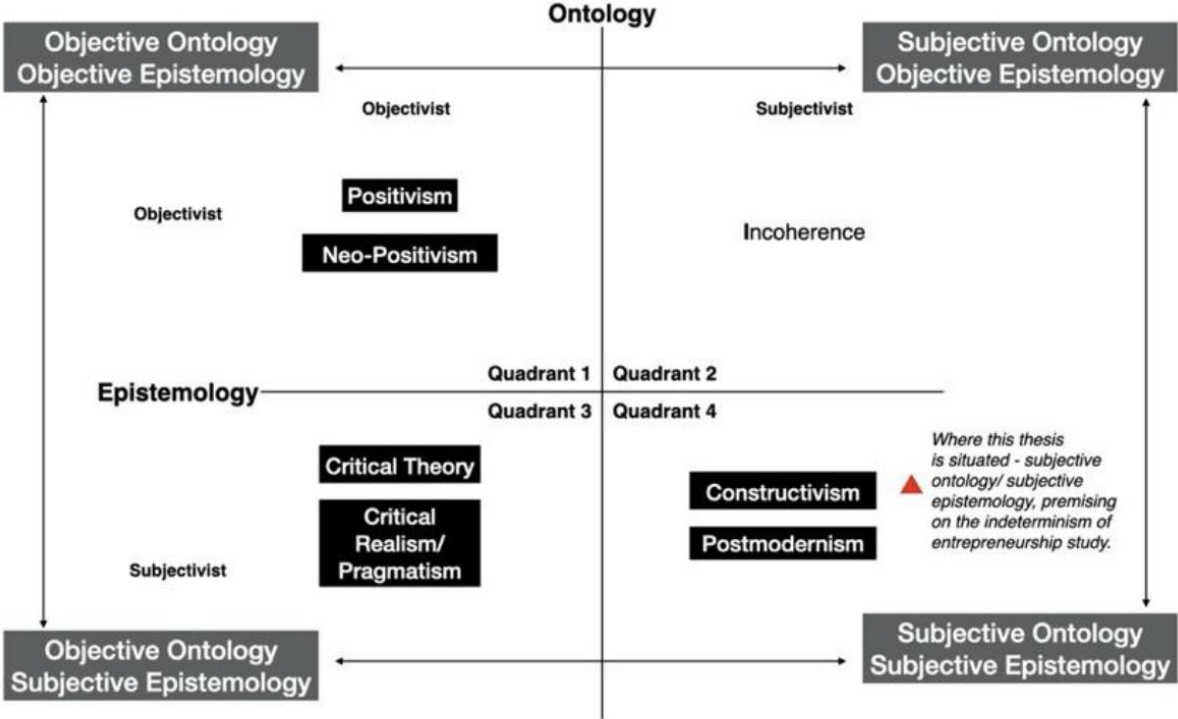
c) Epistemological Orientation

i) Epistemology misses in EE research

Epistemology orientation debate is quite absent from Entrepreneurial Ecosystem research. To our best knowledge, even if epistemological argumentation is frequent in qualitative analysis papers, we found no evidence of a proper Epistemological debate on the Entrepreneurial Ecosystem concept itself. This research does not have the ambition to properly address an Epistemological analysis of Entrepreneurial Ecosystem research.

So raises the question of the existing epistemological orientations occurring in EE research, and what should be ours, considering the various issues, mentioned above. In entrepreneurship research, scholars (Johnson and Duberley, 2000) suggest an interesting positioning of epistemological orientations relative to entrepreneurship research (fig. 1).

Figure 1 : Epistemological orientation in Entrepreneurship research



Adapted from Johnson, P., & Duberley, J. (2000). Introduction - the Importance of Epistemology in Management Research. *Understanding Management Research*. doi:10.4135/9780857020185.n1

But even if interesting, those do not really open perspective on Entrepreneurial Ecosystem research, maybe except with recent attempts, such as a recent research centered on the entrepreneur himself (Leong, 2021), we are led to propose alternative epistemological orientation (Alvarez and Barney, 2007) on entrepreneurial ecosystem.

ii) Positivist and Ethnographic are dominant perspectives

We act that *positivism* (Steinmetz, 2007) is dominant in econometric oriented Entrepreneurial Ecosystem research. We also observe *ethnographic*-based Qualitative analysis (Seale, 2003) on micro-level phenomena, mainly mobilized for methodological purposes, not theoretical. Theoretically, Entrepreneurial Ecosystem is actually a positivist-oriented concept, as the principal constructs are powered by an economic description of its elements. Entrepreneurial

Ecosystem research might be trapped in a symbolic understanding of reality. We suspect that the dominant theoretical propositions in Entrepreneurial Ecosystem research mobilize an abstraction level which limits, or even prevents, related theoretical and managerial propositions in an actionable way.

iii) A realist orientation

In order to open new perspectives in Entrepreneurial Ecosystem research, we propose to experiment new lenses, and do a step aside in the way we observe reality, in a more essentialist, objective, autonomous way to see the world. The *realist* orientation which is based on natural science models, as it tends to develop an empirically validated knowledge of the observed phenomenon (Kuhn, 1957; Reed, 2005), might fit with the ecology-based metaphor of Entrepreneurial Ecosystems (Guba and Lincoln, 1982). At first sight, such orientation appears to have an optimal fit with the research challenge of this thesis, and shall require, as suggested by Kuhn, a research pivot on three distinctive dimensions : method, semantics and ontology. For all these reasons, we propose to adopt this epistemological orientation.

d) Methodological interest

As previously introduced, actual methods and theories in Entrepreneurial Ecosystem research present limits. In order to break this glass ceiling we propose to adopt a new research approach, with its specific related limits. This research aims to open the black box of Entrepreneurial Ecosystem structural and processual analysis, adopting a relational perspective. We chose to leverage network theory, which has the power to reveal Entrepreneurial Ecosystem structural and processual patterns. This choice raises many methodological challenges, and validity issues, in terms of unit of analysis, variables and mechanisms to observe, data source and measurement methods.

i) Unit of analysis

Inspired by recent research on both Network and Ecosystem research framework (Shipilov and Gawer, 2020), social science oriented research on Entrepreneurial Ecosystem should adopt a whole scale analysis of Entrepreneurial Ecosystems, by the observation of organizations and people relationships. Such research should clarify the attributes of each observed component, and the exact nature of their relationships. In our knowledge, such analyses were never conducted in Entrepreneurial Ecosystem research.

ii) Variables and Mechanisms

Based on those units of analysis, we expect to open very interesting research on the complex multilateral and multilevel Dependencies, Complementarities, and Bottleneck occurring in Entrepreneurial Ecosystems, and to what extent those are related to EE outcomes. This would also open up very interesting collaboration structure analysis, to understand levels of cooperation and competition, and their dynamics, in relationship with the effectiveness of their influence on EE outcomes, and for example observed delay between causes and effects on productive entrepreneurship, and entrepreneurs satisfaction itself. Observation of mechanisms occurring in the Entrepreneurial Ecosystem has the potential to understand how governance affects Entrepreneurial Ecosystems, what is its structural evolution, what configuration is correlated to what cause or what effect, all this and beyond having an important interest in respect to managerial contribution of this research.

iii) Data and measurement

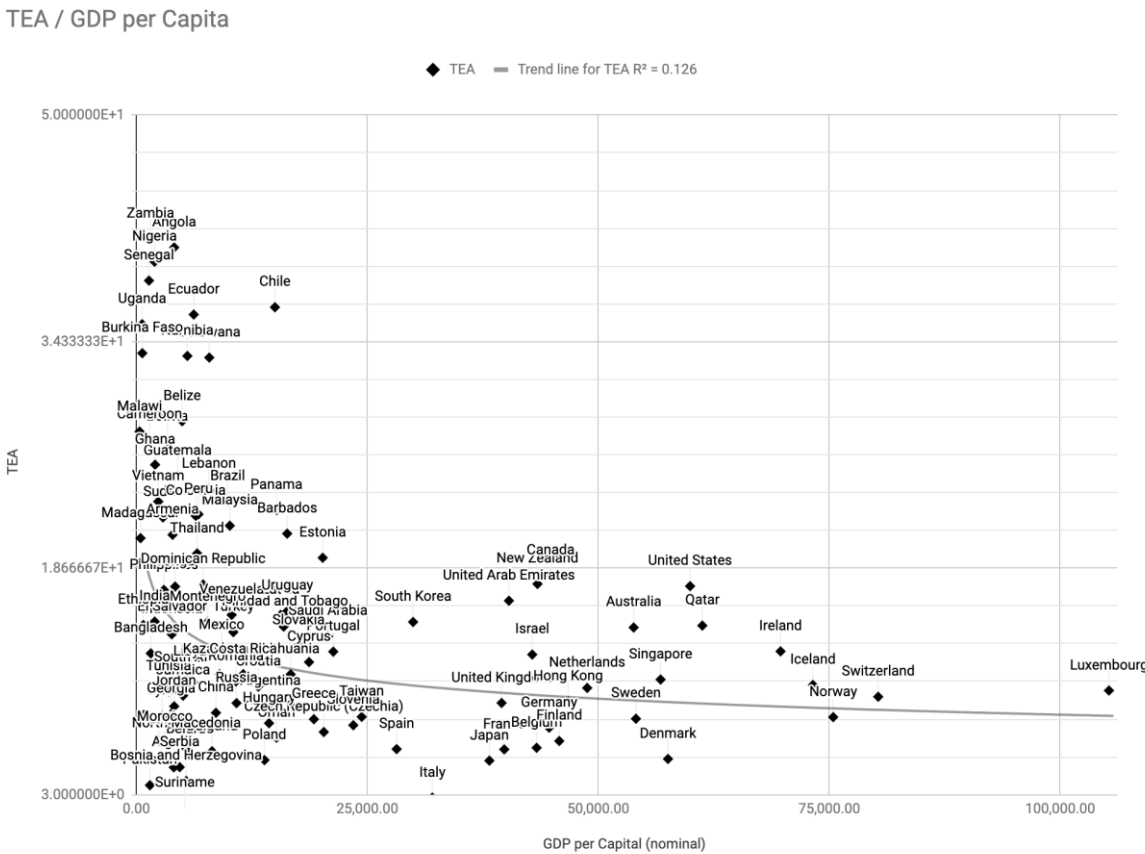
Probably a highly demanding dimension of this research is a proper understanding of how to measure Entrepreneurial Ecosystem structural configuration, topology and archetypal shape. Research suggests to use repositories of Entrepreneurial Ecosystem actors, or create them if they do not exist. And as a matter of fact, we observe that few of those repositories exist, or are far from exhaustive. We should also be conducted to run document analysis in order to identify relationships, as well as interviews with Entrepreneurial Ecosystem experts. The data source of relationship identification is neither an easy task, as we observe that most of the available documents do not sufficiently trace the total amount of relationship between EE actors. Social media based analysis could be interesting though, but the ties they embed are interpersonal, and meaningless. We have to identify a proper way to detect inter-organizational ties among Entrepreneurial Ecosystem actors.

2) Thesis and Research Program Birth

In 2018 the Global Entrepreneurship Monitor (GEM) published its Moroccan annual report. At that time, and it did not change much since then, Morocco presented the weakest Total Early-Stage Entrepreneurial Activity of the whole African continent (figure 2). Due to the importance of Entrepreneurship to generate growth (Carre and Thurik, 2003; Acs, 2006; Audretsch *et al.*, 2006), a particular attention is required to understand this fact. But the analysis and

explanations of this phenomenon were not really convincing, and the associate recommended a roadmap neither accessible for a low income country, nor having the potential to produce short or even medium term results. And Morocco is neither the only country, nor territory, in the World that requires Entrepreneurial stimulation, particularly in the lowest GDP per capita places.

Figure 2 : World’s Registered GEM’s TEA vs GDP per Capita



Living in Morocco for 4 years at that time, and knowing Moroccan’s willingness to perform in that area, I was puzzled by this lack of entrepreneurial performance, and began to try to understand the “why” by confronting TEA levels to GEM’s environmental factors published in its Country Profile. A surprise arises comparing those levels to other African country profiles : the environmental factors presented at that time did not have an explanatory power regarding Morocco's Total Early Stage Entrepreneurial Activity (TEA), nor its economic performances levels (GDP per capita), compared to other African countries. There was no apparent correlation between all those measures. Apparently, no causal analysis could be conducted. A

question arose strongly at that time, and initiated my doctoral journey : “*why (and how) a given territory is more conducive to entrepreneurial dynamics than another ?*”.

Having this in mind, deep diving in reports and scientific papers did not quench my thirst, but reading an interesting call for paper (Audretsch *et al.*, 2018) provided me with the firm belief that this question was wide open and should be further investigated. Without shaking the robustness of the economic understanding of Entrepreneurial Ecosystems that was emerging at that time (Stam and Spigel, 2016), there may be other lenses to adopt in order to have a clearer and more direct understanding of Entrepreneurial Ecosystems. Their behaviors, in order to be able to see differently what is the cause and what is the consequence regarding the Entrepreneurial Ecosystem phenomenon, should be analyzed. Its literature was at that time booming, entering in expansion phase (Theodoraki, Dana and Caputo, 2022). Published papers are mainly theoretical, literature reviews, qualitative, mixed-methods papers for a total of 72,2% of the most cited papers. Quantitative ones (26,1%) are mainly presenting econometric perspective data using GEM, GEI or WorldBank databases. Almost no paper presented social science oriented quantitative papers, and those mainly observing startups and not really the entrepreneurial ecosystem itself. In addition, at that time, research acknowledged that this field of research was requiring new methodologies to explore Entrepreneurial Ecosystem as an organizational ensemble (Carayannis, Provan and Grigoroudis, 2016; Erina, Shatrevich and Gaile-Sarkane, 2017).

Adopting a *realist* point of view (Kuhn, 1957), and due to its inter-organizational and evolutionary nature, EE can be observed -in social science- under various organizational theory perspectives, such as agency, neo-institutional or network. Considering scientific parsimony necessity, taking in consideration major scholar’s affirmation that Entrepreneurial Ecosystems are a relational ensemble (Spigel, 2017b), and after rich and stimulating debates with known specialists such as *Frederic Delmar*, Network theory is identified as the most accurate angle to enlighten the EE phenomenon, providing many possibilities for future research. Here my thesis was taking form, in addition to another perspective to consider : modularity (Baldwin and Clark, 2000) proposed by my research director, *Didier Chabaud*.

3) Entrepreneurs are Lego players, opening a modularity perspective

The big idea to sustain this understanding of EE, is that Entrepreneurs are lego players. They need relevant ‘pieces’ to build their projects. EE actors are providers of those pieces, delivering a form of ‘Business Process Outsourcing’ for Entrepreneurs by various ways and forms. In that sense, some authors raise the concept of local affordance that underline this perspective (Autio *et al.*, 2018). Taking seriously the ecology metaphor in Entrepreneurial Ecosystem research (Auerswald, 2015), our hypothesis is that the accuracy, diversity, quantity and availability of those pieces allowed by an appropriate network configuration is a key factor to stimulate Entrepreneurial Dynamics in a given territory. Those pieces, let’s name them ‘Entrepreneurial Nurturing Components’ (ENC), which should not be named ‘elements’ as the term designates understanding of the econometric components of EEs (Stam and van de Ven, 2019), area not actually defined, but are described by parts in various papers.

Therefore, how could we define the Nature of those Entrepreneurial Nurturing Components ? First we shall remind ourselves that entrepreneurs are constantly in quest of resource acquisition to fulfill their goals, either to cross the entrepreneurial death valley, or to build their ventures by various means (Spigel, 2017a). They shall of course be in quest for additional financial funds, but not only. Beyond their finance role, it is actually unclear what precise added value EE actors deliver to entrepreneurs (Theodoraki and Messeghem, 2017). But various research underlines Entrepreneur’s use of consultancy or coaching to finalize their business plan, business model, corporate or marketing strategy. They either need to complete their innovation process, organize their organization and access to the right human resources. They often also need Legal and Intellectual Property support -which can be a bottleneck-, or access to prototyping facilities and skills, test their early product or service, or -at last- need to access to commercial and sales opportunities. For all that, early entrepreneurs can take advantage of Support Programs (Buffart *et al.*, 2020) proposed by public and international actors, or consortium of interests (Theodoraki and Messeghem, 2015; Messeghem *et al.*, 2020). To elaborate their entrepreneurial projects, entrepreneurs most of the time use bricolage techniques (Baker and Nelson, 2005), using and leveraging available resources in their environment. As a consequence, the resource provider role of EE actors is a critical attribute in EE (Ratinho *et al.*, 2020). This also means that abundance of available resources in Entrepreneurs' general environment, independently of the EE, makes them less dependent on a given EE performance.

The Wideness and Deepness portfolio of Entrepreneurial Nurturing Components is an under explored perspective in Entrepreneurial Ecosystem literature, as scholars focus more on macro and micro level research. Nevertheless, we have some evidence that the entrepreneurial process itself depends on local affordances, of any kind. They underline the critical role of available cutting edge technologies and knowledge as quality components to reach Entrepreneurial Competitiveness in a given territory (Autio *et al.*, 2018; Song *et al.*, 2022). That said, resource availability for Entrepreneurs through EEs can also be explored under a Resource Based View (RBV) perspective (Freiling and Baron, 2017). This research posture can lead to interesting theoretical and managerial results and contributions. RBV perspective requires a better understanding of the related resource, and proper methods to measure their respective available quantity and use in a given EE.

The Availability of Entrepreneurial Nurturing Components is also an under-explored perspective. It could lead to a dynamic capabilities perspective (Bhattacharyya and Jha, 2015) which could be of some interest for academic and managerial stakeholders. Indeed available resources, or stock of resources, is crucial to plan an entrepreneurial support strategy. It is particularly important and essential for any forms of growth and internationalization strategies (Harima, Harima and Freiling, 2020). This evidence is related to economic complexity theory (Hidalgo and Hausmann, 2009) that takes its roots in local capability for excellence, seen under international lenses. As a consequence, the general availability of ENC's are critical to sustain Entrepreneurship, but at the core of such strategy should be the quest to leverage territory excellence in order -for an Entrepreneurial Ecosystem- to compete, internationally.

These perspectives underline the critical role of Entrepreneurial Nurturing Component quality, quantity, and availability in a given territory. But it raises the question of how such components should be created, generated, and distributed.

4) Entrepreneurial Ecosystem actors deliver “Entrepreneurial Nurturing Components”

The lego player's metaphor is interesting but by nature incomplete. This metaphor suggests that the entrepreneurial project can be built with “bricks”, which -considering for instance the value chain perspective, or modularity perspective- a relevant concept. But in the case of an Entrepreneurial project, those bricks can serve to build entrepreneurs themselves, their team

and skills, their innovation, their business model, their product or service, the finance of their project, and their organization itself. Here comes the importance and the relevance of Entrepreneurial Ecosystem research, as an Entrepreneurial Nurturing Components provider. But not only.

a) Long Story Short of Entrepreneurial Ecosystem research

The Entrepreneurial Ecosystem concept takes its historical roots in the Schumpeterian approach related to Entrepreneurship and their support (Henrekson and Sanandaji, 2019). Interestingly, the Schumpeterian approach underlines natural selection in the new ventures population, making a natural linkage with the ecological approach of Entrepreneurial Ecosystems. Infrastructure for Entrepreneurship, ancestor of the Entrepreneurial Ecosystem concept, rose with Van de Ven seminal work (Van De Ven, 1993). Van de Ven underlines the macro-level lenses used for this observation, and various interesting propositions related to entrepreneurial process and lateral dependencies. Later on, interesting related perspectives emerged such as Clusters, Industrial Districts, Innovative Ecosystems, Business Ecosystems (Digiovanna, 1996) which paradoxically compared with how EE is considered actually as a separate concept, in fact is a part of an overall current of research to observe and explain how territories excel in various ways, with a multilateral dependency hypothesis. More recently, the Entrepreneurial Ecosystem emerged by itself in an attempt to understand how to start an Entrepreneurial revolution (Isenberg, 2010).

The approach initially generated doubts upon EE conceptual framework, but progressively met the acceptance of the scientific community, with growing published papers in top tier scientific journals (Theodoraki, Dana and Caputo, 2022). Nevertheless, within EE community scholars, critics emerged, pointing to an emerging but under-developed theoretical stream of research (Spigel, 2017b; Wurth, Stam and Spigel, 2021). Since 2017, EE research is now considered in its expansion phase meeting academic community acceptance. But EE efficiency is not actually proven (Theodoraki, Messeghem and Audretsch, 2020) and raises major concerns in research.

EE concepts take its place in another way to see the world, trades and business (Moore, 1996) in a multilateral, ecosystemic, way to do business. Deep interdependencies are now considered, either under economic, international and managerial lenses. In that sense, ecosystems are elements of a liberal economy, constituted by interorganizational networks (Benson, 1975)

which supports entrepreneurial efforts. It underlines the importance of multilateral exchanges between EE organizations to sustain Entrepreneurship. The object of those exchanges being Entrepreneurial Nurturing Components and their elaboration. Under those lenses, scholars are led to deep dive in social science perspectives in order to better understand EE actors, their relationships, and their transactions.

b) Fuzzy definition of EE actors

According to this perspective, a better understanding of who belongs to an Entrepreneurial Ecosystem, how, why, is critical for scientific observation. First, research acknowledges that those actors are part of an ecosystem (Adner, 2017), which is a Structure by itself, an inter-organizational and inter-personal structure. We also know that EE and their actors are anchored in particular places and territories (Boutillier, Carré and Levratto, 2016), which is related to EE spatial affordances perspectives (O'Connor *et al.*, 2018).

We also know, in particular, that Incubators and Accelerators are key EE actors (Goswami, Mitchell and Bhagavatula, 2018), and their role is critical to sustain Entrepreneurship. Their role is partially unveiled by research (Purbasari, Wijaya and Rahayu, 2020b) with the first attempt to mobilize network methods in EE research. But, yet, EE actors attributes are unclear beyond their financial or nonfinancial support to entrepreneurial efforts.

a) EE actors' value proposition

For a better understanding of EE actors' role, we are led to a better understanding of their value proposition.

First, which in fact is an historical perspective in EE research, the triple-helix perspective underlines the role of educational players to sustain entrepreneurship in an EE (Guerrero and Urbano, 2017; Purbasari, Wijaya and Rahayu, 2020a). This perspective, aligned with the relational perspective of EEs, tends to study the efficiency of Universities or School activity and collaboration to stimulate student's entrepreneurial dynamics (Brem and Radziwon, 2017), putting Education as a pillar in EE research, backed with the dominant EE research current and framework, to irrigate the EE with Knowledge.

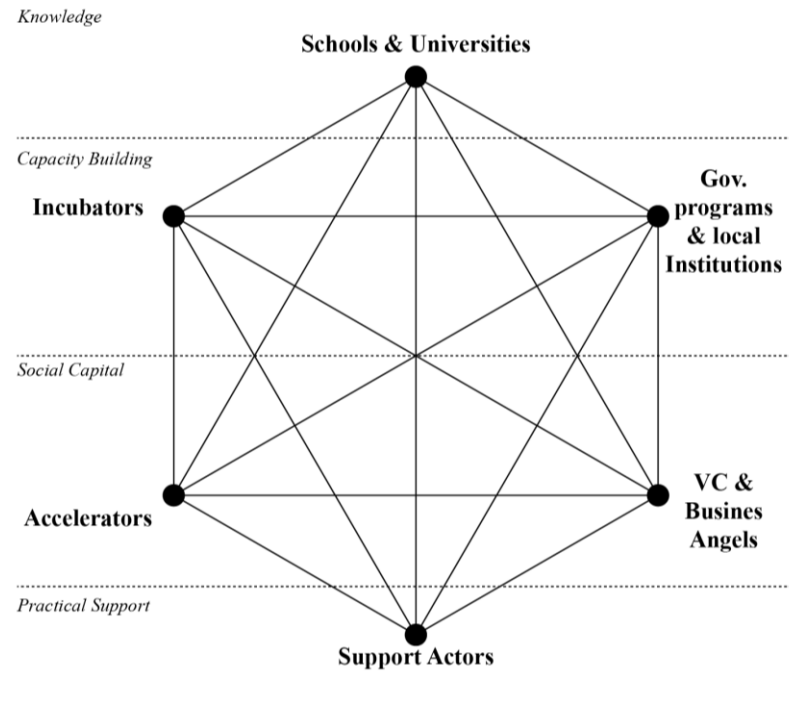
Capacity Building is also frequently mentioned in Entrepreneurship literature (Nwazor, 2012; Karmokar, 2019; Towers *et al.*, 2020) but surprisingly rarely raised in EE literature itself. Nevertheless, some targeted research on EE actors, such as incubators, as Capacity Building providers (Theodoraki, Messeghem and Audretsch, 2020) raising various interesting questions such as their precise role regarding the entrepreneurial process (Peters, Rice and Sundararajan, 2004). Capacity Building is also considered as the role of Entrepreneurial Support programs principally proposed through government programs and local institutions. Capacity Building intervenes principally in Entrepreneurial birth stage phases.

Qualitative papers also underline Social Capital (Light and Dana, 2013) as a critical resource for entrepreneurs. It is also raised in EEs literature (Theodoraki, Messeghem and Rice, 2018) as an important component to sustain Entrepreneurial Dynamics. Social Capital is known to be a critical asset for Entrepreneurs, and research acknowledges that Financial actors in EEs consider themselves as Social Capital providers more than Finance providers. Same with accelerators, which use their Social Capital assets to open market perspectives to new ventures.

Practical Support actors such as fablabs (Osunyomi *et al.*, 2016) coworking spaces (Gauger, Strych and Pfnür, 2021), more generally entrepreneurial culture support organizations (Audretsch, 2020; Donaldson, 2021), such as events, medias, third places, nurseries, dedicated places, are also considered as EE actors. In fact they actually deliver interesting Entrepreneurial Nurturing Components. The actors delivering those components are most of the time distinct and specialized organizations in EEs.

Put all together -Knowledge, Capacity Building, Social Capital and Practical Support types of components- each delivered preferably by a type of actor, can allow us to propose a synthetic structural understanding of Entrepreneurial Ecosystems (Fig. 3), which is coherent with Van de Ven initial proposition, and complementary with Economic understanding of EEs which dominates since Isenberg.

Figure 3 : Type of Entrepreneurial Ecosystem actors and Entrepreneurial Nurturing Components



5) “Entrepreneurial Nurturing Components” distribution

Now that Entrepreneurial Nurturing Components are understood, and their main providers designated, a new research challenge is reached : how those ENC are delivered to Entrepreneurs. It is also an under explored perspective in EE research that leads us to raise theoretical concerns (Nayak, 2008). Due to the nature of EEs, their scale, diversity of actors and components, reaching an actionable theoretical framework requires leveraging complexity theory (Larsen-Freeman, 2012) which uses symbolic representations for a better understanding of the complex phenomenon we attempt to capture.

In our understanding of the Entrepreneurial Ecosystem phenomenon, Knowledge Creation (Bathelt, Malmberg and Maskell, 2004) is seen as a foundation of Entrepreneurial Dynamics. This perspective refers to Knowledge transfer capabilities in a given territory and the actual spread of this knowledge operated by the actors embedded in EEs. This process is critical in EE research as scholars acknowledge through the Creative Construction perspective (Agarwal, Audretsch and Sarkar, 2007) that Entrepreneurship requires active circulation of knowledge.

Essential Entrepreneurial Ecosystem actors such as Incubators are playing a central role regarding Entrepreneurial Process (Peters, Rice and Sundararajan, 2004), but are only a part of

a whole system to sustain Entrepreneurship in a given territory. Nevertheless, they are known to be a Knowledge transfer relay, as well as a Capacity Building, having a measurable impact on Entrepreneurial Journey of the new ventures they support, through the services they provide in terms of coaching and training. But such deep diving research on actual attributes of every type of actors in Entrepreneurial Ecosystem is under explored, and should require first a deeper understanding of Entrepreneurial Ecosystem configuration before investigating Entrepreneurial Ecosystem actors attributes.

a) Entrepreneurial Ecosystem Structure

Previous research suggests the relational nature of entrepreneurial ecosystems (Spigel, 2017), but given this assumption, what does research tell us about its structural relational nature ? In our best knowledge, and given the latest literature reviews (Theodoraki et al., 2022), research does not provide direct answers to this question. Interorganizational research suggests community-based or distance-based structure. In the case of the Entrepreneurial Ecosystem, its structure is by definition tied with a particular territory, making its structure community-based oriented. Literature on clusters, such as innovation clusters, even if those clusters are mainly not place based, but specialty or function-based, suggest grapes of organization based on their complementarities to elaborate specific value chains. Porterian approaches on the value chain have been also applied to interorganizational research on open innovation, which confirms this complementarities of functions held by interorganizational collaborations. Similar results are found in Industrial Districts research. Applied to the Entrepreneurial Ecosystem, we are led to understand its structure by function-oriented interorganizational ties.

In Entrepreneurial Ecosystems, we can find organizations, actors, which have archetypal functions, such as investment funds, incubators, accelerators, entrepreneurial universities, co-working spaces, startup nurseries, business angels, etc. One could argue that some actors propose various functions, and some of them out of their core mission. For example, some investment funds propose acceleration services. Nevertheless, each type of actor provides its core mission first and foremost. This means that to properly observe Entrepreneurial Ecosystem structure and structural configuration, we should both list Entrepreneurial Ecosystem organizations, and verify their functions. To follow the previously proposed framework (Figure 3), the researcher shall verify the vertical distribution of functions between incubators and accelerators, dedicated public institutions and private funding organizations ; and horizontal

distribution of functions between incubators and dedicated public institutions, accelerators and private funding organizations.

The understanding of both interorganizational relationships and functions complementarities form the structure of Entrepreneurial Ecosystems, a structure allowing an efficient distribution of available resources to entrepreneurs, shall include a detailed listing of actors, their attributes in terms of functions, and their ties in order to analyze their relations, communities, complementarities and interdependencies. This approach moves away from the actual reference research framework, legacy of Isenberg's proposition.

b) Entrepreneurial Ecosystem Structural Configurations

The various forms of EE configurations only recently captured Scholar's attention, but remains for the most under explored. Such observations could, for example, enlighten the causes of innovation capabilities in given territories (Khedhaouria and Thurik, 2017). Only few research raise EE configurations, underlining the research tropism on handful locations, and the interest of configurational understanding of EE that would allow -with sufficient data- to propose a social science theoretical framework of EEs (Alves *et al.*, 2019). This stream of research suggest also an actual relationship between EE configurational structure and the effectiveness of its spillovers in terms of Entrepreneurial Dynamics (Cherubini Alves, Fischer and Vonortas, 2021)

c) Theorizing Entrepreneurial Ecosystem structural configurations

At every stage yet of our presentation of Entrepreneurial Ecosystem research, we face under explored perspectives. Some are open debates in the EE research community, such as those leveraged during January 2022 Utrecht University Winter School, in which scholars consensually voted to deep dive in configurational, network or longitudinal research in the EE field of research.

Scholars actually are interested in observing causes of successful EEs, as well as processes impacting EE spillovers. They are particularly interested in what configuration is more beneficial to a given EE outcome than another, as well as understanding the governance / institutional causes of those configurations, especially in a relational perspective.

Network perspective also captures scholar's attention, and related processes occurring in Entrepreneurial Ecosystems. They also acknowledge the porosity of EEs and raise concerns about how an EE attracts talents, and mobility of people across EEs. Through network measurements, questions are asked about its healthiness, robustness and maturity, observing communities, collaboration modalities, ties formation and their strength. As EEs are anchored in particular places, spatial configurations also capture attention. First perspective to rise is the inter-EE ties and transactions, as well as sub-ecosystem interactions. Localisation of actors, activities and spillovers are also in question to deep dive into spatial affordances and their spillovers, opening to a topology perspective.

Time is also considered as a key factor in EE research. The highest interest is reached in finding proper research means to measure the evolution of interactions occurring within EEs, and understand EE structural dynamics. Other perspectives are open such as the understanding of the impact over time of EE policies. Other time related perspectives, such as measuring the Entrepreneurial Process delays variations, the growth of an EE, tie persistence in EEs, and Social Capital speedness occurring in EEs, capture scholar's attention. An evolutionary perspective of EE arises with concerns about EE stages of evolution, multi-level interactions, as well as inter-ecosystem and intra-ecosystem dynamics and relationships.

Governance is also a central concern, particularly in the understanding of various types of governance and their impact, under various sub-stream of research : the measurement of policy impact, the impact of investment policies, and any other longitudinal perspective regarding governance and EE policy. Structure of power is also leveraged and its impact, level of democracy, communities, leaders and their centrality.

Many other concerns exist in EE research, such as EE policy impact on its configuration, a 'fail' perspective to understand causes of failures, finding appropriate measures and data to measure EE and Spillovers at different levels, leadership in EEs.

6) A configurational perspective of Entrepreneurial Ecosystems mobilizing Network theory

Now we act that EE is an under explored Relational Structure (Spigel, 2017b), capturing actual scholar's attention. As a consequence, we are led to mobilize Network Theory as a core perspective to observe and analyze EEs.

a) Legacy of Network Theory

Network Theory (Borgatti and Haglin, 2011) and related Embeddedness (Uzzi, 1997) perspective arose 25 years ago producing interesting research in social network area, and - closer to our subject- in inter-organizational network perspective (Evan, 1965; Benson, 1975; Wooten and Sacco, 2017). Research acknowledges that network and subnetwork structure, configuration and attributes, clusters, structural holes and many other network attributes, through the observation of ties and dyadic associations (Dahlander and McFarland, 2013), have a measurable impact on the related network outcomes and spillovers.

Network Theory is also interesting related to the Social Capital perspective embedded in the Entrepreneurial Ecosystem research framework. Beyond structural EE understanding, network theory can also be mobilized to better understand causal relationships with the entrepreneurial process itself, leveraging Social Capital attributes, related to EE network capabilities.

a) An Entrepreneurial Ecosystem is an inter-organizational structure

Following the Network Theory research framework (Shipilov and Gawer, 2020), we have to better understand EE network components. We can define as Network nodes individuals or organizations (or both), and consider different layers of networks occurring in EEs. Regarding the transactional object - Entrepreneurial Nurturing Components- we predict the most accurate and impact network level happening in Entrepreneurial Ecosystems is its inter-organizational network. From this starting point, we understand Entrepreneurial Ecosystems are inter-organizational structures. Each organization within the Entrepreneurial Ecosystem can be seen as a node, their relationships as vertices. Entrepreneurial Ecosystem organizations build various forms of ties, formal and informal, as various collaborations to support entrepreneurs or new ventures.

This Network understanding of Entrepreneurial Ecosystem opens many interesting observation means and measures such as network basic attributes : density, centrality (and its numerous sub-measurements), mean distance measures, clustering measures, average weight measures, and many others. Longitudinal measures of Entrepreneurial Ecosystem opening ecological oriented perspectives. All those perspectives weren't investigated before we started our stream of research.

7) A modularity perspective in Entrepreneurial Ecosystem research

In social science, Network Attributes and Dynamics are related to interesting attributes in terms of knowledge, collaboration, mobility, accessibility of various resources available in a given structure. Those resources, Entrepreneurial Nurturing Components, are made available - through EE network attributes- to entrepreneurs. Why does it matter ?

a) Entrepreneurial Nurturing Components unique configurations : Entrepreneurial Uniqueness

Research acknowledges differentiation is a key factor for startup performance (Jalali, Jaafar and Ramayah, 2014). Such differentiation is reached through a unique value proposition for the final consumer, which can be found with an appropriate combination of innovation, value chain and business model. This uniqueness is elaborated most of the time through bricolage (Ghezzi, 2019) using resources grabbed by entrepreneurs mainly in their direct environment, and beyond. As a consequence, those resource unique configurations form the Venture Differentiation in the market. The ability of entrepreneurs to differentiate depends on their own project, but supported by the quality, quantity and availability of those resources : Entrepreneurial Nurturing Components.

Under a Dynamic Capabilities View, unique combination, configuration and use of available resources allow an organization to achieve a competitive advantage (Teece, 2007). As New Venture embeds nascent internal organization, their quest for differentiation relies a lot on external resources of various kinds, made available by and through Entrepreneurial Ecosystem inter-organizational network.

b) Entrepreneurial Nurturing Components, Entrepreneurial Ecosystems and Modularity

Modularity has been raised in relation with Entrepreneurial Orientation (Bouncken, Lehmann and Fellnhofer, 2016) demonstrating how Entrepreneurial Nurturing Components sustain essential function to support the overall value proposition of a given new venture. Doing so, the final venture is an optimal combination of those components, producing added value.

Modularity perspective indicates that the “modules” available should be standard, only a unique and specific combination of those modules creates value for the final consumer. To create a performing new venture, it is a unique combination of Entrepreneurial Nurturing Components which create venture value. Those components should be standardized, only a specific and unique combination of those are creating differentiation.

As a consequence, the entrepreneurial environment dynamism, through Entrepreneurial Ecosystem, allows to deliver a sufficient portfolio of Entrepreneurial Nurturing Components, as standard “modules”, to allow entrepreneurs to elaborate unique and distinctive new businesses. The availability of those components, made possible by an optimal configuration of the entrepreneurial ecosystem, or a particular abundance of resources, is conducive to Entrepreneurial Dynamics.

Finally, the global competitiveness of New Ventures emerging from a given Entrepreneurial Ecosystem relies on its Entrepreneurial Nurturing Components portfolio, its availability, diversity, and quality. And due to the necessity to adapt and be agile in a global competitive environment, the capacity of the Entrepreneurial Ecosystem to provide a wide and profound portfolio of ENC's allows new ventures to adapt more quickly and more accurately.

c) New Ventures as outcomes of Entrepreneurial Ecosystems

Most commonly, Entrepreneurial Ecosystem is defined as *‘a set of interdependent actors and factors that are governed in such a way that they enable productive entrepreneurship within a particular territory’* (Leendertse, Schrijvers and Stam, 2021). New Ventures, and especially productive ones, are outcomes of Entrepreneurial Ecosystems, and they are fueled by the resources made available by EEs : Entrepreneurial Nurturing Components.

d) The explanatory power of this approach

The interest of this approach relies on its explanatory power. Network Theory, even in an inter-organizational perspective, is a parsimonious and powerful theoretical approach ; combined with modularity perspective, it allows both to observe and analyze EE configurations. Through modularity, we can also understand EE impact on productive entrepreneurship. This perspective fits to the actual relational understanding of Entrepreneurial Ecosystems, and the analysis of Entrepreneurial Processes. It also allows elaborate longitudinal studies for an evolutionary perspective. Through the understanding of ENC, to raise RBV applied to the Entrepreneurial Process. All combined opens interesting perspectives in EE research.

8) What is cause, what is effect in our understanding of Entrepreneurial Ecosystem research

a) Entrepreneurial Ecosystem spillovers a dependent variable

EE outcome is at first stage productive entrepreneurship, and indirectly well being (Wurth, Stam and Spigel, 2021). Most of the time, scholars focus on productive entrepreneurship to measure Entrepreneurial Ecosystem spillovers. And those spillovers can be of different types : knowledge, growth, well being, job creation, new ventures creations, etc.

Entrepreneurial Dynamics (Gartner *et al.*, 2004) is a processual approach of new business creation, led by entrepreneurs. Beyond the various aspects of Entrepreneurial Dynamics, is the narrow relationship between Entrepreneurial Dynamics and Entrepreneurial Ecosystem where they occur. EEs are facilitators, stimulators, generators of Entrepreneurial Dynamics, using all kinds of means to fulfill this goal, Entrepreneurial Dynamics are spillovers of Entrepreneurial Ecosystems.

b) Measuring Entrepreneurial Dynamics

Scholars actually use various dataset and measures to evaluate Entrepreneurial Dynamics in a given territory. The most commonly accepted and relevant measure in the research community is the Total Early-Stage Entrepreneurial Activity (Peris-Ortiz, Ferreira and Fernandes, 2018), with the complementary measure of opportunity-driven entrepreneurship (Nicotra *et al.*, 2018) among others such as WorldBank's World Development Index, World Economic Forum, the

Global Entrepreneurship and Development Index, OECD indicators, Eurostat database, Espon database or EU Regional Competitiveness Index.

c) Paradoxes of Entrepreneurial Dynamics and Ecosystem Measures

But a surprise arises here : Entrepreneurial Dynamics and Ecosystems are local phenomena that can be observed at a scale of a city or a region, such as Silicon Valley, Boulder Colorado or Route 126. Available measures, actually, are proposed at the national level. It represents a bottleneck for EE research which can be solved by localizing TEA-like measures, with NUTS oriented dataset approaches (Leendertse, Schrijvers and Stam, 2021).

d) Entrepreneurial Ecosystem as a Cause of Entrepreneurial Dynamics levels

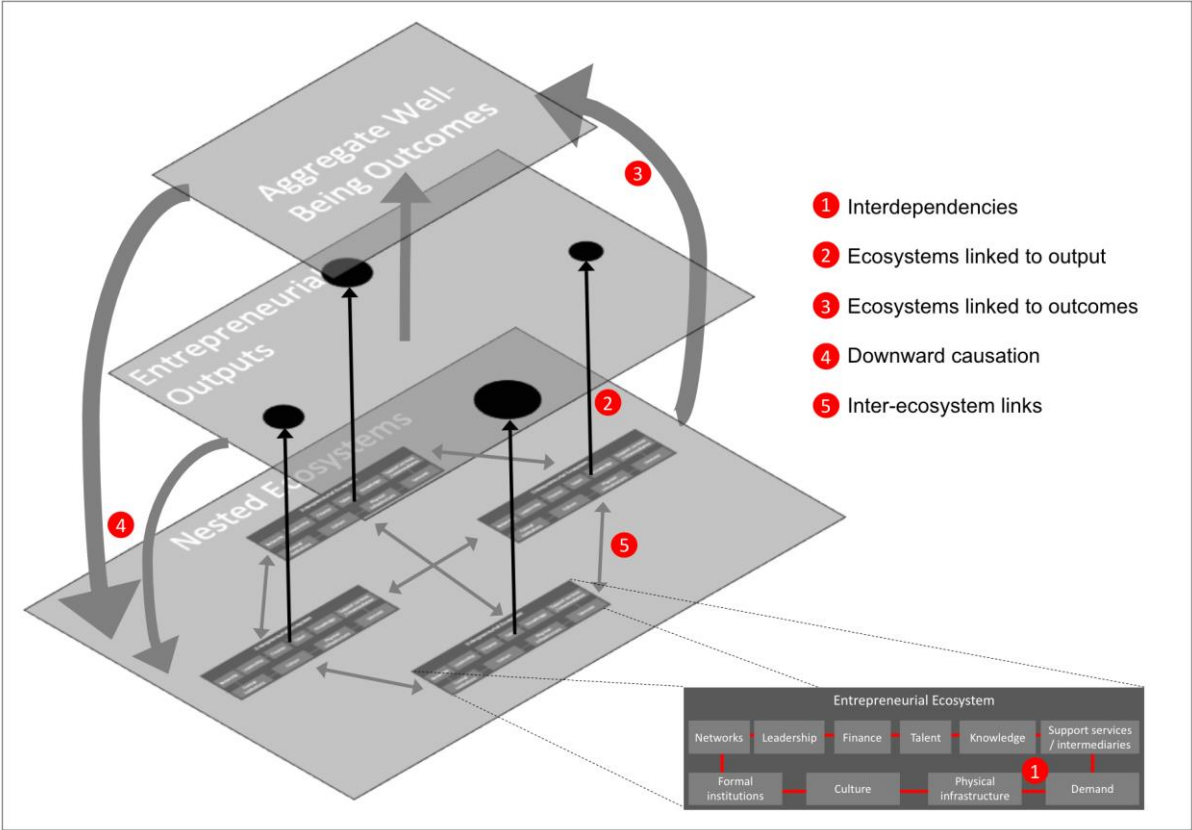
Nevertheless, the Entrepreneurial Ecosystem, as a whole structure, is a cause of Entrepreneurial Dynamics, as EEs provide support and resources to sustain entrepreneurial process and activity in its territory. Other environmental factors may be involved, indeed, but EE has a direct impact and measurable effect on related Entrepreneurial Dynamics.

e) Measuring an Entrepreneurial Ecosystem as a whole

Yet, only econometric measures are proposed to measure an Entrepreneurial Ecosystem as a whole. Those measures are provided by the actual central EE research program (Fig. 4) which suggest that ten elements (Stam and van de Ven, 2019) are constitutive of Entrepreneurial Ecosystem are Networks, Leadership, Finance, Talent, Knowledge, Support Services / Intermediaries, Formal Institutions, Culture and Formal Institutions. This conception of Entrepreneurial Ecosystems, as previously mentioned, takes its roots in Isenerg's seminal proposition.

As proposed in this thesis, this conception of Entrepreneurial Ecosystem fits a macro-level understanding of this phenomenon. At a meso-level of research, as proposed in research (Theodoraki and Messeghem, 2017), social science oriented research should be mobilized as Entrepreneurial Ecosystem a structure, which is not characterized actually in research. But to do so, we propose to mobilize both Network and Modularity perspectives, which provide interesting measures.

Figure 4. : causal mechanisms in the entrepreneurial ecosystem research program (Wurth, Stam and Spiegel, 2021)



f) Attributes of Entrepreneurial Ecosystems

The measures proposed in Network Theory, as previously introduced, are known, and their meaning in inter-organizational research, defined (Shipilov and Gawer, 2020). We propose three sets of measures, each one having a specific explanatory power.

First we propose the Information and Knowledge spread factor across the Entrepreneurial Ecosystem (Purbasari, Wijaya and Rahayu, 2020b) as a key measure to understand the degree of Entrepreneur’s knowledge of available resources existing in a given Entrepreneurial Ecosystem. It is a fundamental attribute as it is the foundation of the Modularity capability of an Entrepreneurial Ecosystem. Information and Knowledge are also known to be related to an Entrepreneurial Ecosystem capability for Innovation and productivity (Agarwal, Audretsch and Sarkar, 2007; Kuebart and Ibert, 2019; Audretsch and Belitski, 2020). This factor can be measured using both centrality and density network measures which can be merged in a Cohesiveness factor.

Second, modularity requires accessibility of its components (Camarinha-Matos and Afsarmanesh, 2018). Accessibility comes in second as Entrepreneurs do not save effort or energy to acquire a critical resource, but low levels of accessibility can represent a barrier to achieving entrepreneurial goals. This accessibility measure can be reached through a network's Average Weight measure, which can be associated with its interconnectivity level.

Last, a well organized Entrepreneurial Ecosystem can be measured through the intensity of collaboration between its actors (Xu, Yan and Xiong, 2019). This is also an important measure as it reveals the collaboration or competition culture vs. competition occurring in an Entrepreneurial Ecosystem. Low collaboration levels can negatively impact Entrepreneurial Dynamics. Collaboration can be evaluated through distance measures, such as Average Shortest Path, Clustering Coefficient or Mean Distance measures.

Those three sets of measures are meant to open this Network-Modularity perspective, as network theory embeds an impressive number of methods, tools and analytic methods that can be leveraged in that field of research.

g) Comparing Entrepreneurial Ecosystem : a challenge

One only Entrepreneurial Ecosystem can be challenging to be measured, as Network theory would then require to properly identify its every actor (node) and inter-organizational ties (vetrices). But another challenge, which is actually known in the actual Entrepreneurial Ecosystem macro-level research, is the comparability between ecosystems.

First, the data collection is sensible. Each geographic zone, each culture, each local system has its own understanding of a given data. Second, if biases can be homogenous within a given territory, it is unlikely the case across various territories. Third, every Entrepreneurial Ecosystem configuration has its own structural specificities, depending on its own history, culture of collaboration, governance and power, and its specific Entrepreneurial Dynamics attributes.

As a consequence, any research design to compare Entrepreneurial Ecosystems in order to be able to quantitatively, or using case methods, compare them, should strongly include a bias

reduction approach, in order to initially select the most comparable territories, or a-posteriori reduce data heterogeneity.

9) A place-based field of research

Entrepreneurial Ecosystem is a place-based phenomenon (Maroufkhani, Wagner and Wan Ismail, 2018) in which distance plays against Entrepreneurial Dynamics as it is related with cost of entrepreneurship (Roundy and Fayard, 2020). Spatial density is, by consequence, a critical attribute of the Entrepreneurial Ecosystem. This underlines also that due to its geographical attribute, every Entrepreneurial Ecosystem is unique (Cowell, Lyon-Hill and Tate, 2018) and can not be replicated as it is. The geographic scope of Entrepreneurial Ecosystem research is by consequence very specific to understand its performance (Feldman, 2014).

In addition to previously mentioned inter-Entrepreneurial Ecosystem observation, is its geographic scope, in order to compare what can be compared. It should be quite accessible to compare the National level Entrepreneurial Ecosystem, when we meet a unique and centralized Entrepreneurial Ecosystem, but shall not be proposed in developed countries or vast geographical areas, where you find multiple Entrepreneurial Ecosystems, and only national level measurements. Entrepreneurial Ecosystem research should be targeted at a local level, which is more relevant compared to national levels, but more challenging to reduce local bias related to EE size and geography.

10) Entrepreneurial Ecosystem role when low Entrepreneurial Dynamics levels are met

Many scholars underline the research and policy makers' obsession for successful Entrepreneurial places, which generate important levels of Productive Entrepreneurship. But as they are limited in number, specific in terms of geography, and other configurational attributes. As a consequence it is hazardous to take them in consideration for any theoretical generalization attempt.

Low Entrepreneurial Dynamic places are in higher quantities, and are most often related to weak places which can be compared by various means. But actually, those territories attract

less attention from researchers, as related papers have a lower publication potential in terms of journal ranking or citations.

Nevertheless, low Entrepreneurial Dynamics levels places have a substantial scientific interest. Low Entrepreneurial Dynamics levels are most often met in lower resource environments, such as low income countries or regions. Less abundant resources in the environment are related to lower Entrepreneurial Dynamics. But in those territories, with -for instance- comparable GDP per capita levels, Entrepreneurial Dynamics measured through TEA levels for instance, can meet interesting gaps. In those places, systematic Entrepreneurial Ecosystem measurements have the potential to reveal what and how Entrepreneurial Dynamics levels are affected.

Propositions

Our main hypothesis there, is that Entrepreneurial Ecosystem Structural research has the explanatory power to understand the lowest levels of Entrepreneurial Dynamics, but less likely to predict their highest levels. With the support of both Network and Modularity perspectives, we can unveil interesting configuration patterns having a theoretical and managerial potential.

First, systematic research on Information and Knowledge spread factors found in various Entrepreneurial Ecosystems can be causal conditions of low Entrepreneurial Dynamics levels. Same for Accessibility and Collaboration factors.

Interdependence between these factors can also unveil processual mechanisms occurring in Entrepreneurial Ecosystem Structures, which also can be causal conditions of Entrepreneurial Dynamics evolution.

We shall also deep dive in sub-level Entrepreneurial Ecosystem Structures' network attributes, such as centrality of some kind of actors, structural holes, or actors' typology behaviors, having a potential causal relationship with related Entrepreneurial Dynamics.

Research Question

Given the developed elements above, our main research question is :

Can we measure the structure of an entrepreneurial ecosystem, and what can we learn from it?

To address this, literature has underlined various perspectives, and decided to run our observations in the interesting African Entrepreneurial Ecosystems. This choice, further detailed in the next section, is mainly based on the interest to observe Entrepreneurial Ecosystem phenomenon in low resources environments, where the rarity of resources reveals the efficiency -or not- of the Entrepreneurial Ecosystem as a structure.

We propose to expose those questions in the three chapters exposed in the present document.

First chapter is meant to establish the foundation of a research design to observe Entrepreneurial Ecosystem actors' interactions under network theory perspective. This first research was conducted on only two countries in order to validate the feasibility of such research and the interest of proposed measures.

The second chapter aims to unveil the causal effect of Entrepreneurial Ecosystem structural attributes on related Entrepreneurial Dynamics. This chapter, presented in two parts, analyses those structural attributes in five distinctive and comparable territories.

The third and last chapter proposes a structural and processual analysis, and an ecological perspective on selected Entrepreneurial Ecosystems, presented in two separate parts.

Methods

The whole purpose of our methodological approach in this foundation research project is to provide the means to observe unknown and under-explored aspects of Entrepreneurial Ecosystems. In addition, related theoretical literature regarding inter-organizational network analysis provide few benchmark measures. In addition, ecological and evolutionary perspectives using Network Theory in social science are both unexplored. This research project has the ambition to create brand new methods, measures and ladders in Entrepreneurial Ecosystem research, which presents scientific acceptability challenges in order to emerge. This obliges us both to dare transpose known working methods in other scientific disciplines, and mobilize them with sufficient robustness.

1) Content of Entrepreneurial Ecosystem Black Box, and how to open it

Opening a Research Black Box is a core aspect of Research Contribution. As suggested by *realist* orientation, this approach requires new methods, semantics and ontology. The new method proposed here consists in mobilizing Network Theory

Such research can open very interesting new research streams (Brown and Mason, 2014) and has the potential to open new theories. It requires managing the unknown. Basically, it requires a test-and-learn research strategy, and to conduct exploratory research.

2) Africa as an interesting field of research

As previously introduced, we predict more interesting research theoretical and managerial contributions in low income countries. Such territories can be found in sufficient quantities in Africa, a continent made up of 54 countries. This vast territory also contains comparable countries in many ways detailed in our three chapters, and present the most important observed Entrepreneurial Dynamics gaps in the world - up to 600% (figure 2.), despite their cultural diversity. We observe also that due to their economic weaknesses, those countries run various forms of protectionism, which also reduce bias related to external influences. This makes Africa probably the most interesting continent to investigate in for our research, despite the various data collection challenges we faced.

But in order to operate proper quantitative or qualitative research, we raised some questions about how to address research in such a large and specific continent. In order to conduct interesting research in that area, we questioned how those territories can be compared to other territories worldwide, and how -within Africa- territories can be compared between each other. We focused on different interesting elements : what entrepreneurship means in those areas, do Entrepreneurial Ecosystems share similar attributes, do African Entrepreneurial Ecosystems share the same kind of maturity, governance and scale issues. Can we measure, as we do it in other territories, Entrepreneurial Ecosystem spillovers in terms of Entrepreneurial Dynamics, unicorns emergence, etc. Those first assumptions will need to be confirmed.

Through existing literature reviews (Sheriff and Muffatto, 2015; Jones *et al.*, 2018; Igwe and Icha-Ituma, 2020), including gray literature, our observation of the Entrepreneurial Ecosystem

field in various African countries during 5 year of participant observation, conducted us to formulate various hypothesis. We observe cultural differences mostly between French and English speaking African countries, within those two groups of territories we observe similar characteristics. As a consequence, we propose in the future to split the analysis of these territories. Beyond this first degree difference, we mostly observe similarities in terms of functions operated by Entrepreneurial Ecosystems (supporting, funding, training, mentoring, etc.), similar kinds of actors (incubators, accelerators, investment funds, etc.), similar behavior in terms of entrepreneurship, and similar entrepreneurship measurement bias such as the degree of informal entrepreneurship. We also observe similar policy makers' willingness to support entrepreneurship, even if the means deployed are not the same from one territory to another. We also detect similar interest from bilateral cooperation with European and Northern America countries within those countries, with still the same split between French and English spoken territories. In most of those countries, we observe one and only Entrepreneurial Ecosystem, established around each country's economic capital, with the notable exception of South Africa which has developed a regional Entrepreneurial Ecosystem. During our observation in developing countries such as Tunisia and Morocco, we identified signs of regional Entrepreneurial Ecosystem emergence. But many things are still unknown in Africa regarding Entrepreneurship and Entrepreneurial Ecosystem, as those countries did not attract much attention from scholars.

3) Geographic scale paradox

Approaching the Entrepreneurial Ecosystem phenomenon in Africa, we noticed an interesting challenge regarding scale of measure. To evaluate Entrepreneurial Ecosystem spillovers, we are led to capture in particular the Entrepreneurial Dynamics, through the Total Early Stage Entrepreneurial Activity (TEA), or similar measures proposed by international institutions such as World Bank. Those measures are actually proposed at a national level. Most actual measures of Entrepreneurial Ecosystems themselves, such as the country profiles proposed by the Global Entrepreneurship Monitor, are also proposing national level indicators. But looking closely to litterature, scholars understand Entrepreneurial Ecosystem as a local phenomenon tied to a specific and limited territory. As a consequence, most quantitative research does not propose measurements at the scale of a given Entrepreneurial Ecosystem.

In our actual research, we focused on some African countries, which all present a unique Entrepreneurial Ecosystem, and economic activity concentration around its economic capital. This situation limits the bias of our research, but shall be further investigated.

4) Dyadic association in Entrepreneurial Ecosystem research

How can we observe dyadic associations between Entrepreneurial Ecosystem actors ? First of all, even in the most advanced territories, we do not find an exhaustive list of their Entrepreneurial Ecosystem actors, nor their collaboration ties. A documental based work can quite easily, even if fastidious, allow to elaborate an actual and exhaustive repository of Entrepreneurial Ecosystem actors, which can be verified and checked with robustness by simple and manual means.

Coming to ties, we face a methodological bottleneck. Primary data seems not to allow an exhaustive analysis, as available documents from various kinds of EE actors present an important heterogeneity in terms of availability, quality, quantity, and nature of content. Even online communication policy and update frequency variation does not allow us to mobilize that kind of documentation to detect dyadic ties, or collaborations of any kind, between Entrepreneurial Ecosystem actors. Their social network profiles could be mobilized, but our investigations showed that post publication density, their content, does not fit with the requirements of this research.

Thanks to a marketing scholar in EMLyon, I came to consider various forms of Entrepreneurial Ecosystem actors' press releases as interesting sources of information. It is evidence that EE actors mobilize various amounts of communication budgets, which can be very low, but those actors need to advertise their offer and value proposition to attract Entrepreneurs. The most accessible communication resource available for them are media, which easily relay their activity.

5) How to systematically collect datas

Research acknowledges the relevance of Big Data (Schwab and Zhang, 2019) from online media (Von Bloh *et al.*, 2019) for Entrepreneurship oriented research. As a consequence systematic data collection of those articles can be reached using online Web Scraping

techniques which are now usual, and made available within various softwares. In addition, online media now expose their extensive archives, allowing longitudinal research.

But one would argue that those proposed data are secondary data. Nevertheless, research acknowledges that in the entrepreneurship research field, the robustness of our construct, theory, method, and the interest of longitudinal research in order to maximize validity of our analysis (Chandler and Lyon, 2001).

6) Data treatment protocol

Supposing we are able to import a relevant data collection, a new challenge arises : how to identify dyadic association in order to mobilize network theory-based methods. A basic mean resides in detecting in a given article two actors. The method to analyze such dyadic association is the method of co-occurrence detection (Jackson, Somers and Harvey, 1989; Feicheng and Yating, 2014) which consists in detecting that two expressions are present in the same document, or segment of text. The sum of co-occurrence detection allows to trace a network.

7) Tools

Actually, the two main solutions for research to proceed robust web scraping and various demanding calculations are Python and the open-source software RStudio. RStudio is actually known as valid, and accessible (Watkins, 2020). RStudio also allows the mobilization of modules called Packages (Guleria and Kaur, 2021) which provide proper tools for web scraping, natural language processing, network calculations and plot design, and many other interesting solutions. There are also network tools such as Gephi (Bastian, Heymann and Jacomy, 2009) that provide complementary and interesting tools.

The use of softwares such as RStudio is preferable, as it is embedded with already setup calculation packages which are -sometimes- produced in partnership with specialists of various fields of research. It is the case for example with Quanteda elaborated using Quantitative Graph Theory specialist methods, *Mathias Dehmer*.

8) Calibration

As previously introduced, to run our analysis, we need two elements : a proper actors list, and a target online media site. For the actors list, we need various elements to be able to run our analysis properly. First, a given actor might have different names, depending on language (french, english), or might have either an extended name and an acronym, and at last, a given actor might have changed his name over time. We have to be able to either run research requests on all those name versions, and at last be able to tokenize all those names in one unique expression, on which we can run co-occurrence calculation. This expression would likely contain no space or special character. In addition, as our research can use roles, attributes or typologies, we are led -for each actor- to include keywords in separate lists or columns (Table 1). In a given territory, we have to produce the most exhaustive list possible, in order to observe its related Entrepreneurial Ecosystem as a whole.

Table 1. Actors table example

Name#1	Name#2	Name#3	Type	Role
Caisse Centrale de Garantie	Tawilcom	CCG	National Institution	Funding

The second foundation is the perfect knowledge of the various technical aspects of the online media website in which we are led to run web scraping techniques. For that, a technical review of each type of targeted page has to be conducted accordingly with web scraping preparation known techniques¹. In our case, we have to identify the specific online research syntax to apply. For example, in the 'l'économiste' website, we can identify that the research method involves inserting the researched term in the website URL in a specific way : [https://www.leconomiste.com/recherche-leconomiste?search_api_views_fulltext=\(term\)](https://www.leconomiste.com/recherche-leconomiste?search_api_views_fulltext=(term)). The second step of Web Scraping consists in scrapping the list of the results. The particular aspect of research results is that they are presented in separate pages when the number of results exceeds each website limit. To properly scrap all the targeted pages, we have to identify the specific tags to import each result URL, as well as the proper method to explore each result page. At last, we have to identify the specific structure of the articles, results of our research, in

¹ <https://smac-group.github.io/ds/web-scraping-in-r.html>

order to be able to separately scrap its title, date of publication and text body. For all those elements, we have to run a technical analysis of the specific HTML and CSS tags of the result pages and the article pages.

9) Data Collection

Mobilizing a web scraping loop with RStudio is a known technique in research (Zhao, 2017; Bradley and James, 2019). Due to the specific aspect of online media website which sometimes requires to have an account and be logged in, we chose to mobilize RStudio Package RSelenium² to run those operations.

The very first step consists in opening a session using the following code :

```
rD <- rsDriver(browser="firefox", port=4545L, verbose=F)
remDr <- rD[["client"]]
remDr$open()
remDr$navigate(site_url)
```

Our method consist in the elaboration of the research request, and paste in in a browsing request as following :

```
remDr$navigate(search_url)
```

As a consequence, RStudio opens the targeted page, and we are then in situation to import its content with the following piece of code :

```
scrp_content <- remDr$getPageSource()[[1]]
```

And then be able to convert the imported content in a proper HTML structure, using rvest³ package :

```
scrp_content <- read_html(scrp_content)
```

The overall structure of our code follows the following logic :

```
for each searched item, run a research query
  for each result page, import the the content
  in this content, identify the list of article URLs
  run a sub-loop to explore the paginated result pages
  if there is no more result for a given item, skip and go to the next item
end the research loop
```

² <https://cran.r-project.org/web/packages/RSelenium/index.html>

³ <https://rvest.tidyverse.org/>

At the end of this procedure, we have a list of researched results as URL for each article containing the researched expressions in which we make sure not to have any duplicate using the following instruction :

```
articles_urls[!duplicated(articles_urls)]
```

Then our code runs a secondary loop to open each URL using *'navigate'* instruction, and scrap the content, analyze it in order to import separately each element needed for the next step of our procedure. To do that, we use rvest specific instructions to import each specific element, the page title, the page text body, and the page publication date. For instance, the page body can be identified using this instruction :

```
html_nodes(scp_page, '.body')
```

10) Data Cleaning and Preparation

At this stage, we first make sure we properly backup our data, as the web scraping procedure can take a lot of time to run all those encapsulated loops and web queries. For example, in one territory we had to import more than 150 000 articles, which required about a week of night and day attention.

We then duplicate all our databases in a separate database to run our next procedures which consist of data cleaning procedures. In that extend, we proceed as following :

- remove punctuation
 - `gsub("[?.;!;ç·]", " ", our_database$content)`
- remove other annoying elements
 - `gsub("[[:punct:]]|[:digit:]]|^http:\\\\.*|^https:\\\\.*", "", our_database$content)`
- convert the whole text in lower case
 - `tolower(our_database$content)`

In this case, \$content designates the 'column' in which the pages bodies are registered. Now our corpus is ready for further treatments. In order to run proper co-occurrence procedures, we have first to tokenize the elements on which co-occurrence identification will be runned. To do that, we create two sub lists :

- a clean item list, which has been treated like the text above : `search_clean_list`
- a tokenized item list : `tokenized_list`

Then, we run the following instruction to convert all the items in tokens :

```
gsub(search_clean_list[[xg]], tokenized_list[[xg]], work_df$content)
```

11) Data Treatment

Now we are almost ready to run our co-occurrence procedure. To do that, we extract our corpus in a separate dataframe and tokenize this dataframe as follow :

```
our_corpus <- corpus(our_database, text_field = "content")
cleaned_corpus <- tokens(our_corpus, remove_punct = TRUE, remove_numbers = TRUE, remove_separators = TRUE)
```

Based on this, we can create a treated token dataframe :

```
token_matrix <- dfm(cleaned_corpus, select = tokendatalist)
```

This opens to create the co-occurrence table, and convert it into a matrix:

```
cooc_table <- t(cleaned_corpus) %*% cleaned_corpus
cooc_matrix <- as.matrix(cooc_table[1:ncol(cooc_table), 1:ncol(cooc_table)])
```

As a result, we have this kind of matrix (Table 2.).

Table 2. co-occurrence matrix

	cgem	berd	anapec	mcise	klusterfcim	ccg
cgem		93	89	0	8	295
berd	93		0	0	0	32
anapec	89	0		0	0	22
mcise	0	0	0		36	0
klusterfcim	8	0	0	36		78
ccg	295	32	22	0	78	

With few additional operations, we can extract a unidirectional graph matrix as follows (Table 3.).

Table 3. tie matrix

from	to	sig
cgem	afem	55.5448610559688
cgem	apebi	31.5469128331169
cgem	cnea	26.5181377185509
cgem	cjd	25.676509740646

cgem	cit	15.1764631059486
cgem	ccg	14.9196315903682
cgem	fondationocp	13.7944807590102
cgem	entreelles	9.41861003357917
cgem	berd	8.74305326421745

12) Network Data Analysis

Network analysis has a consistent legacy, but only recently a sub-methodological discipline allowed to go beyond basic graph analysis in order to produce more quantitative-based results, this discipline is called Quantitative Graph Theory (QGT) (Dehmer, Emmert-Streib and Shi, 2017), and allows to extract dozens of measures, datas and plots from a network.

a) Network measures

The most common and known measures for network analysis are centrality measures (Bloch and Jackson, 2016). These measures can either apply to a network as a whole, or in order to proceed to node analysis in a network. Each centrality measure also has its own meaning, which depends on various network parameters. It also opens to clustering analysis in order to explore the network attributes of a network as a whole, or to analyze sub ensembles in a network, which is particularly interesting to analyze innovation networks (Belso-Martínez, Mas-Verdu and Chinchilla-Mira, 2020).

Then comes density (Marsden, 1993) and distance (Breznik, 2016) measures which allows the analysis of a network as a whole, or on segments. Those very interesting measures can be conceptually parallelized with geographic density and distance measures in order to open new interesting research. Those measures are mobilized in the following chapters.

b) Network plots

Beside the visual qualitative analysis of a network plot, QGT proposes also very interesting graph comparison methods (Emmert-Streib, Dehmer and Shi, 2016) in order to extract interesting attributes. Dendrograms (Caliński, 2014) are interesting plots which have the power to visually represent clusters within a network, and can be of some interest in exploration phase.

c) Compare small number of Ecosystems with QCA

Even if we are led to manipulate big data from our web scraping methods, the bottom line measures we propose are the QCA method (Schneider and Wagemann, 2010). But as we are initially conducted to compare a small number of ecosystems, the most accurate method to compare a small number of cases is fsQCA methods (Kraus, Ribeiro-Soriano and Schüssler, 2018) which is efficient starting from four cases. This method is actually well documented (Lehiany and Chiambaretto, 2019), and softwares and packages to run such methods are available in open source.

d) Longitudinal Network analysis

To explore an evolutionary perspective in Entrepreneurial Ecosystem configuration research, we can also raise longitudinal network analysis (Snijders, 2005), which is a quite rare perspective in research, particularly in social science, but has a very interesting statistical power (Stadtfeld *et al.*, 2020) and can increase validity of results, even based on secondary data. It is made possible if we can identify the actual date of tie creation, which is made possible with online media data.

e) Inter-organizational as individuals or 'species' based measures

In social network research, in our best knowledge, only individual or organizational ties are measured. But if we take the ecological metaphor of Entrepreneurial Ecosystems, we can clearly identify the type of organizations (entrepreneurs, incubators, accelerators, banks, venture capital firms, etc.), each representing a specific species. The interesting analysis of species behavior provides very interesting research in natural science, which inspires to apply the same approach, under network perspective, in Entrepreneurial Ecosystem research.

It can be done by grouping all Entrepreneurial Ecosystem actors belonging to the same species in one simple measure, and observing the strength of ties between species and their evolution. On this basis, the overall methods based on Quantitative Graph Theory can be applied to our research.

13) Thesis plan introduction

To elaborate this thesis, we integrate five complementary articles on African Entrepreneurial Ecosystems. Those articles step by step explore the potentiality of our method, and propose some interesting first findings.

In the first chapter, we present the very first research of our research program. This article explores how to use our method, and allows us to extract interesting first results on the Entrepreneurial Ecosystem interorganizational network.

The second chapter presents two complementary articles which compares the causal mechanisms between Entrepreneurial Ecosystem's interorganizational network attributes and related spillovers in terms of Entrepreneurial Dynamics.

The third and final chapter presents two articles which proposes a longitudinal analysis on both evolution of Entrepreneurial Ecosystem's interorganizational network attributes and topology.

Chapter	Articles	Details
Chapter 1	One exploratory article measuring two African Entrepreneurial Ecosystems	Exploratory research as a first attempt to use our method
Chapter 2	Two articles on five African Entrepreneurial Ecosystems	Explore causal relationships between Entrepreneurial Ecosystem network structural attributes and Entrepreneurial Dynamics levels and trends using fsQCA
Chapter 3	Two articles on four African Entrepreneurial Ecosystems	Explore various Entrepreneurial Ecosystems dynamic structural attributes (longitudinal and processual analysis, topology and network persistence)

Ch. 1. : Creation of a Method

Our first challenge was to build the foundations of our research instrument and method, in order to open the Entrepreneurial Ecosystem structural black box. In this first chapter we present the genesis of this research method, mobilizing both systematic data collection through web scraping, and Quantitative Graph Theory means, through the first analysis of both Moroccan's and Malagasi's Entrepreneurial Ecosystem.

This seminal paper was presented at RENT 2020 conference and selectionned in its RENT ANTHOLOGY book, which will be released in fall 2022. As a consequence many aspects of our theoretical background and method are the foundations of our whole work are drafted in this first seminal paper. It allowed us to validate the scientific interest of our approach, and launch a more demanding research program.

The principal challenge of this first phase of our research was to elaborate our method, tools and measurements, and provide comprehensive results regarding Entrepreneurial Ecosystem research. By doing so, we elaborate an original R code, and test it on two Entrepreneurial Ecosystems, which are two interesting cases in Africa, as those countries present a +300% TEA gap.

This initial research allowed us to identify indications of a so-called discontinuity perspective, i.e., that some entrepreneurial ecosystems present structural weaknesses which have the potential to negatively affect the entrepreneurial dynamics in their territory. Those interesting results justify the potential of our method, and encourage us to continue to develop it in our next research.

Article 1 : Entrepreneurial Ecosystem's Black Box : inter-organizational ties in low income countries, the case of Morocco and Madagascar

Grégory Guéneau⁴, Didier Chabaud⁵, Marie-Christine Chalus Sauvannet⁶

ABSTRACT

What makes one specific Entrepreneurial Ecosystem (EE) more conducive to entrepreneurial activity than another? We mobilize ecosystem and network theories to describe EE processual patterns having an impact on Entrepreneurial Dynamics outcomes. We targeted low income environments to identify the EE effect. An empirical and exploratory research was conducted based on quantitative graph theory, using big data from the scraping of 1,302 web-based articles about 185 organizations. We found that Morocco's disaggregated ecosystem, compared to Madagascar's denser and more modular ecosystem, explains the significant difference of entrepreneurial dynamics between the two countries. It reduces the availability of Entrepreneurial Ecosystem components for Entrepreneurs. These results indicate a process of ecosystem discontinuity that has a negative impact on the associated entrepreneurial dynamics.

1. INTRODUCTION

Entrepreneurial activity presents substantial and unexplained variances globally depending on place, economic or political environments. We observe greater entrepreneurial activity gaps in low income countries such as in Africa (Tran, 2018). These gaps suggest that Entrepreneurial environments in these countries have a significant impact on the effective distribution of available entrepreneurial resources (skills, technologies, facilities, funds)(Stam and van de Ven, 2019). Despite data reliability issues (Bergmann, Mueller and Schrettle, 2014), and methodological lacks (Bell-Masterson and Stangler, 2015), scholars acknowledge that entrepreneur's environment networks and institutional configurations produce better entrepreneurial dynamics than others. Understanding how, in these areas, one specific Entrepreneurial Ecosystem is more conducive to entrepreneurial activity than another is a key

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issue for scholars, practitioners and policy makers. It raises the importance of proper diagnosis and strategies of Entrepreneurial Ecosystems to emerge in a regional or global competition, especially to positively moderate growth issues (Acs, 2006; Boudreaux, 2019), and of the effects of EE on the entrepreneurial dynamics.

Seen under a ‘process-based view’(Spigel and Harrison, 2018b), ‘ecosystems provide a better framework to understand their role in supporting new venture creation’. EE ‘can be better understood as ongoing processes through which entrepreneurs acquire resources, knowledge, and support, increasing their competitive advantage and ability to scale up’. In this same work, Spigel and Harrison argued that successful ecosystems serve entrepreneurs to take advantage of the knowledge, talent, and other resources produced by previous rounds of successful and failed entrepreneurship; they are characterized by stronger positive imprinting effects on entrepreneurs and new ventures, their technology and institutional infrastructures; and as a consequence, are not defined by their levels of entrepreneurial activity or firm formation. Those resources are allocated through the interplay of various kinds of actors such as institutions, associations, dedicated organizations (incubators, accelerators, investment funds, etc.) and academic institutions.

It is so necessary to be able to shed light on the influence of EE on entrepreneurial dynamics: to do that we need to take into account the interplay of actors. On this point, some scholars criticize EE research (Acs, Szerb and Autio, 2016; Stam and Spigel, 2016; O’Connor *et al.*, 2018; Cunningham, Menter and Wirsching, 2019), considering it undertheorized (Audretsch *et al.*, 2018), raising the opening of the ‘blackbox’ of the intrinsic process within Entrepreneurial Ecosystem as a central issue. As we need to take into account the multi-level nature of EE and the interplay between the actors (Theodoraki and Messeghem, 2017), we propose to address this point by providing an analysis of the networking structure of the EE, by using Quantitative Graph Theory. A surprise arise here : if Network Theory is regularly underlined(Pittz, White and Zoller, 2019; Purbasari, Wijaya and Rahayu, 2020b; Shipilov and Gawer, 2020) and induced in most EE definition (Malecki, 2018), it has almost never been mobilized to analyse ties in an EE as a whole. We propose to unlock this limit.

Our exploratory study will explore the impact of EE on entrepreneurial dynamics in two African countries. Detecting and measuring the inherent process of Morocco’s and Madagascar’s Entrepreneurial Ecosystem, as an attempt to understand their information and

knowledge sharing attributes, and moreover their modularity attributes, will help to show their influence on associated Entrepreneurial Dynamics.

2. THEORY

An Entrepreneurial Ecosystem is a place centric interorganizational evolving network which works to produce related successful entrepreneurial dynamics. Under an inter-organizational perspective it relies on both Network and Ecosystems theories. The concept can be analyzed at a macro-level of analysis (macro-curriculum, governance system, institution), a meso-level of analysis (rules and regulations, actors supporting the ecosystem as a whole), or at a micro-level of analysis (sub-group of actors) (Theodoraki and Messeghem, 2017). These different levels of analysis are actually debated, underlying weaknesses such as the proper empirical attributes and components of Entrepreneurial Ecosystems. For example the question of who belongs to Entrepreneurial Ecosystems, or what are the resources of an EE, hasn't been clarified. Nevertheless, considering different layers of analysis seems accurate due to the complexity of the concept. But the availability of such components refers for entrepreneurs, at the meso-level of Entrepreneurial Ecosystem, to the concept of Modularity (Baldwin and Clark, 2000). Modularity in terms of resources such as skills, technologies, service, and different forms of financial support. The measure of how those resources are made available and distributed to entrepreneurs thanks to EE network attributes has not been studied yet.

2.1. MESO-LEVEL OF ANALYSIS OF ENTREPRENEURIAL ECOSYSTEM

The first question to define the concept of Entrepreneurial Ecosystem is to define its external boundaries (Tsujiimoto *et al.*, 2018), and the different internal boundaries of its multi-actor network. This question is not yet clarified, of whom should be considered as an Entrepreneurial Ecosystem actor, under which specific attributes or nature of activity. Entrepreneurial Ecosystem concept is related to the new venture creation process in a way that suggests it can embed sector-specific sub-ecosystems (Malecki, 2018) as it becomes more mature. Scholars have underlined that EE is structured in various levels or layers (Spigel, 2017b), as others describe the three levels of analysis of EE (Ben Letaifa, Edvardsson and Tronvoll, 2016), its macro-level for policy makers of institutional change actors, meso-level involves the network of supporting organizations and people to the entrepreneurial process, and micro level dedicated to sub-group of organizations or individuals.

Meso-level of analysis targets the network of all its supporting actors, including various categories of organizations such as institutions, incubators or accelerators, funding institutions dedicated to entrepreneurship, infrastructure actors such as co-working spaces, and group of entrepreneurship oriented organizations such as business angels associations or business leaders associations. The exact attributes of those organizations for their inclusion in the Entrepreneurial Ecosystem is to be defined. The meso-level of Entrepreneurial Ecosystem is an entrepreneurial nurturing components distribution network as its function is to support the entrepreneurial process.

2.2. MODULARITY, NETWORK, AND AVAILABILITY OF RESOURCES

Introduced by (Baldwin and Clark, 2000), the concept of Modularity has since been developed under various perspectives. The relation between modularity and various performance consideration (innovation, economic, etc.) has been developed in a way that suggest that in inter-organizational network, modularity can maintain a relatively good level of shared knowledge, while information spread and share is reduced (Cabigiosu *et al.*, 2015). Both elements are related to entrepreneurial and innovation opportunities. Scholars underline also that various configurations of service modularity, and radical innovation capability, are inter-related (Cheng and Shiu, 2016). As a consequence the network configuration of an Entrepreneurial Ecosystem has an impact on the capability to combine the various components of the Entrepreneurial Ecosystem in various and unique ways to support entrepreneurial efforts.

However, we found convincing evidence that an ecosystem's performance has an impact on its outcomes. Scholars argue that the diversity of ecosystem outcomes affects final consumer satisfaction, for example in the context of the video games industry (Cennamo and Santaló, 2019). For modularity experts, such diversity of outcomes depends on the richness of available components. It suggests there is a positive effect of the availability of various components in an Entrepreneurial Ecosystem and its outcomes.

2.3. ENTREPRENEURIAL ECOSYSTEM STUDY IN LOW INCOME COUNTRIES

Low income countries' specificity is that the general level of infrastructure (Abiad, Debuque-Gonzales and Sy, 2017), research, education (Chua Kenn, 2016) or skills in general (Hidalgo and Hausmann, 2009), through the perspective of economic complexity, are low. As a consequence various oligo-components, and in general the various forms of resources useful

for entrepreneurship are in less quantity and quality compared to more developed areas. As a consequence the entrepreneurial activities in such areas are highly volatile (Tran, 2018), while in higher income countries the entrepreneurial activity gap is reduced. And as most of the time entrepreneurial activity has an impact on economic growth (Carre and Thurik, 2003), for low income countries, having in consequence lower levels of entrepreneurial resources, the question of how to reach a higher level of opportunistic entrepreneurship is a key issue.

This study aims to participate in scholar's efforts to open the Black Box of Entrepreneurial Ecosystems, by the observation of Entrepreneurial Ecosystems's meso-level of analysis. At this level, we analyse EE actors as a whole inter-organizational ensemble. As a consequence we will take in consideration nation's ecosystem, taking into account different kind of organization such as various forms of Incubators (university incubators, private incubators, corporate incubators), venture accelerators, early stage investment funds, fablabs, various entrepreneurial oriented associations and clubs, business angel clubs, dedicated training centers, dedicated clusters, entrepreneurial oriented co-working spaces, schools or universities with dedicated programs, dedicates conferences and forums, nurseries, dedicated supportive institutions (Chabaud and Germain, 2006).

To properly capture the Entrepreneurial Ecosystem impact on its spillovers, we will target low incomes countries having a significant Total early-stage Entrepreneurial Activity gap. As previously introduced we expect that low income generates a low resource environment in which the processual impact of the Entrepreneurial Ecosystem plays a prominent role on its related Entrepreneurial Dynamics. In such an environment, one wonders whether the frugality of available resources makes the Entrepreneurial Ecosystem's impact more tangible. We also predict that in such environments, we can meet difficulties in identifying the exhaustive population of EE actors. We also expect in such an environment having similar ratios of opportunistic entrepreneurship compared to necessity.

In low income countries, we expect to meet nascent or weak ecosystems, and as a consequence competitive behaviors (versus coepetitive behaviors) between its actors, and as a consequence we expect to find poorly interconnected number of actors (actors in the EE network), and meet higher inter-connectivity (Barnes, 1969) rate in high TEA countries. Inter-connectivity is the most basic measure that indicates the ability of an Entrepreneurial Ecosystem to deliver its services effectively, it reduces the time and efforts for entrepreneurs to gather the proper and specific material or immaterial resources dedicated to their project.

We also expect to meet lower density (Marsden, 1993; Liu, 2011) and centrality (Bloch and Jackson, 2016; Pittz, White and Zoller, 2019) levers in lower TEA countries, as density and centrality levels are correlated with information and knowledge spread. Information and Knowledge are key elements for entrepreneurs to accelerate their project, make them more accurate to the market, identify the proper resources in their environment, auto-evaluate their innovation, or gather precious knowledge to complete the various holes in their project.

Meanwhile we expect to meet higher distance metrics (average shortest path, diameter, clustering coefficient, mean distance) in higher TEA countries (Bienstock and Györi, 1988). Distance reduces the opportunity to reach the proper components for an entrepreneurial project, and an Entrepreneurial Ecosystem having high distance rates reduces its modularity potential.

Finally, grouping all these metrics, we expect in low income countries to see weak entrepreneurial ecosystems, and to be able to classify their ecosystem as disaggregated in low TEA conditions, and agile in high TEA conditions.

***H1** : In Entrepreneurial Ecosystems in low income countries, inter-connectivity rate between actors have a positive impact on TEA level*

***H2** : In Entrepreneurial Ecosystems in low income countries, density & centrality rates have a positive impact on TEA level*

***H3** : In Entrepreneurial Ecosystems in low income countries, distance rates have a negative impact on TEA level*

3. METHODS

3.1. FIELD

It is in Africa we expect to find interesting cases. 2018's Global Entrepreneurship Monitor provides a list of Middle East and Africa countries TEA study, in which we find the following low income countries, ranked from the lowest to the highest level of TEA : Morocco, Egypt, Madagascar, Sudan, Angola.

Morocco, Egypt, Madagascar, Sudan and Angola are listed as low income countries, and looking closely we find the lowest level of TEA in the whole continent in Morocco. Countries

like Egypt present a $\pm 200\%$ gap with Morocco, Madagascar a $\pm 300\%$ gap, and Angola a $\pm 600\%$ gap (Figure 5). The probably most comparable countries, with the highest TEA gap, are Morocco and Madagascar. Both have French occupation history, political and administrative structure, common roots, bi-language, population density, low natural resources level, etc. Both have a similar mature press sector due to their colonial roots, providing the same level of information availability on their Entrepreneurship activity (Table 4).

Figure 5. African TEA levels per country (GEM 2018)

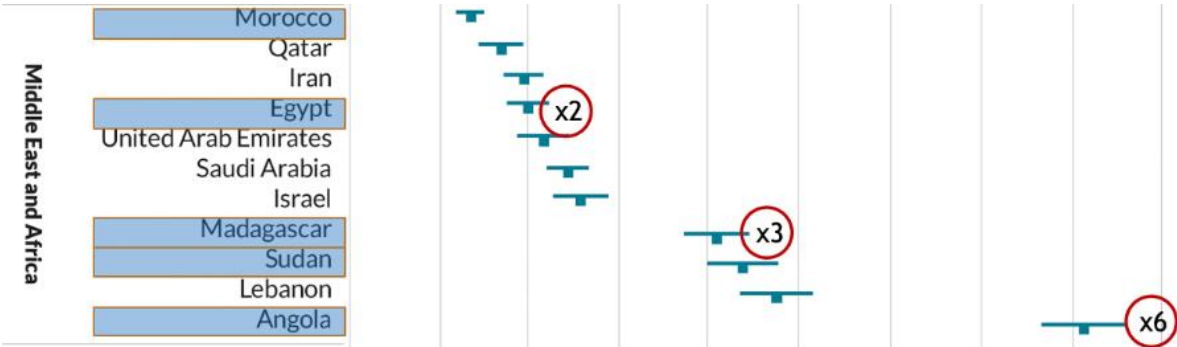
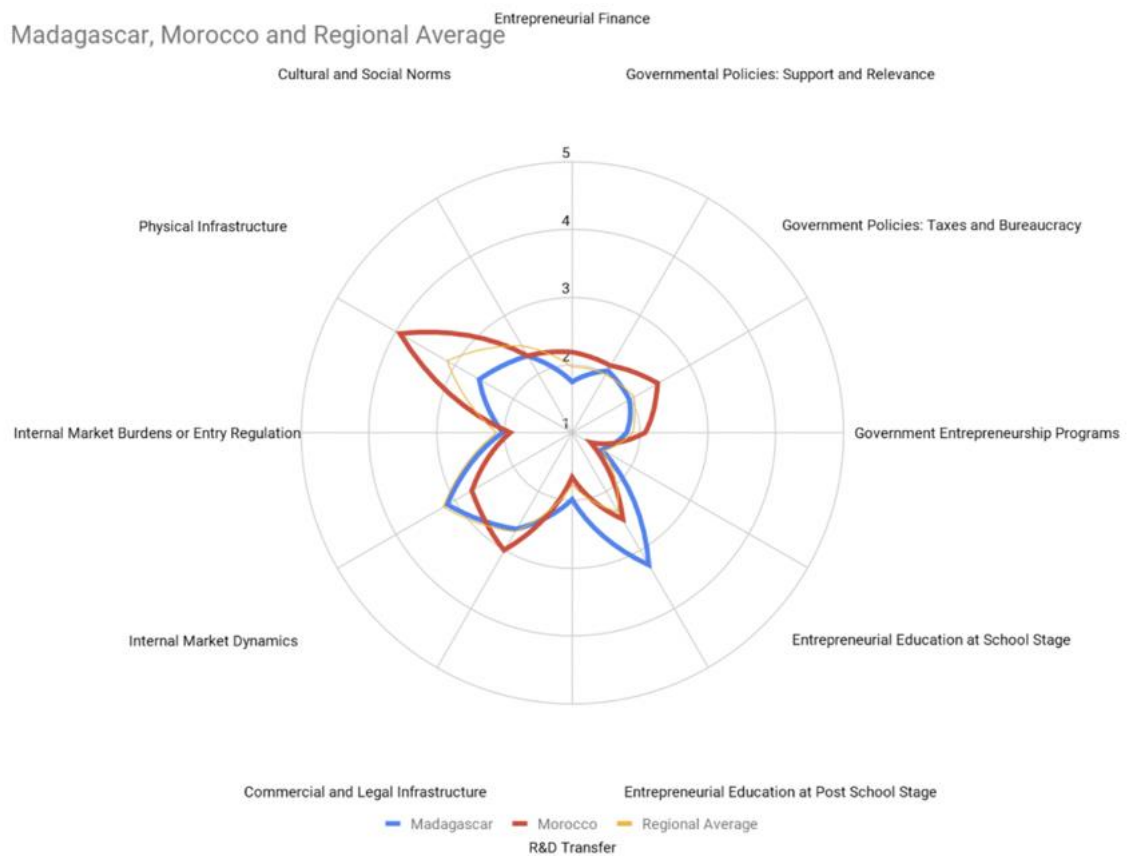


Table 4. Comparison table between Morocco and Madagascar

	Morocco	Madagascar
Total surface	710 850 km ²	587 041 km ²
Population	34 314 130 p.	25 683 610 p.
Population Density	48 p/m ²	44 p/m ²
Languages	Arabic and French	Malagasy and French
GDP per capita	2 997 \$ (2016)	461 \$ (2018)
GDP growth	1,1% (2016)	2,8% (2018)
TEA	6,65 (2018)	20,74 (2018)

The analysis of the environment run by the Global Entrepreneurship Monitor (Figure 6) shows clearly that if there is an environmental advantage, it is more in favor of Morocco who over-perform in terms of physical infrastructure compared to Madagascar, and the whole region average.

Figure 6. Macro-level measurements of Morocco’s and Madagascar’s EEs (GEM 2018)



But despite these similarities, their TEA ratio gap is 311% (Morocco : 6,65; Madagascar : 20,74). The classic evaluation does not propose an explanation for this gap. As Morocco has raised Entrepreneurship as a strategic development priority, with creation of many initiatives for Entrepreneurship with financial tools (such as those proposed by CCG), creation of large business incubators (Technoparks), and welcoming many private initiatives on the field of incubators, accelerators, fablabs, creation of the 'etudiant-entrepreneur' status, etc. Due to history and culture, Morocco is known to develop a strong family and tribal culture (Elboubekri, 2016). Such a strong society structure produces a 'clan network' structure form, with strong community links but medium to low connectedness. In this context, the issue of what specific configuration and process Morocco produces a weak TEA is raised. That raises also the importance of proper diagnosis and strategies to emerge in a regional or global competition, especially to moderate positively growth issues (Acs, 2006; Boudreaux, 2019).

3.2. DATASET

Organizations within an Entrepreneurial Ecosystem need to advertise their effort to develop their attractiveness. Each time they do something useful for entrepreneurs, develop a new offer, or sign a joint-venture to raise the level of their service to new ventures, or each time a state program is deployed across the ecosystem, actors announce those projects to the public, using press relation techniques to obtain publications, taking for granted that journalists are sensible to the general interest and entrepreneurial efforts are key for the whole country.

Interconnectivity between actors in an Entrepreneurial Ecosystem can be identified through press releases and public announcements as described hereafter. In the kind of unformalized ecosystem we study in the present research, we do not expect to have access to contracts (if they exist) of partnership between EE actors, and social network analysis such as people interconnection. Social Media relationships wouldn't be relevant to capture partnership or alliance announcement though the entire EE as they are very low level links, and anyway those data are actually unavailable due to the closure of Facebook API. We saw two ways to study EE through the network. The first one would be direct study with entrepreneurs to study their entrepreneurial journey, this would be for sure the most robust study, but the absence of availability of an exhaustive Entrepreneur database, and the possibility to run interviews or polls over the population of nascent entrepreneurs seems impossible in low income countries. Another way is public information such as press articles. Actors want to publicize their efforts and be visible to the population of entrepreneurs to attract them. Press releases and articles are accurate to collect the information of structured relationships between actors in the EE. It would not capture all the relations, but the most important ones. Availability of information is high, because it is public and accessible in journal's websites.

For both countries we collect the list of EE actors. For Morocco, 'OSE au Maroc' (Observatory of Support for Entrepreneurship in Morocco) has been launched in 2019, providing primary datas. For Madagascar, both the French Embassy and Foreign Chamber of Commerce provided the list of EE actors. Morocco has 136 EE actors, Madagascar 50. In both cases, this list is expected to be exhaustive. The available categories of actors are matching with the definition of EE, but as we do not yet have a proper scientific categorization, we could not go further. In Morocco, 'OSE au Maroc', proposes also complementary information such as location, kind of activity (supporting, training, financing, hosting), EE value chain level for each actor (Fundraising support, Innovation support, Marketing Strategy support, Business Plan support, Team building & HR support, IP support, prototype support, test support, sales support). Based on local reputation, and also on their website architecture and number of

articles, we chose ‘L’Economiste’ for Morocco and ‘Midi Madagasikara’ for Madagascar, who both are their first national economic journal. As argued before, using these secondary big datas from online media coverage is accurate to evaluate the Entrepreneurial Ecosystem.

3.3 APPLICATION OF QUANTITATIVE GRAPH THEORY

Taking in account scholars arguing that networks cause performance changes and not the other way around(Stuart and Sorenson, 2007), and the omni-present network evocation in Entrepreneurial Ecosystem litterature, we are forced to conclude that the field has to be empirically explored under a Network and Ecosystem perspective, as we demonstrated earlier. Those perspectives rely massively on Graph Theory, and new developments in Quantitative Graph Theory suggest its application in the Entrepreneurial Ecosystem field. The various metrics of QGT to identify the general attributes and characteristics of an Entrepreneurial Ecosystem, and attempt to deduct its impact on Entrepreneurial Dynamics, its outcomes. To do that, we can explore various network attributes :

- The general archetype of an Entrepreneurial Ecosystem as a generic information on its category;
- The inter-connectivity of an Entrepreneurial Ecosystem, measured by the proportion of interconnected actors related to the total number of actors, this basic measure provide general information about the “onboarding” level of supporting organizations in the Ecosystem;
- The density and centrality measures provides informations about the information and knowledge spread potential of an Entrepreneurial Ecosystem;
- The distance, clustering, diameter and average shortest path length provide information about the ease to access the modular components of an EE for Entrepreneurs.

The interesting characteristic of Quantitative Graph Theory is that it allows comparison of two networks or more, based on its different attributes(Emmert-Streib, Dehmer and Shi, 2016). This kind of comparison called ‘comparative graph analysis’ in deterministic networks target the differents analytics methods, in which those are accurate to the Entrepreneurial Ecosystem field : isomorphism-based measures, such as comparison of interconnected actors, centrality, density, and various distance attributes.

3.4. PROCEDURES

3.4.1. List the Actors and identify a media

First of all we cleaned the list of actor's names to make them searchable. We uploaded both EE actors databases in a table format, and cleaned the various typing errors. We looked at the web research method of the related media sites, and changed the format of the list depending on search computing format. We created a duplicate list of the same items, and transformed it in lowercase, and erased the spaces. This transformation is necessary to run properly further scripting needs. We then imported the two lists in R⁷, the targeted application for the next steps of the procedure.

3.4.2. Automatic webscrap actor's related articles in media's website

We prepared the web scraping script. Based on rVest⁸ package, we developed a loop script functioning in two steps. The first step launched a web research on the targeted website. The loop allows running this procedure automatically for each supporting organization name. This will allow us to repeat our python programming in R. The result of the search is a page with blocks representing each article with the targeted organization in the article. The two websites present a maximum of 10 results with pagination if the number of articles exceeds 10. We did not program to deep dive into paginations as we supposed that the 10 first articles would provide the last news of those organizations that would represent the actual state of their partnerships at the time of the study. But as those websites represent the whole list of articles in their database, further development will allow longitudinal study. The second step is the opening of each article page, and the import of its content in a proper database in R. To be able for this script to run, we had to expertise the specific HTML and CSS structure of the search result page, and of the article page, for our program to run properly. We runned the two scripts. We manually dismissed 25 queries that found no result, meaning that no article was written on a given organization. We found 812 articles for Morocco, and 490 for Madagascar, both results registered in an R database, which makes an average of 6 articles per actor for Morocco, and 5 for Madagascar. After randomly checking the articles and the formation of dyads of structures in these articles, we decided not to filter those articles, as all of them evoke collaborations

⁷ Using R Studio command "list("actor1" , "actor2" , "actor..." , "actorN")"

⁸ <https://cran.r-project.org/web/packages/rvest/rvest.pdf>

between structures (journalists do not name other organization names if they are not directly related to the subject of the article, and those articles all talk about specific organization activity).

3.4.3. Prepare the imported data to create a co-occurrence table

For each country, we run the following steps. We created in R a corpus⁹ase. A corpus base is a specially structured database for further treatments. We then run various cleaning scripts to transform rough imported texts into usable texts for text mining techniques. Once we had cleaned web scrapped corpus, and cleaned the structure list, we ran a document frame matrix transformation of our corpus base using our list of structures, then established a structure to structure co-occurrence matrix (Figure 7) to evaluate the relations between structures. The analysis of the result provides the following information (for Morocco) meaning that 812 articles were found talking on 79 organizations.

Document-feature matrix of: 812 documents, 79 features (98.3% sparse).

Figure 7. Co-occurrence Matrix

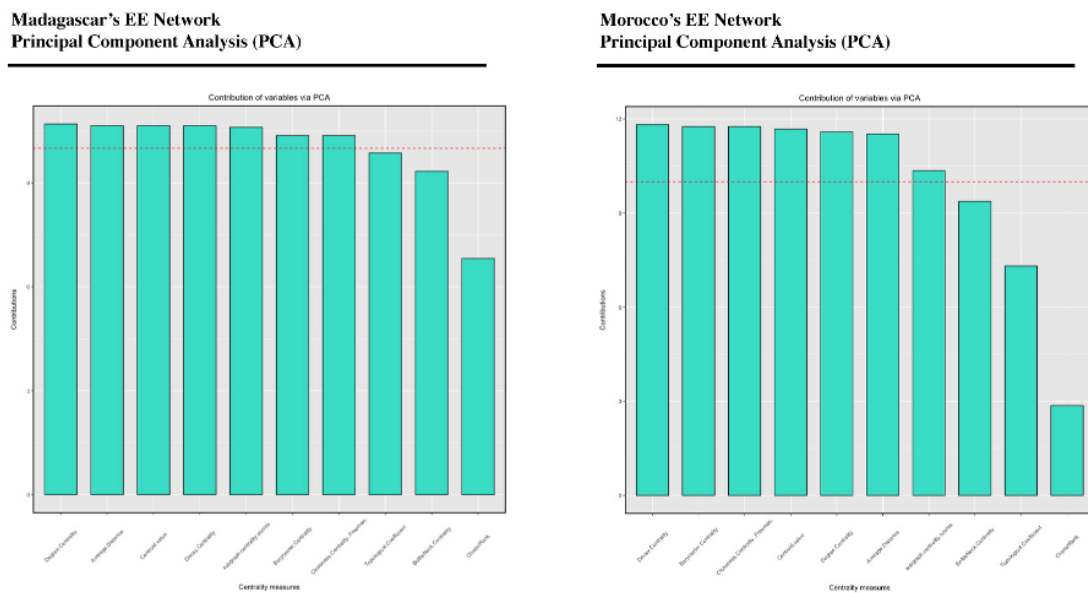
```
> as.matrix(coocCounts[1:10, 1:10])
```

	7ay	cid	cdg	anapec	adalia	add	apebi	giz	afineety	africinvest
7ay	1	0	0	0	0	0	0	0	0	0
cid	0	3	0	0	0	0	0	0	0	0
cdg	0	0	1079	0	0	0	0	0	0	1
anapec	0	0	0	13	0	0	0	1	0	1
adalia	0	0	0	0	102	0	0	0	0	0
add	0	0	0	0	0	13	8	5	0	0
apebi	0	0	0	0	0	8	18	5	0	0
giz	0	0	0	1	0	5	5	33	0	1
afineety	0	0	0	0	0	0	0	0	4	0
africinvest	0	0	1	1	0	0	0	1	0	42

For each structure we created a 'Freq' variable to sum the number of findings of the structure name over the database, the 'mutual information' name and significance ranked, the 'dice index' ranked, and the 'log-likelihood index' ranked. For instance, all these metrics are indicating the centrality role of CCG in the Moroccan EE around CCG. Then we created a statistical significance table and exported it.

⁹ <https://www.rdocumentation.org/packages/tm/versions/0.7-8/topics/Corpus>

Figure 9. PCA on both Madagascar's and Morocco's EE Networks

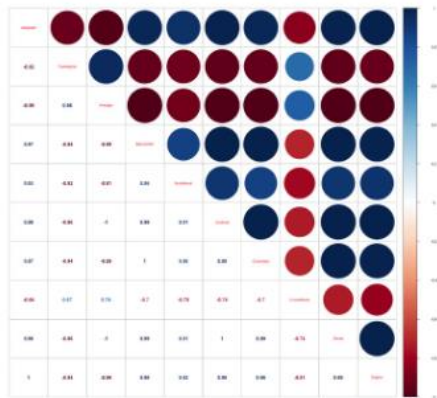


As a complementary proper centrality measure, we created the Pearson correlation matrix using CINNA¹⁰ (Figure 10.) among computed centrality measures. The red to blue highlighted circles represent the top to bottom Pearson correlation coefficients (Benesty et al. 2009) which differ from -1 to 1. The higher the value becomes larger, circles' sizes get larger too. We compared the PCA and Pearson results, and identified a pair of measures above the red line both representing distance and centrality measures. As a complementary check, we can visualize centrality measures and heatmaps of centrality measures of each actor in the EE. We identified Closeness Centrality (Freeman) and Average Distance centralities to be studied.

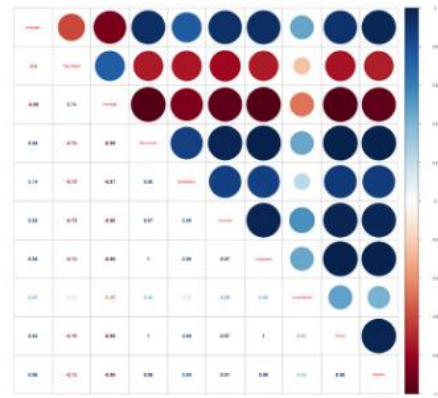
Figure 10. Madagascar's and Morocco's EE Networks Pearson correlation matrix

¹⁰ <https://cran.r-project.org/web/packages/CINNA/index.html>

Madagascar's EE Network
Pearson's correlations

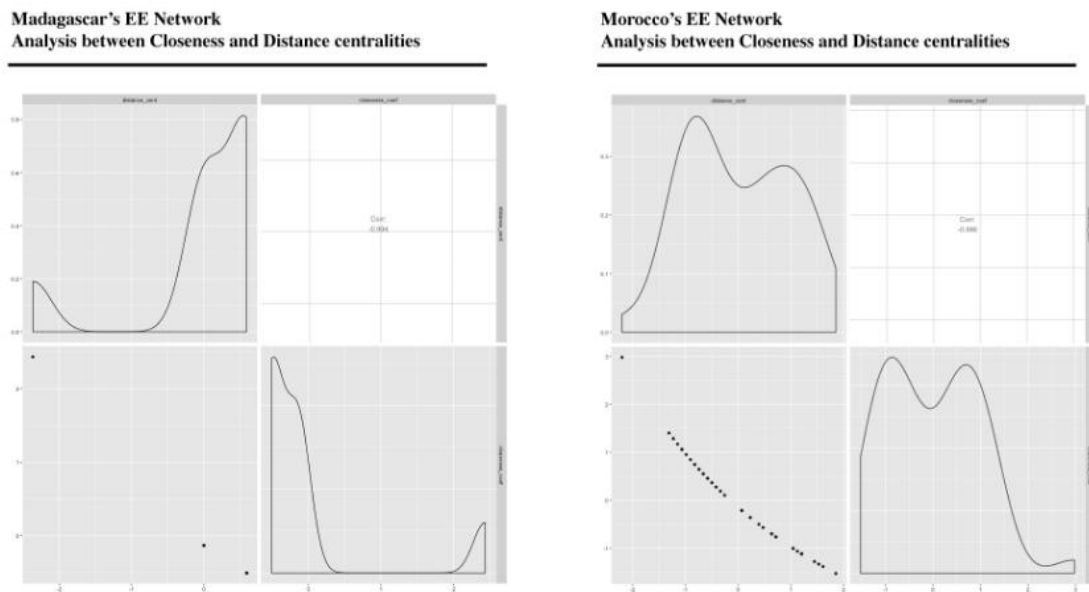


Morocco's EE Network
Pearson's correlations



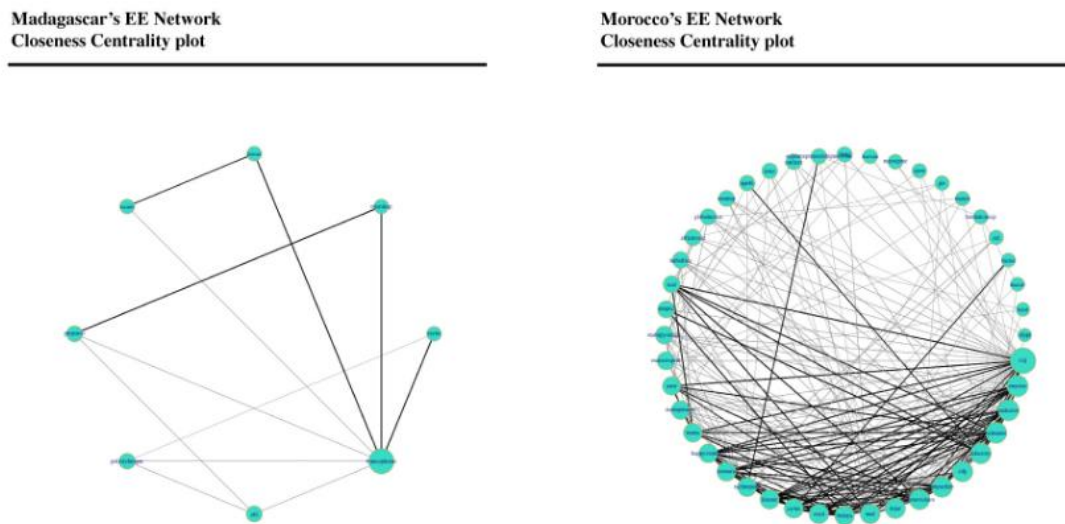
We then runned correlation analysis between Closeness and Distances Centrality measures, we applied linear regression for each pair of centralities. To access the distribution of centrality values and their corresponding pair correlation value, the Pearson correlation (Benesty et al. 2009) is used for this method (Figure 11.).

Figure 11. Analysis between Closeness and Distances measures in both countries



3.4.6. Producing proper measurement plots for both countries

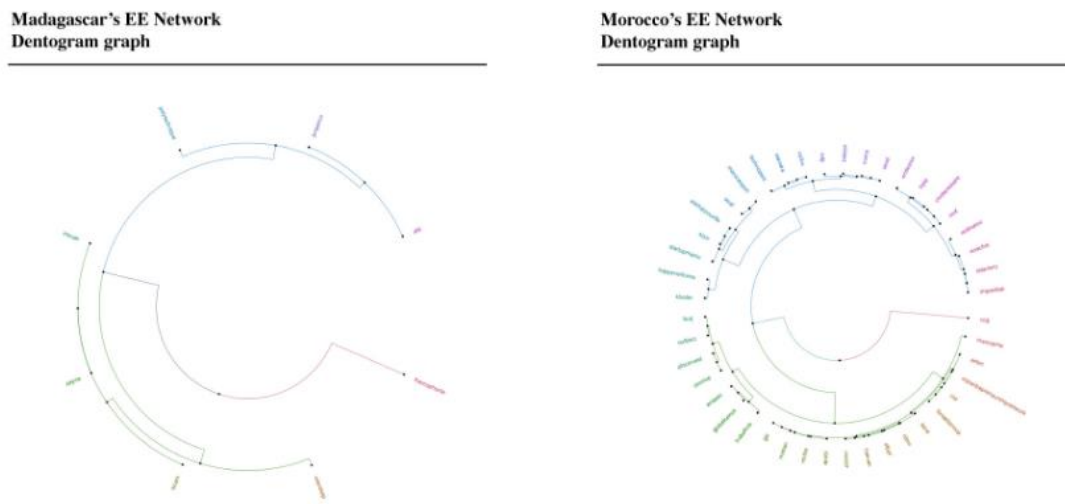
Figure 12. Madagascar's and Morocco's EE Networks Closeness Centrality plots



After evaluating centrality measures, demonstrating high values of centralities in some nodes gives an overall insight about the network. By using plot visualizing functions, we illustrate the input graph based on specified centrality value. We produced a Closeness Centrality plot (Figure 12) and Wiener Centrality plot.

In order to visualize a simple clustering across the nodes of a graph based on a specific centrality measure, we can use the Dendrogram graph in which colors indicate the clusters. Circular dendrogram plot of vertices based on specified centrality measure. Each color represents a cluster (Figure 13.).

Figure 13. Madagascar's and Morocco's EE Networks dendrograms



All these analyses are meant to deeper analyze the various configurations within an Entrepreneurial Ecosystem.

3.4.7. Consolidated top level measurements

Finally we build a consolidated table of top level measurements (Table 5.).

Table 5. Moroccan and Malgasy Entrepreneurial Ecosystems measurements

Results	Morocco	Madagascar	Gap
Actors -a	136	50	
Nodes - N	35	10	
Interconnected actors (N/a)	25.74%	20.00%	77.71%
Vertices - M	393	22	
Interconnectivity (M/N)	11.22857143	2.2	19.59%
Density - d	0.4154334	0.7857143	189.13%
Centrality -c	0.4799154	1	208.37%

Average Weight	3	2	
Average Shortest Path	1.910148	1.5714286	82.27%
Clustering Coefficient	0.4919646	0.4411765	89.68%
Mean Distance	1.910148	1.5714286	82.27%
Total early-stage Entrepreneurial Activity	6.65	20.74	311.88%

4. RESULTS

We will present our results for each of our hypotheses.

H1 : In Entrepreneurial Ecosystems in low income countries, inter-connectivity rate between actors have a positive impact on TEA level : rejected

In Madagascar and Morocco, interconnected actors ratio is low, (20% and 25,74%), which means that respectively 80% and 74,26% of actors are isolated. It means that the major actors working effectively in the Entrepreneurial Ecosystem are those in interconnection. The quite simple and short Madagascar's interconnected Entrepreneurial Ecosystem provides a better support for Entrepreneurship compared to Morocco's one. A deeper dive in Morocco's Entrepreneurial Ecosystem components (see Practical implications) shows that Morocco's Entrepreneurial Ecosystem is mainly focused on fundraising support to Entrepreneurs, as Madagascar's one is more balanced. It shows also that the higher degree of actor's interconnection does not apparently play a substantific role on the TEA, as we have here a slightly negative effect of interconnectivity on TEA.

We do not actually have data from more developed countries, but the number of EE actors in these countries, and their interconnection, seems to indicate Nascent Entrepreneurial Ecosystems, where competition prevails. This should be validated in the future with proper studies in medium and high income countries.

H2 : In Entrepreneurial Ecosystems in low income countries, density & centrality rates have a positive impact on TEA level : validated

Madagascar's and Morocco's results show a positive correlation between density and centrality measures and their TEA levels. Those measures have a $\pm 200\%$ increase as the TEA have a $\pm 300\%$ increase, indicating that those measures have a substantial weight on TEA growth. Considering their meaning on the Information and Knowledge share, we argue that those considerations play a great role in an Entrepreneurial Ecosystem. As a consequence, every program that aims to spread laterally substantial information about entrepreneurial opportunities, and share of knowledge would have a substantial impact on local TEA.

***H3** : In Entrepreneurial Ecosystems in low income countries, distance rates have a negative impact on TEA level : validated*

As predicted, distance measures (diameter, average shortest path length, mean distance, clustering coefficient) are lower in a higher TEA country (Madagascar). Their shorter gap indicates an even greater impact of modularity of components on Entrepreneurial Dynamics. Proximity to Entrepreneurial Ecosystem actors benefit related Entrepreneurial Efforts, as entrepreneurs can easily pick in the various available resources to build or reinforce their project.

Based on these results we can classify Madagascar's Entrepreneurial Ecosystem as an Agile EE. Morocco is a disaggregated parasite EE, as its scale indicates a median position on the weak-strong axis.

5. DISCUSSION

5.1. THEORETICAL IMPLICATIONS

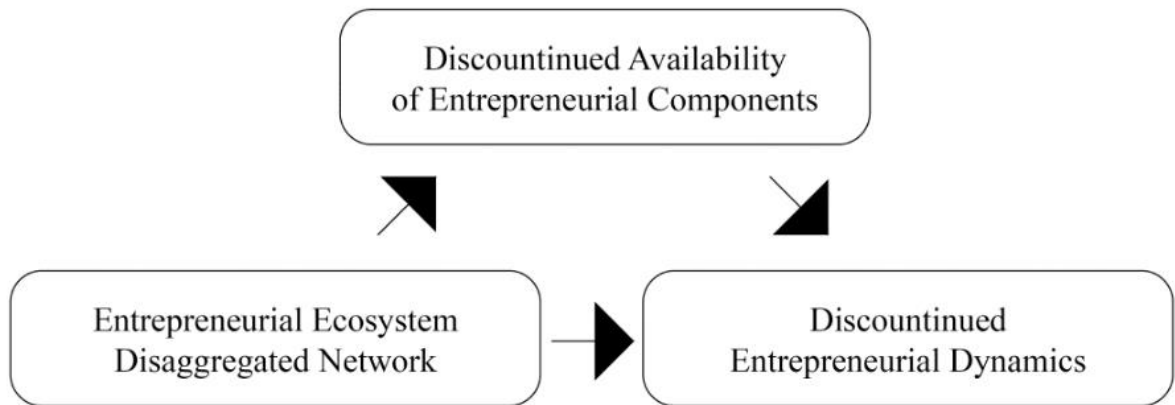
The essential contribution of this work is at a meso-level of analysis of EEs. At a Macro level of analysis, governance and culture topics are considered. In this perspective the actual result indicates essentially future research questions such as how actors ties are encouraged, the specification and accuracy of the various Entrepreneurship oriented infrastructures such as multi-actor facilities, and a definition canvas for entrepreneurial oriented shared resources. It meets scholar's indications on EE governance (Audretsch and Moog, 2020). At a meso-level of analysis, this research indicates EE behavior, such as the potential parasite nature of EE

under various conditions of resources and size. Supporting actors have to feed themselves to survive, if their population is high, they capture resources that are meant to feed the Entrepreneurial effort, putting a negative pressure on Entrepreneurial Dynamics.

This research is one of the firsts to empirically measure EE as a whole, opening interesting perspectives to deep dive into the various network attributes of EE, their meaning, causes of those attributes, and impact on its spillovers.

At a meso-level of analysis, our research purpose, we learn from this exploratory study that the various network attributes of an Entrepreneurial Ecosystem impact related Entrepreneurial Dynamics. How ? By distributing Entrepreneurial nurturing components, suggesting a Modularity perspective. This ability relies on the presence of support components (skills, knowledge, dedicated services, etc.) and their distance to the entrepreneur's hand. Entrepreneurial Ecosystem Actors produce and deliver those components, but their inter-organizational network configuration can hinder their accessibility to the entrepreneurs. We showed that poor network attributes of an Entrepreneurial Ecosystem can both undermine its related Entrepreneurial Dynamics, by reducing the spread of information about the existence of those components, and reducing their accessibility. Reduced accessibility attributes have a negative impact on Entrepreneurial Dynamics. This empirical evidence sketches a discontinuity process in Entrepreneurial Ecosystems (Figure 14.) and new research perspectives. This interesting perspective resonates with complexity oriented papers (Hidalgo and Hausmann, 2009; Muñoz and Kibler, 2016).

Figure 14. Discontinuity process in Entrepreneurial Ecosystem



Discontinuity of the Entrepreneurial Ecosystem has a double negative effect on Entrepreneurial Dynamics. An ecosystem which has substantial distance attributes, and poor inter-connectivity level, will reduce the accessibility of the various available components, entrepreneurs will either ignore their existence or meet resistance to access them, slowing the general Entrepreneurial Dynamics levels. There is also a direct relation, a weak EE will slow Entrepreneurial Dynamics, as it produces a hindering effect on Entrepreneurial Dynamics.

At a micro-level, there are practical implications.

5.2. PRACTICAL IMPLICATIONS

For actors themselves, this evidence leads to new possibilities to combine their value chain with others, clarify their proposition value, and the inputs and the outputs of their offering. It reinforces the necessity to create shared events, tool sharing, entrepreneurial culture events. The new theoretical angle of view on Entrepreneurial Ecosystems can provide new ‘bridging’ practices between actors.

On the meso-level of analysis, we have attempted to go further with the use of non-scientific datas coming from OSE au Maroc, as an empiric effort to clarify the Entrepreneurial Ecosystem value chain in Morocco. These attributes are Fundraising, Innovation, Marketing Strategy, Business Plan, Team Building & HR, IP, Prototype, Test and Sales support. The various members of its ecosystem were evaluated under a likert-like scale (low 1 - 5 high) for each attribute. Based on this database, we run a basic calculation to identify the average weight of the various EE value chain elements, targeted only on the significant actors in the EE.

Due to the network configuration, most of the components of value creation across the Moroccan Entrepreneurial Ecosystem are not in a situation to be easily assembled in favor of new ventures, with real potential -or not- of each offer. On the other hand we easily see that the EE Moroccan network is focused on funding, and not on complementarity of elements, key entrepreneurial resources, distribution of skills, market and product orientation. It means that despite the fact that Moroccan's Entrepreneurial Ecosystem's Network is more inclusive of its actors, those actors are likely more fundraising oriented. It leads to the conclusion that Morocco is a 'Parasite Entrepreneurial Ecosystem' as it essentially helps entrepreneurs to raise funds, and in between pay themselves, rather than delivering the proper diversity of components for a proper Entrepreneurial Dynamics growth.

The actual work also provides substantial evidence at the macro-level of analysis, that a proper governance model should be identified, within the field, or may be in adjacent fields such as in Italian Industrial Districts, whose structure and dynamics are similar to Entrepreneurial Ecosystems. It also provides risk management highlights on actors inclusion (a governance issue is to promote collaboration between EE actors, and their diversity), modularity management (governance should be attentive to 'parasite' behaviors, promote the production of diverse and quality components in the ecosystem, clarification about their inputs and outputs, and create a 'market' for those components) and information and knowledge sharing (promote a large, multi-lateral and deep effort of entrepreneurial information and knowledge share).

5.3. LIMITS

This research is the first of its kind, with many limits due to the innovativeness of our approach.

First of all, we have to moderate our findings considering different environments and culture impacting EE behavior; GEM metrics and more generally network and ecosystem measurements should have different meanings, interpretation and understanding due to specific language, culture, history, social and business norms between countries like Morocco and Madagascar.

As a consequence there is an intrinsic bias in this study we could not moderate in the results. But as said before, there is a significant difference between the two countries TEA, that ecosystem and network perspective should explain most of the related effects. We could not measure weight of network effect, due to lack of control variables that should allow us to identify the significance of our results related to TEA, this should be done in the future, though a qualitative study with a randomly selected entrepreneurs to understand what other elements limit their efforts, then stepping back on quantitative approach to measure those factors.

Despite the possibility to compare two or more graphs using Quantitative Graph Theory method, we could not propose a more robust comparison to the dyadic analysis between Morocco and Madagascar, such as Quantitative Comparative Analysis methods (Ragin, 1987; Kraus, Ribeiro-Soriano and Schüssler, 2018), limiting the robustness of our last results. We could not capture other forms of collaboration, due for instance to traditional business forms, in low resource countries there can be strong ties but under the floating line, this could be captured with qualitative research with isolated EE actors to explore what kind of side but not public collaboration can occur across the network, and then again run quantitative approaches. In order to identify variances and process details in our Entrepreneurial Ecosystem discontinuity process, we should in the future run a longitudinal study to capture the evolutionary pattern between EE form, resource discontinuity effect and Entrepreneurial Dynamics evolution.

As Necessity, Opportunity and High Growth Entrepreneurship are different levels of analysis related to the outcomes of Entrepreneurial Ecosystem, and we face a lack of dataset on those dimensions, there is a natural limit to understanding the TEA gaps between Madagascar and Morocco. We can only deduct from their respective level of development that those levels are kept into the same scale. But this could substantially change the final result.

The Total early-stage Entrepreneurial Activity ratio is a nationwide measure. It can not capture actually a more local based Entrepreneurial Activity. The Entrepreneurial Ecosystem concept, as initially built on a local based evidence (silicon valley), and as Entrepreneurial Ecosystems are more developed at a local scale (city or region), we are not actually sure that our study fits the concept. In more developed countries, TEA measures entrepreneurial activity which can be very consistent even where Entrepreneurial Ecosystems are not present. Measuring at the national level those ecosystems can create validity issues. But as in low

income countries the economic and innovative activity is very centralized where their Entrepreneurial Ecosystems are installed, measures are then much more accurate. But a proper study should be run on these perspectives.

We ran this study at the time of capture of datas (based on the last 10 online media articles on each actor), but consistent effects of Entrepreneurial Ecosystems on their Entrepreneurial Dynamics should be studied using longitudinal datas. This also should be done.

Finally, our theoretical and methodological approach has to be consensually approved.

5.4. FUTURE RESEARCH

This first exploratory research on Entrepreneurial Ecosystem's black box, especially in the field of components and modularity should be done in the near future. It will be essential to capture in the future the proper ecosystem effect on entrepreneurs. Exploring the nature and the various attributes of Entrepreneurial Ecosystem's components is a central question for the near future. Such a study should open the perspective to draw the 'value chain' of the Entrepreneurial Ecosystem as a whole.

A second future research perspective should be run on how an Entrepreneurial Ecosystem impacts the final customer satisfaction (the startup's clients). Such an outcome oriented study could provide critical information on the specific Entrepreneurial Ecosystem configuration of network and component providing more attractivity to the market.

More study of the same kind should also be conducted to gather more data to enrich the present study and refine its outcomes, validate its theoretical perspectives, identify control variables, and robustness techniques. These complements, especially if they are realized in other countries, would enable the use of Qualitative Comparative Analysis, as a way to test the robustness of comparisons between countries. This would be interesting to understand, through Network Theory lenses, how an EE, in its working process using inter-organizational ties between its actors, impacts the level or evolution of related Entrepreneurial Dynamics. Such research could bring new insights on EE at a meso-level of analysis.

6. CONCLUSION

This exploratory study opens many empirical applications of Quantitative Graph Theory to the field of Entrepreneurial Ecosystem field, having substantial theoretical explanation potential on various phenomena. The unique bridge between those three elements brings many new perspectives. It opens new angles of analysis within the field with quantitative big data methods and measurements.

Based on recent network-ecosystem research work, and new perspectives in the Entrepreneurial Ecosystem field, we contributed to organizational theories suggesting the application of both network and ecosystem theory to the Entrepreneurial Ecosystem field. The contribution to the EE field lies first in a structured research canvas, using both these perspectives, that details reference definitions, field of study, research questions, variables and mechanisms, data and measurements. With this empirical study we showed the accuracy of such an approach.

Opening the Black Box of the Entrepreneurial Ecosystem field, we opened new areas of research. As there is a strong relation between organizational and strategy theories, we could also, in the future, open new areas of research in terms of EE strategies.

At a managerial level this work opens perspectives to better understand EE work and identify organizational and managerial tools to raise actors' competitiveness at the organizational and ecosystem level.

This work opens many other perspectives and a research agenda, suggested by our research canvas. Our present attempt to identify the mechanisms and behaviors of EE by combining the data and variables to be studied, implies the emergence of a discontinuity theory related to EE, and suggests to open up empirical research to stimulate and develop EE and improve entrepreneurial dynamics in low income countries.

Ch. 2 : Entrepreneurial Ecosystem network impact on Entrepreneurial Dynamics

The two papers presented in this chapter consist of exploring interesting configurational causal effects of the entrepreneurial ecosystem on their outcomes, in our case Entrepreneurial Dynamics represented through Global Entrepreneurship Monitor's TEA measure. Those papers' interests were acknowledged by the scientific community with an International Entrepreneurship and Management Journal publication for the first paper, and a presentation in the Academy of Management conference paper session for the second.

Our research challenge in this phase of our research program was to make it possible to identify causal mechanisms between Entrepreneurial Ecosystem interorganizational network attributes and related Entrepreneurial Dynamics measured through TEA levels. Research provides an interesting method in order to compare a limited number of cases : fuzzy set Qualitative Comparative Analysis (fsQCA). We decided to expand our research to five interesting African countries which present interesting similarities and an homogenous set of cases in order to meet validity criterias.

We explored the role of three groups of network measures : closeness, cohesiveness and interconnectedness ; the role of the central actor in those Entrepreneurial Ecosystems, and found interesting attributes which are causal conditions of strong TEA levels or trends. Given our results, we have complementarity discontinuity indications, and present interesting potential strategies to stimulate Entrepreneurship for the weakest places.

Article 2 : Opening entrepreneurial ecosystem's black box: the power of networks in African low income countries

Grégory Guéneau¹¹, Didier Chabaud¹², Marie-Christine Chalus Sauvannet¹³

ABSTRACT

What makes one type of entrepreneurial ecosystem (EE) more conducive to entrepreneurial dynamics than another? EE research is a hot topic, and considerable progress has been made as regards its elements, network, and actors' components. However, some scholars regret the absence of an empirical analysis of EE as a whole to understand how EE configuration operates. To introduce this perspective, we propose an unexplored inter-organizational ties analysis among all EE actors, at a country-level scale. Based on the network theory perspective, we conduct an exploratory research in five low-income African countries, using innovative research methods (the quantitative graph theory, web scraping, the fuzzy-set qualitative comparative analysis) to understand the organizational patterns in these EEs, and their impact on entrepreneurial outcomes. At the core of this perspective lie inter-organizational ties measures of closeness, cohesiveness, and inter-connectedness, which are key causal conditions for high entrepreneurial dynamics levels and rates in low-income countries. This research underlines the importance of EE network attributes to facilitate the easy distribution of entrepreneurial nurturing components to entrepreneurs. It also highlights the importance of ease of information and knowledge flow, as well as a strong collaborative and competitive environment to make an EE more conducive to entrepreneurial dynamics.

Keywords

Entrepreneurial Ecosystem • Network Theory • Quantitative Graph Theory • fsQCA • Big Data • Africa • Entrepreneurial Dynamics

1. INTRODUCTION

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Since Van De Ven's (1993) paper on "infrastructure for entrepreneurship," and Isenberg's (Isenberg, 2010) seminal work, the analysis of entrepreneurial ecosystem (EE) has become a popular research topic (Velt, Torkkeli and Laine, 2020). EE is a "set of interdependent actors and factors coordinated in such a way that they enable productive Entrepreneurship" (Stam, 2015). It underlines the inter-organizational nature of EE, and—by design—a field of research meant to "explain entrepreneurial activities" (Cantner *et al.*, 2020). Even as the knowledge of EE has improved drastically, several core topics remain under-explored; scholars criticized the EE concept (Acs, Szerb and Autio, 2016; Cunningham, Menter and Wirsching, 2019), pointing at "superficial generalisations" research (Stam and Spigel, 2016), regretting the inconsistency in terms of social science-oriented methods (O'Connor *et al.*, 2018) and the lack of a "clear analytical framework that makes explicit what is cause and what is effect in an EE" (Alvedalena and Boschmaa, 2017). This might be explained by a theoretical and empirical research (Cavallo, Ghezzi and Balocco, 2019; Cao and Shi, 2020) void at a meso-level of analysis, and a lack of research on structural and organizational patterns among the EE elements at a full EE scale. Such analysis would explain how EE-specific organizational configuration weighs on the effective distribution of its resources, and is a causality of entrepreneurial dynamics.

In order to address these criticisms, we have to take into account the composition of EEs, their inter-dependencies, and, especially, understand the properties of EE interactions at a global level. EE comprise interacting elements (Stam and van de Ven, 2019) that are diverse in their roles and nature: physical infrastructure, demand, intermediaries, talent, knowledge, leadership, or finance (Isenberg, 2010). If the system theory (Daniel *et al.*, 2018) and the complexity theory (Roundy, Bradshaw and Brockman, 2018) are classically evoked to modelize EEs, it appears interesting to consider a core aspect of EE: the network theory.

The network theory is regularly highlighted (Purbasari, Wijaya and Rahayu, 2020b) and induced in most EE definitions (Malecki, 2018), but it has never been empirically mobilized to understand what arises at an EE whole scale. We propose to improve on such research. As EEs comprise organizations, to understand their interactions, we are led to research their inter-organizational ties (Granovetter, 1985; Tatarynowicz, Sytch and Gulati, 2016; Gaonkar and Mele, 2019; Xu, Yan and Xiong, 2019). We chose the quantitative graph theory (QGT) (Dehmer, Emmert-Streib and Shi, 2017), an innovative method for EEs, in order to analyze its actors' dyadic ties. Indeed, this method allows us to identify EE network properties (Barnes, 1969; Auschra, Schmidt and Sydow, 2019), and better understand EE effectiveness in resource

distribution to entrepreneurs. As the use of this method in the context of EE is new, we decided to realize an exploratory empirical analysis.

To avoid a high noise effect of external elements in the understanding of the EE impact on entrepreneurial dynamics, we chose low resource environments. In ecosystems, everything matters. If an important factor is reduced (in our case resources), the other elements, such as the efficiency of inter-organizational ties, reveal the properties that influence related entrepreneurial dynamics. Research on causes of entrepreneurial dynamics reveals interesting results in the lowest resources environments. Indications that low knowledge and resources stimulate international entrepreneurship (Baier-Fuentes, Guerrero and Amorós, 2020) are interesting, as well as indications of existing higher efficiency EE in low-incomes countries (Dionisio, Inácio Júnior and Fischer, 2021). Such evidence suggests that in low-resource environments, EE plays a more significant role to stimulate entrepreneurial dynamics compared to high-resource environments, where the relative abundance of resources attenuates the importance of a well-performing EE. Research acknowledges that a low-resource environment undermines entrepreneurial dynamics (Muñoz *et al.*, 2020), underlining a positive effect on necessity entrepreneurship and a negative effect on opportunistic entrepreneurship. However, these studies do not capture the EE configurational causes of those entrepreneurial dynamic variances in the low-income countries group. In this group we can see an unexplained and significant Total early-stage Entrepreneurial Activity (TEA) level and evolution variance (Tran, 2018) among low-income countries. For this reason, we chose to run this research in a continent where we can find similar and comparable low-income countries: Africa.

We propose to open new perspectives on EE under a network theory standpoint, by measuring inter-organizational ties between its actors using QGT methods, in the context of select low-income countries in Africa, especially Morocco, Tunisia, Burkina Faso, Senegal, and Madagascar. The analysis of the causality of EE outcomes in a reduced number of countries is evaluated through a fuzzy-set qualitative comparative analysis (fsQCA). By doing so, we provide a new understanding of the power of network within the entrepreneurial ecosystem, and how its network attributes stimulate or undermine related entrepreneurial dynamics. One would consider that, in a sense, we open “the black box” of EE, and so, new points of view in this field of research (van Gelderen, Wiklund, and McMullen, 2021).

2. THEORETICAL BACKGROUND AND HYPOTHESIS

The under-explored entrepreneurial ecosystem under social science perspective

A rising number of scholars point out that EE literature lacks “rigorous social science research” perspectives (Stam and Spigel, 2016; Audretsch *et al.*, 2018). Recent empirical studies explored micro-level of the analysis scale approach, for example, with a network theory micro-level of analysis on incubators (van Rijnsoever, 2020), entrepreneur network-oriented perspective (Tiba, van Rijnsoever and Hekkert, 2020), structural perspective at a local micro-level scale (Scheidgen, 2020), network perspective at a local micro-level scale (Purbasari, Wijaya and Rahayu, 2020b), network-oriented triple-helix approach at a local scale (Purbasari, Wijaya and Rahayu, 2020a), and mix-method to capture local evaluation of antecedents and outcomes (Muñoz *et al.*, 2020). These micro-level analyses address local or small groups of actors, but none addresses the analysis of EE at a country level, or the analysis of inter-organizational ties of all EE actors or elements.

Some scholars propose a research canvas in network adjacent fields of research (Shipilov and Gawer, 2020), but it is not actually mobilized in EE research. Nevertheless, the network theory research canvas suggests an interesting question in the EE research field: how can one EE produce more entrepreneurial dynamics than another ?

Inter-organizational ties within entrepreneurial ecosystems

The inter-organizational ties stream of research, established by William Evan (1965), saw interesting research in trust measurement (Seppänen, Blomqvist and Sundqvist, 2007), relations between network structure and innovation attitude (Ferraro and Iovanella, 2016), configurations (Wooten and Sacco, 2017), and network formation (Gaonkar and Mele, 2019), all suggesting that inter-organizational network configuration has a significant impact on performance. Inter-organizational ties in EE are place-centric (Autio *et al.*, 2018; Kuebart and Ibert, 2019), suggesting that physical distance plays a key role in its effectiveness. However, the issue of network distance has not yet been addressed, despite the fact that network closeness appears to be key in an EE (Purbasari, Wijaya and Rahayu, 2020b). This opens an inter-organizational perspective in EE research.

EE is a complex phenomenon. Scholars highlight its multi-level characteristic (Theodoraki and Messeghem, 2017), complexity (Phillips and Ritala, 2019), and its underlying various forms of

cooperation (Xu, Yan and Xiong, 2019; Purbasari, Wijaya and Rahayu, 2020a). Nevertheless, in EEs, inter-organizational ties (Dagnino, Levanti and Mocciaro Li Destri, 2016; Tatarynowicz, Sytch and Gulati, 2016; Belso-Martínez, Mas-Verdu and Chinchilla-Mira, 2020; Shipilov and Gawer, 2020) appear to be a key research element to evaluate the efficiency of entrepreneurial support, especially regarding the “central role of alignment between structure and process” (Krishnan *et al.*, 2020). The outputs of multiple dyads can be combined into a “broader innovative whole” (Davis, 2016), which can explain EE outcomes variances.

Entrepreneurial ecosystem spillover measurement

The “creation of new business is seen as a key factor to reach economic goals at regional and national levels” (Micozzi, 2020). There are various entrepreneurial dynamics measurement methods (Mathews and Zander, 2007) mainly at a national level (Sternberg, Bloh and Coduras, 2019), such as the Global Entrepreneurship Monitor’s (GEM) TEA, and the motivation index, which evaluate the opportunity entrepreneurship level. Moreover, the GEM provides a multi-factor econometric-oriented evaluation of EEs at a country level. The World Bank Group Entrepreneurship Survey (WBGES) proposes entry density measurement. The “GEM data may represent the potential supply of entrepreneurs, whereas the World Bank data may represent the actual rate of entrepreneurship” (Acs, Desai and Klapper, 2008). Therefore, Research designates the TEA level and rate (TEA evolution on time basis) as the preferred metric to evaluate EE’s attributes’ impact on its outcomes.

Network theory measurements applied to entrepreneurial ecosystems

Some studies apply the network theory at a micro-level of analysis, but never on a larger scale. Recent research on the network and ecosystem theories (Shipilov and Gawer, 2020) has offered an interesting perspective on the elaboration of an EE research canvas (Theodoraki, Messeghem and Rice, 2018). As the network theory relies massively on the graph theory, the recent development of the QGT (Dehmer, Emmert-Streib and Shi, 2017) and associated methods, measurements, and tools provide fresh empirical research perspectives. The provided analytic methods facilitate the grasping of EE’s global properties through its network attributes based on its actors’ dyadic ties. There are three groups of interesting attributes: cohesiveness, inter-connectedness, and closeness, which capture different dimensions of the EE configuration.

Entrepreneurial ecosystem cohesiveness

Two measures provide a network's cohesiveness information: centrality and density. Locally addressed research on actor roles (Purbasari, Wijaya and Rahayu, 2020b) reveals the importance of these measures for understanding how information and knowledge spread impact an ecosystem outcome. They are extremely important in the context of EE (Agarwal, Audretsch and Sarkar, 2007; Kuebart and Ibert, 2019; Audretsch and Belitski, 2020) as they are strongly related to its innovation and productivity capabilities. Centrality measures indicate the cohesiveness level of a network (Borgatti and Everett, 2006). An EE that has high cohesiveness provides an entrepreneur a high degree of information on its resources and actors, which leads to a positive impact on the outcomes. It benefits the autonomy of the entrepreneurs and the effectiveness and speed of their entrepreneurial process. Therefore, we predict that a high level of cohesiveness is a causal condition for a high level and high rate of entrepreneurial dynamics.

Hypothesis 1a: EE actors-ties high cohesiveness is a causal condition for high TEA level

Hypothesis 1b: EE actors-ties high cohesiveness is a causal condition for high TEA rate

Entrepreneurial ecosystem inter-connectedness

The inter-connectedness measure is based on the average weight measure, which calculates the average number of ties of each actor in a network. This indicates the degree to which a network provides multiple paths possibilities to entrepreneurs who have to travel across the EE to collect a resource. As an addition, we completed this measure with the rate of actors that have at least one tie, as we see that some EE actors seem isolated, with no partnerships. We predict that high inter-connectedness levels are a causal condition for high entrepreneurial dynamics level and rate.

Hypothesis 2a: EE actors-ties' high inter-connectedness is a causal condition for high TEA level

Hypothesis 2b: EE actors-ties' high inter-connectedness is a causal condition for high TEA rate

Entrepreneurial ecosystem closeness

A third set of measures, the distance measures, with the average shortest path, clustering coefficient, and mean distance, is also highly useful to evaluate a network. It allows us to evaluate the connectedness and connectivity (Barnes, 1969) between network actors, and, consequently, the intensity of various forms of collaborations (Xu, Yan and Xiong, 2019) across the EE. This information is important to appreciate the distribution capability of entrepreneurial nurturing components. Short distance measure means proximity, and we reversed those measures to provide a proximity factor. We predict that a high level of closeness is a causal condition for high entrepreneurial dynamics level and rate.

Hypothesis 3a: EE actors-ties' high closeness is a causal condition for high TEA level.

Hypothesis 3b: EE actors-ties' high closeness is a causal condition for high TEA rate.

3. DATA AND METHODS

EE actors in 5 African low-income countries: Morocco, Madagascar, Burkina Faso, Senegal, and Tunisia

We decided to apply this methodological approach to an unexplored but stimulating context: Africa. We chose, as a case study sample, five culturally similar low-income countries, presenting important TEA gaps (-6,46% to 115%) (GEM, 2019): Morocco, Madagascar, Burkina Faso, Senegal and Tunisia. These countries present other similarities too: French occupation history, similar institutional structures, and cultural similarities (Donaldson, 2020).

Research design and protocol

We designed a new research protocol to perform a rigorous and relevant analysis of the EE of each of these countries, and to conduct a comparative analysis between them. We defined 10 methodological steps: (1) draw the complete list of EE actors within each country; (2) verify that list and identify the appropriate online media that contains the most EE actors' information; (3) clean the actors' list and prepare sub-set lists for automated treatment; (4) identify the dyadic data source and identify web CSS codes to run a web scraping loop; (5) run the web scraping

loop and verify the result; (6) run a data pretreatment protocol to identify dyadic associations; (7) identify the central actor and the number of inter-connected actors; (8) run the various R specialized packages to extract measures, plots, and statistics; (9) build a country comparative table from extracted measures; and (10) run an fsQCA data calibration and an fsQCA statistics protocol.

Steps 1 to 3

To identify all the EE actors (incubators, accelerators, fablabs, institutions, business angels, etc.) we decided to mobilize economic services from French and German embassies to identify the proper source(s) to list the EE actors. We verified the robustness and accuracy of the given repositories of actors by checking social networks and web pages of each actor, corrected typographical errors in their names, and removed some actors that appeared not to belong to EE, such as accountants or communication agencies. The final list presents a total of 472 actors: 141 for Morocco; 50 for Madagascar; 62 for Burkina Faso; 56 for Senegal; and 163 for Tunisia.

Steps 4 to 5

Thereafter, we needed to analyze ties between actors, and for this, we used online media coverage. EE actors advertise their partnerships and ties through press releases; journalists directly report them, making media coverage relevant for detecting positive dyadic associations. They indicate strong and positive inter-organizational ties, as none of the actors would publicly communicate an existing negative or weak tie, or the end of a partnership. Other forms of communication, such as social network posts, embed noisy messages or negative ties, making these sources of information irrelevant. Partnerships among EE actors are neither always contractually formalized, nor reported in existing EE repositories. This makes press releases the only available and the most significant secondary data source to track positive, and known, inter-organizational ties among EE actors. To identify EE actors' inter-organizational ties, we used big-data from online media coverage (Von Bloh *et al.*, 2019) in the targeted country's top economic online journals, employing web scraping.

We chose the open-source R Studio software packages¹⁴ to run web scraping protocols, and various network measures, plots, and analyses. To operate this protocol, we developed a

¹⁴ Main R packages used: rvest, ggraph, netrankr, tnet, and CINNA

genuine R code of 800+ lines to run the web scraping loop and treatments, and QGT calculations, plots and statistics. In order to develop the code, we prepared a cleaned list of actors, as well as identified the target HTML page web structure to operate and target the web scraping method.

Steps 6 to 9

We analyzed the network properties of the EE. We used the QGT measurements to quantify structural information of networks (Dehmer, Emmert-Streib, and Shi, 2017), as well as various forms of comparative analyses, based on isomorphism-based measures, graph edit distance, iterative graph similarity methods, string-based measures, and graph kernels. Its characterization for determining the complexity of a given network can be obtained through distance-based graph measures, degree-based measures, eigenvalue-based measures, or information-theoretic measures. For this exploratory research, we chose to extract cohesiveness, inter-connectedness, and closeness measurements. This research, using the QGT, provides five countries nine sets of results, each measure having specific explanations (Table 2) related to EE outcomes casualties.

Step 10

After modelizing the five EEs through network theory-related methods, it becomes possible to compare them to understand what is going on. The appropriate method to compare a limited number of cases is the qualitative comparative analysis (QCA) method (Ragin, 1987). It can provide an interesting causality analysis of EE measures on its outcomes. However, for this exploratory research, QCA does not fit to run this attribute-base comparative analysis (Kraus, Ribeiro-Soriano and Schüssler, 2018). Contrastingly, the fsQCA is suitable to reach this goal, and has been successfully used in EE research in Africa (Beynon *et al.*, 2020). In order to perform the fsQCA, we first created a data calibration matrix, and prepared our dataset. Using the fsQCA's truth table, we obtained the potential causal configurations. We used the fsqca¹⁵ software for the calculations (Beynon, Jones and Pickernell, 2021).

This research design, applied to the five selected low-income countries, led to some interesting results that we present in the following section.

4. RESULTS

We web scrapped each national top online economic journal for a total of 54,060 articles citing at least one of the 472 listed actors, representing inter-organizational ties announcements from 2014 to 2020. Counting the co-occurrence of those actors in articles allowed establishing dyadic associations and elaborating the QGT graph matrices, network plots, and measures. Using bottom-line network measures, we drove a comparative analysis using fsQCA methods to identify how the EE network impacts its outcomes in these countries.

Country level network measures

Extracted measures from our protocol provided interesting metrics on the expected dimensions (Table 6.), each one having a specific meaning (Table 7, Measure). They represent the various cohesiveness (centrality and density), inter-connectedness (average weight and inter-connected actors' ratio), and closeness measures (reverse average shortest path and mean distance, and clustering coefficient). We reported the known TEA levels for the five selected countries from the country profile page of the GEM website.

¹⁵ <http://www.socsci.uci.edu/~cragin/fsQCA/software.shtml>

Table 6 : Country level EE network and outcomes measures

		Morocco	Madagascar	Burkina Faso	Senegal	Tunisia
	Actors (a)	141	50	62	56	163
	Articles (ar)	16,588	6,863	2,388	4,653	23,568
	Nodes (N)	85	19	7	19	75
	Vertices (M)	970	25	4	85	411
Cohesiveness	Density (d)	0.34	0.16	0.67	0.81	0.3
	Centrality (c)	0.46	0.41	1	0.69	0.38
	Cohesiveness factor (c*d)	0.16	0.07	0.67	0.56	0.11
Inter-connectedness	Inter-connectivity (N/a)	0.6	0.38	0.11	0.34	0.46
	Average weight (aw)	4	7	2	3	4
Closeness	Average shortest path (asp)	1.99	3.08	1.5	1.56	2.07
	Clustering coefficient (cc)	0.44	0.14	0	0.47	0.35
	Mean distance (md)	1.99	3.08	1.5	1.56	2.07
	Proximity factor $_{((1-asp)*(1-md))}$	0.25	0.11	0.44	0.41	0.23
Outcome	TEA level 2018 (ta)	6.65	20.74	29.75	38.55	4.78
	TEA level 2019 (tb)	11.4	19.4	33.53	40.28	10.3
	TEA rate 18_19 (tb/ta)-1	0.71	-0.06	0.13	0.04	1.15

The first interesting result is the inter-connectivity ratio, presenting the proportion of actors reporting inter-organizational ties.

fsQCA data calibration

Those sets of measures (cohesiveness, inter-connectedness, closeness) have not yet been mobilized in the EE field of research; we do not have measurement benchmarks to compare our results to existing ones. Based on a Boolean approach, owing to the limited number of studied countries, and the relative contrast of those measurements, we built the following data calibration matrix, except for the outcome measures (Table 7). For each measure, we described

its global meaning, crossover point, and qualitative threshold calibration rules in order to obtain a Boolean result.

Table 7: The fsQCA data calibration

Abbreviation	Concept	Measure	Crossover point	Qualitative threshold calibration
D	Density	Global cohesiveness of the EE	0.6	[1] for full membership ≥ 0.6 [0.5] crossover point 0.6 [0] for non-membership < 0.6
C	Centrality	Global cohesiveness of the EE around the central actor	0.5	[1] for full membership ≥ 0.5 [0.5] crossover point 0.5 [0] for non-membership < 0.5
Aw	Average weight	Average number of inter-connections between EE actors, indicating a collaboration activity rate	4	[1] for full membership ≥ 4 [0.5] crossover point 4 [0] for non-membership < 4
Asp	Average short path	Average number of actors to pass through to cross the EE, indicating the ease for an entrepreneur to navigate through the EE	2	[1] for full membership ≥ 2 [0.5] crossover point 2 [0] for non-membership < 2
Cc	Clustering coefficient	The coefficient of grouping and agglomeration of EE actors, presenting potential sub-communities within the EE	0.4	[1] for full membership ≥ 0.4 [0.5] crossover point 0.4 [0] for non-membership < 0.4
Md	Mean distance	Is the summa of all shortest paths between actor couples divided for the total number of actor couples, providing a complementary asp measure	2	[1] for full membership ≥ 2 [0.5] crossover point 2 [0] for non-membership < 2
Inter_r	Inter-connectivity rate between EE actors	Rate of inter-connected actors (N) among the total EE actors population (a): (N/a) , indicating the spread of EE partnership activity	0.4	[1] for full membership ≥ 0.4 [0.5] crossover point 0.4 [0] for non-membership < 0.4
cohe_f	Centrality and density measures factor, as indication mean: $(c*d)$ of information and knowledge spread, and network cohesiveness	Centrality (c) and Density (d)	0.5	[1] for full membership ≥ 0.5 [0.5] crossover point 0.5 [0] for non-membership < 0.7
prox_f	Reverse distance measures is an indication of EE actors' proximity rate	Proximity of actors factor: $((1-asp)*(1-md))$	0.4	[1] for full membership ≥ 0.4 [0.5] crossover point 0.4 [0] for non-membership < 0.4

TEA level	Total early-stage Entrepreneurial Activity 2019	Global Entrepreneurship Monitor in country profile data	30	[1] for full membership ≥ 30 [0.5] crossover point 30 [0] for non-membership < 15
TEA rate	TEA yearly evolution levels	TEA evolution rate between 2018 and 2019	1	[1] for full membership ≥ 1 [0.5] crossover point 1 [0] for non-membership < 0.5

Following this matrix, we built an algorithm to automatically calculate the calibrated data (Table 8) in order to avoid any error.

Table 8: fsQCA calibrated data

Country		Morocco	Madagascar	Burkina Faso	Senegal	Tunisia
		Cohesiveness	Density	0	0	1
	Centrality	0	0	1	1	0
	Cohesiveness	0	0	1	1	0
Inter-connectedness	Inter-connectivity	1	0	0	0	1
	Average weight	1	1	0	0	1
Closeness	Average short path	0	1	0	0	1
	Clustering coefficient	1	0	0	1	0
	Mean distance	0	1	0	0	1
	Proximity	0	0	1	1	0
Outcome	TEA level	0	0,5	0,5	1	0
	TEA rate	1	1	1	1	1

Based on this calibrated data (Table 8.) , we first elaborated the fsQCA truth tables so as to identify five significant causal solutions: (C1) centered on a high cohesiveness and proximity among EE actors; (C2) with high cohesiveness, clustering coefficient, and proximity; (C3) with high inter-connectivity, average weight, and clustering coefficient; (C4) with high average weight and low average short path and mean distance; and (C5) with high inter-connectivity and average weight with low average short path and mean distance.

Based on these solutions we drove a necessary conditions analysis in order to identify the most consistent and explanatory solutions (Table 9).

Table 9: Solution table

Attributes	Solutions	C1	C2	C3	C4	C5
Cohesiveness	Density					
	(h1) Centrality					
	Cohesiveness	●	●			
Inter-connectedness	Inter-connectivity			●		●
	(h2) Average weight			●	●	●
Closeness	Average short path				○	○
	(h3) Clustering coefficient		●	●		
	Mean distance				○	○
	Proximity	●	●			
Outcome	TEA level (a)					
	Consistency	0,80*	0,80*	0,60	0,20	0,20
	Coverage	1,00**	0,67*			
				0,3	0,1	0,1
				7	7	7
	TEA rate (b)					
Consistency		0,33	1,00**	1,00**	1,00**	
Coverage		0,17	0,37	0,50	0,50	

no indication: solution might be high or low

● High level

○ Low level

C1 & C2 solutions' consistency: 1,00**; solutions' coverage: 0,40; combined: 0,63

C3 & C4 & C5 solutions' consistency: 0,50; solutions' coverage: 0,33; combined: 0,13

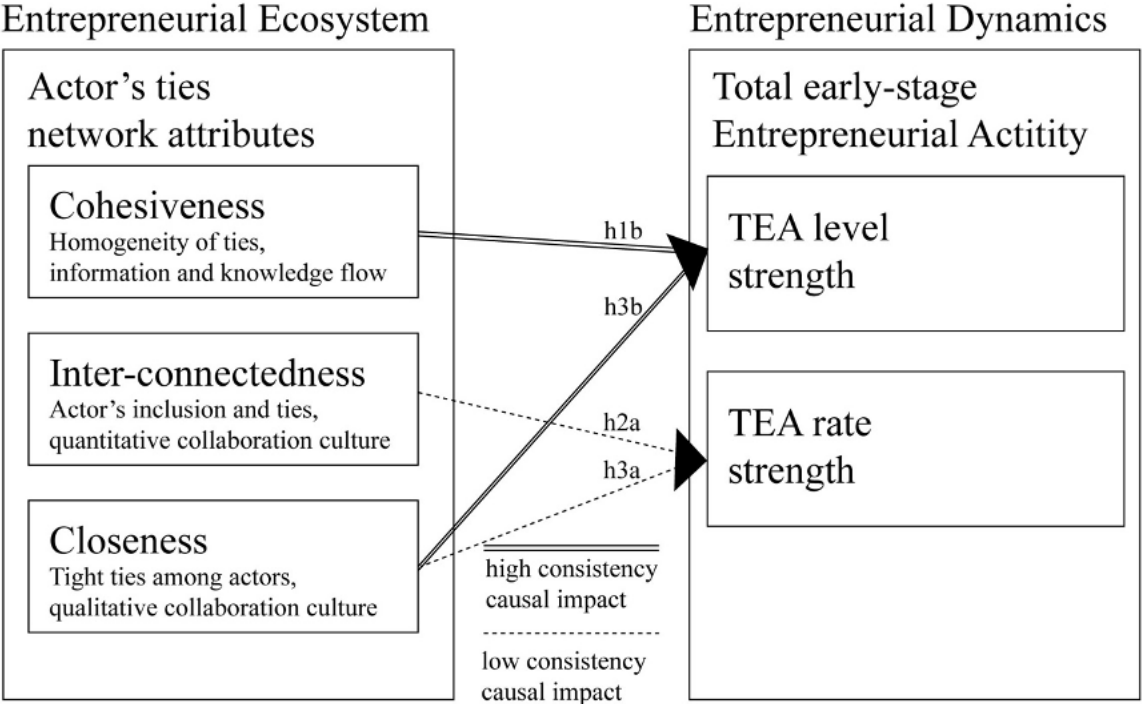
When the consistency of a causal combination is less than 1, it implies that the combination incorporates one or more non-stable cases—the standard threshold being set at 0.80 for sufficient conditions (Ragin, 2008). In this study, results explain the extent to which two causal conditions (C1 and C2) lead to a high TEA. The TEA rate's solution consistency—made of C3, C4, and C5 causal conditions—is sufficient to explain its stability. The degree to which these causal conditions belong to the complete solution forms a sufficient set of causal combinations so as to produce a high TEA rate.

The various causal conditions sub-set measures are presented in three groups: cohesiveness, including centrality, density, and a cohesiveness factor; inter-connectedness including average weight and inter-connectivity ratio; and closeness, two negated measures: average short path and mean distance, a proximity factor elaborated with these two measures, and the clustering coefficient. There are two analyzed outcomes: the TEA, and its rate between 2018 and 2019. We chose this yearly rate because of the availability of the GEM data and coherence with web scrapped dyadic ties.

5. FINDINGS

The causal conditions presenting a significant consistency level include C1 and C2 for the TEA level, and C3, C4, and, C5 for the TEA rate. We found that our first hypothesis was partially supported by C1 and C2 causal conditions on high TEA levels (h1a); the second hypothesis by C3, C4, and C5 solutions (h2b); and the third hypothesis by all solutions (h3a and h3b) (Figure 16.).

Figure 16 : The power of network in entrepreneurial ecosystem



Solution consistency indicates the extent to which the complete solution (composed of all causal combinations) is sufficient to explain the stability, that is, the extent to which the solution is a sub-set of the observed phenomenon. In our case the C1 and C2 solution consistency coverage is 1, which indicates that all related cases have a high TEA level. Combined causal conditions C3, C4, and C5 do not provide a sufficient coverage (50% and less), but sub-set analysis indicates that combinations of inter-connectivity and average weight, and inter-connectivity alone provide a 1,00 coverage with 0,75 consistency rate, indicating that those attributes are foundations of a high TEA rate.

6. DISCUSSION AND CONCLUSIONS

First, this study confirmed the value of the network theory perspective to open EE's black box. This first exploratory research allowed us to effectively run an empirical study in low-income countries' EEs at a whole scale. It also confirmed both the interest to mobilize the QGT (Dehmer, Emmert-Streib and Shi, 2017) and the fsQCA methods (Ragin, 2008; Kraus, Ribeiro-Soriano and Schüssler, 2018) in low-income African countries (Beynon *et al.*, 2020). Doing so, we emphasize the interest of using big-data (Von Bloh *et al.*, 2019) in EE research. Our mixed-method approach, based on newly applied protocols in the EE field of research, provided interesting results that can allow us to contribute to an empirically based theoretical analysis of organizational configurations. This analysis enables us to highlight inter-organizational ties attributes, such as cohesiveness, inter-connectedness and closeness among EE actors as causal conditions for high TEA levels and rates.

Theoretical implications

Inter-organizational ties among actors make EEs in low-income countries more conducive to entrepreneurial dynamics under various conditions. High entrepreneurial dynamics levels are related to strong cohesiveness and closeness, and high entrepreneurial dynamics rates are related to strong inter-connectedness and closeness.

EE closeness as a foundation of high TEA

The first, and universal, causal condition for a high TEA level or rate is strong closeness among EE actors. Whatever the size of the EE, the fundamental attribute to conduct entrepreneurial dynamics is tight ties between its actors. This emphasizes the importance of a proper collaborative and cooperation mindset among EE actors, rather than a competition mindset, which would undermine related entrepreneurial dynamics, confirming recent micro-levels results (Xu, Yan and Xiong, 2019; Purbasari, Wijaya and Rahayu, 2020a). The ability of an ecosystem to distribute its nurturing components significantly impacts entrepreneurial dynamics. It allows entrepreneurs to pick appropriate resources for their project. Recent research indicates that treatment design is more crucial than selection for innovative firms to achieve growth (Buffart et al., 2020), meaning that in the EE context, natural selection rather than forced selection among entrepreneurial projects produces higher entrepreneurial dynamics. However, to produce its full effect, this approach must be supported by a highly collaborative EE, which allows entrepreneurs find more accurate resources for their project, within a shorter duration. This explains why this attribute is a foundation of a high performing EE

EE cohesiveness as a condition for high TEA level

Cohesiveness among EE actors is a causal condition for high TEA level only. It is interesting to see that it is not a causal condition for high TEA rates, meaning that related capabilities are secondary to sustain a high TEA rate. Strong cohesiveness is the sign that an EE has an average number of ties per actor that allows the overall network to be cohesive. The direct impact of such network attributes is the ease of knowledge and information flow, which is essential to sustain a high TEA level. When closeness is strong, this ease of flow offers entrepreneurs the requisite information to recognize appropriate nurturing components. Robust cohesiveness is also a sign that information and knowledge flow, and entrepreneurs' mobility, is uniform across the EE, thereby making every "corner" useful for the entrepreneur. This is a valuable asset especially for low-income low-resources countries, where optimal use of resources is essential.

EE inter-connectedness as a TEA rate stimulus

Inter-connectedness is associated with high TEA rates, when closeness is high. It indicates the high degree of partnership per actor, meaning that strong partnership intensity is a causal condition for a high TEA rate. The weakest EEs tend to be correlated to high competition between its actors, but when EE actors switch to a more collaborative or cooperative scheme, the TEA rate improves. EE actors are supposed to provide an efficient access to people (Hui-Chen, Kuen-Hung and Chen-Yi, 2014), resources, networking opportunities (Albourini *et al.*, 2020), knowledge (Ratten and Rashid, 2020), and, more generally, to various EE nurturing components (Stam and van de Ven, 2019). These actors interact with each other to support entrepreneurial efforts, and consequently, their ties influence entrepreneurial dynamics and its rates. A collaborative mindset among EE actors, thus, has a spillover effect on entrepreneurial dynamics.

Managerial implications

We identified EE attributes related to high TEA levels and rates. A full presence of appropriate attributes will have a sustaining effect on related EE. Similarly, absence or mitigated presence of those attributes will produce a discontinuity effect by retarding the distribution of existing nurturing components within the EE, and reducing the mobility of entrepreneurs to execute their projects.

Policymakers willing to sustain a high TEA level will promote closeness and cohesiveness among EE actors. In order to raise TEA rates, they will promote closeness and inter-connectedness through an intensive partnership policy across the EE. This resonates with recent research on EE governance in order to promote independent, decentralized, and autonomous decision-making in EEs (Audretsch and Moog, 2020), but with clear guidance on the EE attributes so as to develop and sustain entrepreneurial dynamics at a country level. It will have a positive effect, irrespective of the available portfolio of entrepreneurial nurturing components. This study also provides useful EE indicators and EE success factors to follow. Following the actual research, it is possible to deploy an EE audit framework based on network measures, in order to identify relevant EE attributes and critical configuration patterns.

Limitations and further research

In this study, the low number of subject countries is a limitation. However, the methods deployed, which required a high investment coding for web scraping and network measurement protocol, can be now easily and quickly replicated in any given country or region. Such a campaign to expand our research cases will provide novel results to refine the EE knowledge, for instance, to qualitatively compare low-income countries with other kinds of countries. We are also limited by secondary data—we used online media big data—but which constrained this analysis; however, we do not predict finding better data sources in the immediate future. Finally, we are limited because of the spillover measures set at a national level, limiting this method to countries with only one EE.

There is a potential for future research: building a structured research canvas (Shipilov and Gawer, 2020) and exploring the definition and criteria of EE actors and entrepreneurial nurturing components, the role of the EE central actor, as well as other network measures to be sought. This research leads also to open a strategic research perspective on various ways to stimulate entrepreneurship in a given territory, may be through a resource-based view approach applied to EEs with a modularity perspective (Baldwin and Clark, 2000).

Article 3 : Entrepreneurial Ecosystems Power of Networks : central role impact in low income countries

ABSTRACT

What makes an Entrepreneurial Ecosystem (EE) more conducive to Entrepreneurial Dynamics than another ? EE became a prominent topic, leading to progress on its elements, network, actors components, or levels of analysis. However, some scholars regret empirical analysis of EE as a whole to understand how EE configuration operates. To open this perspective we propose an unexplored inter-organizational ties analysis among all EE actors, at a country level scale. Nested in Network Theory perspective, we run an exploratory research in five low income African countries, using innovative research methods (Quantitative Graph Theory, web scraping, fuzzy-set Qualitative Comparative Analysis) to understand the organisational patterns in these Entrepreneurial Ecosystem having an impact on their outcomes. At the core of this perspective we develop the impact of the central actor role of these Entrepreneurial Ecosystems, as a key causal condition of their spillovers, in our case entrepreneurial dynamics levels and evolution in those low income countries. This research underlines how important are Entrepreneurial Ecosystem network properties to facilitate the efficient distribution of entrepreneurial nurturing components to entrepreneurs. It highlights also the importance of a financial central actor to sustain high Entrepreneurial Dynamics levels in low income countries.

1. INTRODUCTION

Understanding how entrepreneurship is stimulated in a given territory is an important research topic. The concept of Entrepreneurial Ecosystem (EE) is designed to do so. Taking its roots with [Van De Ven \(1993\)](#) and [Isenberg \(2010\)](#) seminal work, EE research is mainly produced through an environmental and econometric perspective. But this field of research, despite a growing interest and substantial publication activity ([Velt, Torkkeli and Laine, 2020](#)) deceived expectations under a social science perspective. Indeed a number of researches produced interesting results at a macro level of analysis, mainly producing econometric oriented results, qualitative or theoretical papers ([Cao and Shi, 2020](#)) or at a micro level of analysis ([Theodoraki and Messeghem, 2017](#)) by the observation of small groups of EE actors such as incubators or accelerators, or entrepreneurs behaviors. But regional or local research on EEs faces limits in terms of its spillover measures, as available measures are produced at a national level. Nevertheless, various critics and calls recently invited scholars to open the “black box” of the

Entrepreneurial Ecosystem by conducting rigorous scientific research under a social science perspective ([Acs, 2018](#)) in order to better understand causal conditions of entrepreneurial dynamics.

The understanding of how EEs are organized, and the impact of their specific configuration or attributes on their outcomes are essential to conduct performative policy and strategies in order to stimulate entrepreneurship. Some attempts have been made since ([Purbasari, Wijaya and Rahayu, 2020b](#)), especially using network theory. But actually very few scholars conducted analysis of the entrepreneurial ecosystem as a whole, and those used econometric data. This missing link in Entrepreneurial Ecosystem research limits social science oriented research. But the understanding of the fundamental nature of EE composition in terms of actors and components, as well as its configuration or archetypal pattern, would be interesting. Do those impact EE spillovers ?

EE are mainly made of organizations such as universities, institutions, associations or companies. But if the universities roles have been analysed regarding the entrepreneurial phenomenon ([Purbasari, Wijaya and Rahayu, 2020a](#)), the nature, role, and relationship of the overall ecosystem actors hasn't been properly defined. We know that various kinds of organizations have a specific role regarding entrepreneurship, such as incubators or accelerators, business angels as individuals or associations, fablabs, co-working spaces, etc. They are organized as a network to provide supporting resources and services to entrepreneurs and nascent enterprises ([Minà and Dagnino, 2015; Albourini et al., 2020](#)). But network perspective, even if omnipresent in EE field of research, hasn't been used to describe its actors' relationships and understand how EE network attributes are causal conditions of its spillovers. The field of Innovative Ecosystem, adjacent to EE, has already demonstrated the interest of Network perspective research ([Adner and Kapoor, 2010; Furr and Shipilov, 2018; Autio and Thomas, 2020; Shipilov and Gawer, 2020](#)) on its outcomes, but not EE research.

The unexplored perspective of EE's inter-organizational ties configuration and organizational pattern of EE as a whole is interesting to investigate how it impacts the strength and evolution of entrepreneurial dynamics in a given territory. Among various network attributes, we know that a network central actor ([Burt, 1995](#)) impacts a network innovation capability ([Galvin et al., 2020](#)) leading us to observe how, in Entrepreneurial Ecosystems, the nature of its central actor affects its performance regarding Entrepreneurial Dynamic strength and evolution. In this paper we explore this perspective, by conducting an Network Theory analysis in five low income

countries in Africa, through the study of interorganizational ties between EE actors, using Quantitative Graph Theory method and measures. To understand the causal relationship between EE central actor nature and its outcomes, we use fuzzy-set Qualitative Comparative Analysis (fsQCA) that have been acknowledged by research ([Roundy, Bradshaw and Brockman, 2018](#)). The purpose of this paper is to feed social science oriented research on EE, and highlight the causal conditions of a EE performance by the study of its central actor role.

2. THEORETICAL FRAMEWORK

Entrepreneurial Ecosystem research potential

Entrepreneurship is at the core of our liberal world ([Schumpeter, 1942](#)). Its role is to transform innovation into value. The emergence of the Entrepreneurial Ecosystem concept ([Van De Ven, 1993](#)) is an attempt to understand the causality of the entrepreneurial phenomenon. Facing the success of high growth places such as silicon valley or boulder colorado, scholars defined an econometric conceptual framework to understand this phenomenon ([Isenberg, 2010](#)). For a decade, research produced a growing number of papers under this perspective ([Velt, Torkkeli and Laine, 2020](#)). Only recently scholars raised critics calling for ‘rigorous social science research’ ([Stam and Spigel, 2016; Audretsch et al., 2018](#)) in order to understand the dynamics of Entrepreneurial Ecosystems, pointing out the importance to open its “black box” of its intrinsic processes and configurational patterns having an impact on its dynamics and its spillovers.

Organizational theories are not prominent in Entrepreneurial Ecosystem research. Some scholars attempted a complexity approach ([Roundy, Bradshaw and Brockman, 2018](#)). Others mainly mobilized organizational theories at a micro level of analysis ([Theodoraki and Messeghem, 2017](#)) to describe and analyze small group of EE actors behaviors, such as incubators ([van Rijnsoever, 2020](#)), universities ([Klofsten et al., 2018](#)), investment funds ([Kapoor and Lee, 2013](#)), accelerators ([Cohen, Bingham and Hallen, 2019](#)). The triple helix approach ([Baier-Fuentes, Guerrero and Amorós, 2020; Purbasari, Wijaya and Rahayu, 2020a](#)) attempts to study the whole Entrepreneurial Ecosystem, but with limited empirical analysis. More recently, scholars tried to mobilize organizational theories, such as agency theory but in an adjacent field of research ([Vlaisavljevic, Medina and Van Looy, 2020](#)), institutional theory with a local case study approach ([Auschra, Schmidt and Sydow, 2019](#)), or network theory but

at a member level (startups) empirical measurement ([van Rijnsoever, 2020](#)). The scholar's efforts to open the 'black box' of Entrepreneurial Ecosystem configuration is on its way, but actually facing theoretical and methodological challenges.

Entrepreneurial Ecosystem Black Box

The concept of EE black box was introduced by [Stam and Spiegel in 2016](#). It describes EE actors (incubators, accelerators, investment funds, institutions, etc.) and components (various kinds of financial or physical resources, supporting services, etc.). Other scholars describe this black box as the EE meso-level of analysis ([Theodoraki and Messeghem, 2017](#); [Auschra, Schmidt and Sydow, 2019](#)), but there is no consensus about its precise definition, and composition. But paradoxically scholars have not yet properly listed the EE typology of actors. There is a consensus about incubator membership to EEs, even if there exist undefined sub-categories of incubators such as (1) academic incubators, (2) business incubators, (3) social incubators, (4) economic development incubators, (5) investment incubators. Other kinds of organizations naturally belong to Entrepreneurial Ecosystems, even if no proper criteria have been scientifically defined to validate their membership. Those are accelerators, fablabs, first stages investment funds, dedicated foundations, business angels (and clubs). But we notice there are other organizations playing an active role supporting entrepreneurship such as co-working places, third-places, executive club associations, clusters, universities (those who propose dedicated programs), banks (those who propose dedicated financing products), dedicated events, institutions and training centers. Those organizations distribute various resources, and supporting services. They either finance or host the entrepreneurial efforts, train or support the entrepreneurs and their teams.

Entrepreneurial Ecosystem as an inter-organizational ensemble

Previously listed EE actors are organizations. To effectively support the entrepreneurial efforts, they establish ties to be more efficient in their mission and feed their portfolio of entrepreneurial opportunities. Those ties allow entrepreneurs to access the appropriate resources available that meet their project and needs. Actors form an inter-organizational ensemble, which can be analysed under organizational theory perspectives. The study of inter-organizational ties relies on Network Theory ([Shipilov and Gawer, 2020](#)). Network theory is used in ecosystem research to analyse for instance the causes of innovation performance. The dynamics of Entrepreneurial

Ecosystems can be observed through network theory, as scholars indicate that EE are networks ([Ben Letaifa, Edvardsson and Tronvoll, 2016](#)). Network archetype ([Tatarynowicz, Sytch and Gulati, 2016](#)) determines its attributes and its effect in the environment. Network's structure affects its innovative outcomes ([Ibarra, 1993](#)), or antecedents in terms of centrality, tie strength and density affect a network outcome such as technology acceptance ([Kate et al., 2010](#)).

Those network attributes determine its efficiency to distribute the available resources in the ecosystem. Entrepreneurs need to nurture their entrepreneurial projects with existing resources, which can be financial, or other forms of support. The ability of an entrepreneur to identify what resources can support his project, and to access them, often predicts its probability to fulfill his means. Especially in low resources environments, where resources are rare, or difficult to identify or use, the ability of the EE to ease the entrepreneurial process is key to sustain Entrepreneurial Dynamics level or evolution (Gueneau, Chabaud and Chalus-Sauvannet, 2020).

Central actor of an inter-organizational network

Place is a key factor for the Entrepreneurial Ecosystem ([Saxenian, 1994; Roundy and Fayard, 2020](#)), and within an Entrepreneurial geographic context, the available affordances can be assured through inter-organizational ties ([Maroufkhani, Wagner and Wan Ismail, 2018; Xu, Yan and Xiong, 2019](#)). The identification of key inter-organizational ties attributes that affect its outcomes can rely on various network measures such as cohesiveness, inter-connectedness, or closeness. Beyond those measures we can add centrality measures. Various centrality measures exist, having various theoretical significations ([Freeman, 1978](#)). Scholars demonstrated the robustness of the relationship of centrality to attributed influence ([Boje and Whetten, 1981](#)), establishing a strong causal relationship between a network and its outcomes under this perspective. We also know that centrality is intimately connected with the cohesive subgroup structure of a network ([Borgatti and Everett, 2006](#)), underlining the deep impact of a central actor on the whole network structure. In EE, centrality impacts knowledge spillover at regional level ([Pittz, White and Zoller, 2019](#)). Considering also that for entrepreneurial firms it is more important to build strong network positions by developing exclusive alliance networks instead of simply collaborating with the greatest number of firms within the region ([Lechner and Leyronas, 2007](#)) underlines the weight of a well performing EE network. Inter-organizational ties among EE actors, whatever the consistency of those ties, plays a key role

regarding the efficiency and the orientation of the entire Entrepreneurial Ecosystem. In addition sparseness and centrality enhance innovativeness through access to information ([Wong and Boh, 2014](#)) which are key capabilities for an EE, as well as R&D performance ([Ahuja, Galletta and Carley, 2003](#)), focus ([Barsness, Diekmann and Seidel, 2005](#)), access to innovation ([Wong and Boh, 2014](#)). Those attributes are related to the ability of an EE to produce productive entrepreneurship. The purpose of this paper is to evaluate the causal effect of EE central actor attributes on its spillovers, in low income countries. We predict that the nature of the central actor, which can be a financial or supporting actor, affects its spillovers.

Hypothesis 1 : EE central actor attribute is a causal condition of a high entrepreneurial dynamic level

Hypothesis 2 : EE central actor attribute is a causal condition of a high entrepreneurial dynamic evolution

3. METHODS

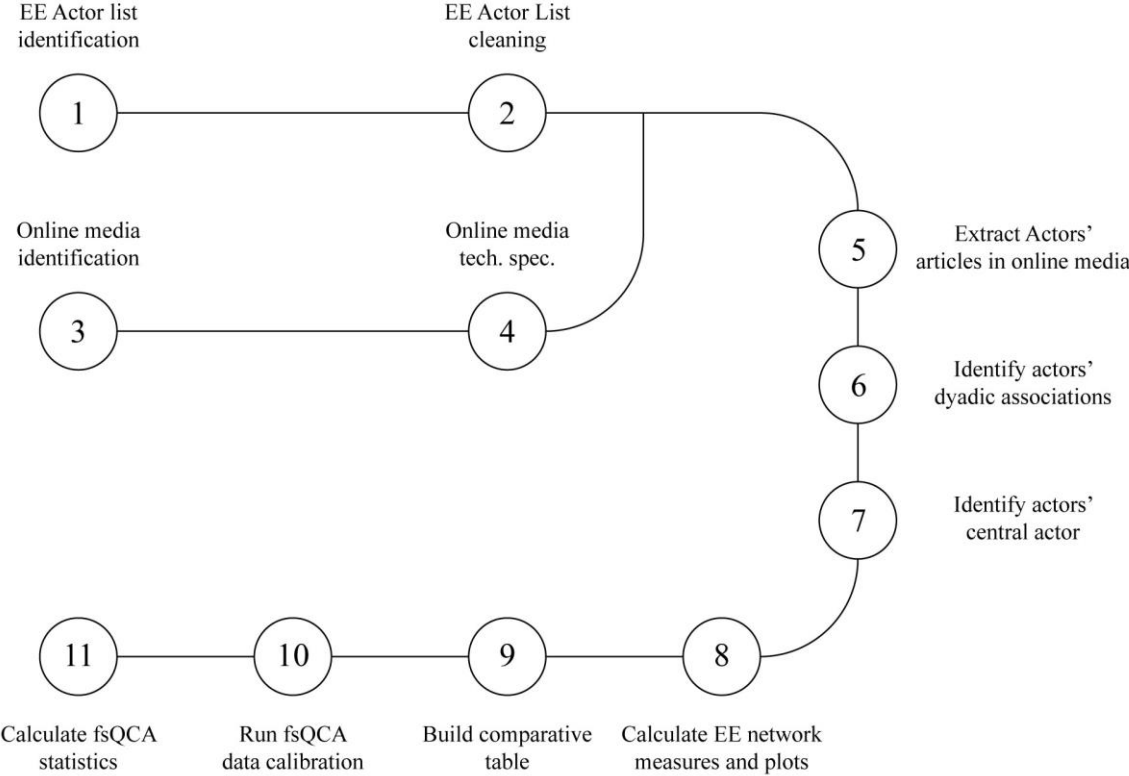
Research design and protocol

To measure EE inter-organizational ties we chose to use QGT, which allows us to capture the most common network measures, including centrality measures, and also interesting other sets of measures for future research. To evaluate dyadic associations within EE, we chose the original methodology of web scraping in order to apprehend the ties and interdependencies between all EE actors (incubators, accelerators, fablabs, institutions, business angels, etc.). We designed the following research structure : first list EE actors and identify their ties, identify their network properties with QGT measures, finally identify causal conditions of EE outcomes evolution indicators through a fuzzy-set Qualitative Comparative Analysis (fsQCA) ([Ragin, 1987](#); [Kraus, Ribeiro-Soriano and Schüssler, 2018](#); [Beynon et al., 2020](#)).

We designed this research protocol in eleven phases (figure 17) : (1) identify the list of EE actors within each country ; (2) clean the actors list, and prepare subset lists for automated treatment; (3) identify the appropriate online media that contains the most EE actors informations ; (4) identify web HTML codes and specifications to run the web scraping loop ; (5) extract actors' by running the web scraping loop and verify the result ; (6) run a data

pretreatment protocol to record dyadic associations ; (7) identify the central actor, its main attribute, and the number of interconnected actors ; (8) run the various R packages to extract measures, plots and statistics ; (9) build a country comparative table from extracted measures ; (10) run a fsQCA data calibration ; (11) run fsQCA statistics protocol.

Figure 17 : Research protocol



EE actors in african low income countries selection and data source

We decide to apply this methodological approach regarding an unexplored but stimulating context : Africa. We chose as a case study sample five culturally similar low income countries, presenting significant Total Early Stage Entrepreneurial Activity (TEA) evolution gaps (6,46% to 115%) (GEM, 2019) : Morocco, Madagascar, Burkina Faso, Senegal and Tunisia (Table 10.). All these countries are low income countries and also present other similarities : french occupancy history, similar institutional structure, and cultural similarities ([Donaldson, 2020](#)), and a unique and national EE located in their economic capital. Within those five countries, we identified EE actors through local institutions, foreign embassies, observatories or EE studies.

We verified the robustness and accuracy of the given repository of actors by checking their social network and web pages, corrected typing errors, and removed some actors that appeared not to belong to EE, such as accountants or communication agencies. The final list presents a total of 472 actors, 141 for Morocco, 50 for Madagascar, 62 for Burkina Faso, 56 for Senegal and 163 for Tunisia.

EE actors use media to advertise their partnerships through press releases, journalists report them, making media coverage relevant to detect dyadic associations. They indicate strong interorganizational ties, as none actor would publicly communicate on an inexistent, negative, or weak tie. Other forms of communication, such as social network posts, embed noisy messages, making this source of information not relevant. Partnerships among EE actors are far from contractually formalized, neither reported in other platforms. This makes press releases secondary data source the only available to track inter-organizational ties among EE actors and the most significant known yet. To identify EE actors inter-organizational ties, we decide to use big data from online media coverage ([Von Bloh et al., 2019](#)) reported in targeted nations top economic online journals.

Table 10 : selected low income countries profiles

		Morocco	Madagascar	Burkina Faso	Senegal	Tunisia
	Population	36M	13M	19M	18M	11M
	GDP per ha. (US\$)	3237	527	715	1521	3447
Outcome	TEA level 2018 (ta)	6.65	20.74	29.75	38.55	4.78
	TEA level 2019 (tb)	11.4	19.4	33.53	40.28	10.3
	TEA evol 18_19 (tb/ta)-1	0.71	-0.06	0.13	0.04	1.15

Centrality measures

Networks allow evaluation of structure effects on its general and innovation spillovers ([Ibarra, 1993](#)). It can be done by understanding the role of key actors in a network ([Das, Samanta and Pal, 2018](#)). Centrality analysis, which can provide indications of network properties impact on its spillovers is an interesting set of measures. Centrality attributes as well as tie strength and density play on social network and technology acceptance ([Kate et al., 2010](#)), on knowledge ([Pittz, White and Zoller, 2019](#)). Innovativeness can be increased through sparseness and centrality ([Wong and Boh, 2014](#)). A better understanding of EE can be achieved through centrality, ties strength and structural holes ([Lee and Kim, 2011](#)), especially regarding its focus and performance ([Barsness, Diekmann and Seidel, 2005](#)). Actor centrality is a strong predictor of R&D performance ([Ahuja, Galletta and Carley, 2003](#)).

The aim of this research is to analyse the impact of EE central actors on EE outcomes. Centrality refers to central position within network relationships ([Freeman, 1978; Wasserman and Faust, 1994](#)). Number of centrality measures exist, meant either to evaluate the centrality strength over the entire network or the analysis of clusters or individual actors, or to identify the central actor of a network ([Wang et al., 2018](#)). Degree, betweenness, and closeness centralities are defined only for classically simple graphs—those with strictly binary relations between vertices ([Bonacich, 2007](#)). Various results can be obtained depending on the various centrality measurements, that allows to identify which actor occupies a specific strategic position regarding the specificity of the measurement. Among those measures we can list degree, closeness, decay, katz-bonacich, eigenvector or diffusion centralities ([Bloch and Jackson, 2016](#)) used in network analysis. Scholars underline that centralities measures have a significant explanation potential in various fields of research including inter-organizational network research, and provide rich description of social structure ([Friedkin, 1991](#)). For instance, firms of low centrality in the industry's network of alliances will extract performance benefits from enhancing bargaining power as a result of exploiting brokerage opportunities in open networks ([Shipilov, 2009](#)); formal knowledge search depth is more effective in fostering innovation performance when firms' network centrality is higher ([Ruan and Chen, 2017](#)). For this research, among the available centrality measures, we chose four : Weiner, Closeness, Barycentric, and Clustering centrality measures. Weiner centrality is often used in social network studies, and is similar to Closeness centrality defines the closest actor of a network. Barycentric centrality is similar to betweenness centrality defines the most accessible actor of a network. Clustering centrality is particularly useful for the study of complex networks

designating the most central actor for networks communities. These four measures provide four different angles to analyse an EE network of actors. We chose to analyse our five EE with these four centrality measures to identify its central actor.

As research actually does not provide a proper list of EE actor attributes, we chose their main functional attributes : are those central actors, financial actors, distributing funds to entrepreneurs, or supporting actors providing other kinds of resources such as mentoring, training, coaching, etc. We are considering this attribute as one of the causal conditions of those five EE spillovers.

fsQCA protocol

Quantitative Graph Theory measurements allow us to quantify structural information of networks ([Dehmer, Emmert-Streib and Shi, 2017](#)), as well as various forms of comparative analysis, based on isomorphism based measures, graph edit distance, iterative graph similarity methods, string-based measures and graph kernels. Its characterisation, to determine the complexity of a given network, can be obtained through distance-based graph measures, degree-based measures, eigenvalue-based measures, or information-theoretic measures. But those comparative methods, for this exploratory research, do not allow to have an attribute base comparative analysis. We identified another method, taking in account cohesiveness, interconnectedness and closeness measures, to operate a comparative analysis on our five countries EEs. Fuzzy-Set Qualitative Comparative Analysis (fsQCA) ([Ragin, 1987](#); [Kraus, Ribeiro-Soriano and Schüssler, 2018](#); [Beynon et al., 2020](#)) is accurate to reach this goal, as it has been successfully used in Entrepreneurial Ecosystem research in Africa.

We chose the open source R Studio software packages to run various network measures, plots and analysis : ggraph, netrankr, tnet, and CINNA. For this exploratory research we chose to extract density, centrality and distance measurements. To operate fsQCA, we first created a data calibration matrix, and prepared our fsQCA dataset. With the truth table we obtained the two potential configurations among the three possible. To operate this protocol, we developed a +800 lines of genuine R code to run the web scraping loop and treatment, and QGT calculations, plots and statistics. We used fsqca software for fsQCA calculations.

4. RESULTS

We web scrapped within each national top online economic journal a total of 54 060 articles (ar) citing at least one of the 472 listed actors (a). Counting the co-occurrence of those actors in articles (N) allowed us to establish dyadic association (M), elaborate QGT graph matrices, network plots and measures. Using bottom line network measures (d, c, c*d, N/a, aw, asp, cc, md), we runned a comparative analysis using fsQCA methods to identify, in these countries, how EE network impacts on its outcomes (Table 11.).

Table 11 : network calculation results

		Morocco	Madagascar	Burkina Faso	Senegal	Tunisia
	Actors (a)	141	50	62	56	163
	Articles (ar)	16588	6863	2388	4653	23568
	Nodes (N)	85	19	7	19	75
	Vertices (M)	970	25	4	85	411
Cohesiveness	Density (d)	0.34	0.16	0.67	0.81	0.3
	Centrality (c)	0.46	0.41	1	0.69	0.38
	Cohesiveness factor (c*d)	0.16	0.07	0.67	0.56	0.11
Inter- connectedness	Interconnectivity (N/a)	0.6	0.38	0.11	0.34	0.46
	Average Weight (aw)	4	7	2	3	4
Closeness	Average Shortest Path (asp)	1.99	3.08	1.5	1.56	2.07
	Clustering Coefficient (cc)	0.44	0.14	0	0.47	0.35
	Mean Distance (md)	1.99	3.08	1.5	1.56	2.07
	Proximity factor $((1-asp)*(1-md))$	0.25	0.11	0.44	0.41	0.23
Centrality		Sustaining (HappySmala)	Financial (AFD)	Financial (Fafpa)	Sustaining (Touba)	Sustaining (Impact)
	Weiner Centrality					

		Sustaining (CGEM)	Financial (AFD)	Financial (Fafpa)	Sustaining (Touba)	Sustaining (Impact)
	Closeness Centrality					
	Barycentric Centrality	Sustaining (CGEM)	Financial (AFD)	Financial (Fafpa)	Sustaining (Touba)	Sustaining (Impact)
	Clustering centrality	Financial (CCG)	Financial (AFD)	Financial (Fafpa)	Financial (Cofina)	Financial (AFD)
Outcome	TEA level 2018 (ta)	6.65	20.74	29.75	38.55	4.78
	TEA level 2019 (tb)	11.4	19.4	33.53	40.28	10.3
	TEA evol 18_19 (tb/ta)- 1	0.71	-0.06	0.13	0.04	1.15

Data calibration

Based on a boolean approach due to the limited number of studied countries, we build the following data calibration matrix, except for the outcome measures (table 12.). For each measure we described its global meaning, cross over point and qualitative threshold calibration rules.

Table 12 : fsQCA data calibration

Abrev.	Concept	Measure	Cross over point	Qualitative threshold calibration
d	Density	Global cohesiveness of the EE	0.6	[1] for full membership >=0.6 [0,5] crossover point 0.6 [0] for non membership <0.6
c	Centrality	Global cohesiveness of the EE around the central actor	0.5	[1] for full membership >=0.5 [0,5] crossover point 0.5 [0] for non membership <0.5
aw	Average Weight	Average number of interconnections between EE actors, indicating a collaboration activity rate	4	[1] for full membership >=4 [0,5] crossover point 4 [0] for non membership <4

asp	Average Short Path	Average number of actors to pass through to cross the EE, indicating the easiness for an entrepreneur to navigate through the EE	2	[1] for full membership >=2 [0,5] crossover point 2 [0] for non membership <2
cc	Clustering Coefficient	The coefficient of grouping and agglomeration of EE actors, presenting potential sub communities within the EE	0.4	[1] for full membership >=0.4 [0,5] crossover point 0.4 [0] for non membership <0.4
md	Mean Distance	Is the summa of all shortest paths between actor couples divided for the total number of actor couples, providing a complementary asp measure	2	[1] for full membership >=2 [0,5] crossover point 2 [0] for non membership <2
Inter_r	Interconnectivity rate between EE actors	Rate of interconnected actors (N) among the total EE actors population (a) : (N/a), indicating the spread of EE partnership activity	0.4	[1] for full membership >=0.4 [0,5] crossover point 0.4 [0] for non membership <0.4
cohe_f	Centrality and Density measures factor, as indication of information and knowledge spread, and network cohesiveness	Centrality (c) and Density (d) mean : (c*d)	0.5	[1] for full membership >=0.5 [0,5] crossover point 0.5 [0] for non membership <0.7
prox_f	Reverse distance measures means, as indication of EE actors proximity rate	Proximity of actors factor : ((1-asp)*(1-md))	0.4	[1] for full membership >=0.4 [0,5] crossover point 0.4 [0] for non membership <0.4
central	Attribute of the central actor	Financial (1) or Sustaining (0) actor	-	[1] for financial actor, [0] for sustaining actor

TEAlevel	Total Early Stage Entrepreneurial Activity in 2019	Global Entrepreneurship Monitor country profile data	30	[1] for full membership ≥ 30 [0,5] crossover point 30 [0] for non membership < 15
TEAevol	TEA Evolution levels	TEA Evolution rate between 2018 and 2019	1	[1] for full membership ≥ 1 [0,5] crossover point 1 [0] for non membership < 0.5

Following this matrix, we built an algorithm to automatically calculate the calibrated datas (table 13.) and avoid any error.

Table 13 : calibrated datas

Country		Burkina				
		Morocco	Madagascar	Faso	Senegal	Tunisia
Cohesiveness	Density	0	0	1	1	0
	Centrality	0	0	1	1	0
	Cohesiveness	0	0	1	1	0

y	Interconnectivity	1	0	0	0	1
	Average Weight	1	1	0	0	1

Closeness	Average Short Path	0	1	0	0	1
	Clustering Coefficient	1	0	0	1	0
	Mean Distance	0	1	0	0	1
	Proximity	0	0	1	1	0

Centrality	Weiner, Closeness, Barycentric	0	1	1	0	0
	Clustering centrality	1	1	1	1	1
Outcome	TEAlevel	0	0,5	0,5	1	0
	TEAevol	1	1	1	1	1

Based on this calibrated datas, we first elaborated fsQCA Truth Tables to identify five significant causal solutions. We identified two groups of solutions. C1, C2 and C4 are associated with high TEA evolution countries, all with a high consistency rate (1), but with low coverage rate (0,37 to 0,5) indicating those solutions might be mitigated as their coverage level is under 0,5. Another set of solutions with 0,8 to 1 consistency rates, and 0,67 to 0,83 coverage rate. C5 has an interesting rate combination, representing the most significant result of this analysis (table 14.).

Table 14 : Solutions table

Solutions		C1	C2	C3	C4	C5
Cohesiveness	Density					
	Centrality					
	Cohesiveness			●		●
Inter-connectedness	Interconnectivity	●	●			
	Average Weight	●	●		●	
Closeness	Average Short Path		●		●	
	Clustering Coefficient	●		●		
	Mean Distance		●		●	
	Proximity			●		●
Centrality	Weiner, Closeness, Barycentric				◆	◆
Outcome	TEA level					
	- Consistency	0,60	0,20	0,80*	0,60	1,00**
	- Coverage	0,37	0,17	0,67	0,37	0,83**
	TEA evolution					
	- Consistency	1,00**	1,00**	0,33	1,00**	
	- Coverage	0,37	0,50	0,17	0,37	

● : high level ◆ : financial central actor no indication : solution might be high or low, or either financial or not

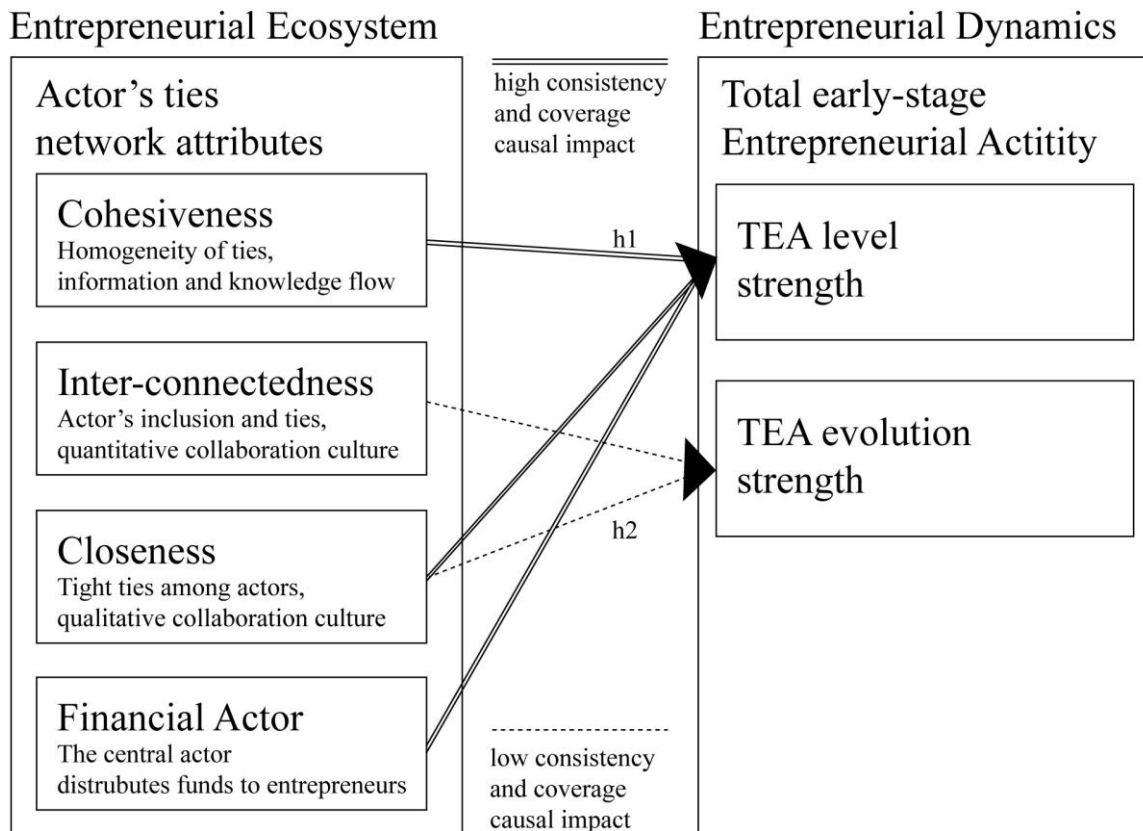
C5 solution indicates that cohesiveness and closeness factor, associated with a financial central actor are causal conditions of a high TEA level. Achieving a high TEA evolution is not central actor dependent.

Findings

A strong TEA level low income country has its Entrepreneurial Dynamics nurtured by a Financial central actor making our Hypothesis 1 validated, as hypothesis 2 could not be validated due to too low coverage results (Figure 18). Those low income countries propose few entrepreneurial nurturing components, but their entrepreneurial ecosystem produces a high Entrepreneurial Dynamics, due to high cohesiveness and proximity among its actors, and conducted by a central financial actor that provides financial means that feeds and maintains a strong TEA level.

To reach a strong TEA evolution, the causal conditions does not include either a financial nor a supporting central actor, their dynamics rely more on strong interconnectivity and closeness attributes (Gueneau, Chabaud and Chalus-Sauvannet, 2020) that ease the Entrepreneurial Ecosystem's nurturing components distribution.

Figure 18 : Entrepreneurial Ecosystem Network attributes effects on Entrepreneurial Dynamics



5. DISCUSSION AND IMPLICATIONS

By this exploratory research we confirmed the interest of the network theory perspective to open the black box of EEs. A small fraction of the various available measures and research means were mobilized. Nevertheless it allowed us to effectively run an empirical study, on five nations EEs at a whole scale. It confirmed also both the interest to mobilize QGT ([Dehmer, Emmert-Streib and Shi, 2017](#)) and fsQCA methods ([Ragin, 2008; Kraus, Ribeiro-Soriano and Schüssler, 2018](#)) in low income African countries ([Beynon et al., 2020](#)). Doing so we emphasized the interest of big data secondary datas ([Von Bloh et al., 2019](#)) in the EE field of research. Our mixed method approach, provided interesting results that can allow us to provide an empirically based theoretical analysis on EE organizational patterns. This analysis enables us to highlight EE central actor attribute causal condition on related TEA levels.

Theoretical implications

Interorganizational ties among its actors make EEs in low income countries more conductible to entrepreneurial dynamics. Strong entrepreneurial dynamics levels are caused by strong cohesiveness and closeness ties attributes associated with a central financial actor. The first and universal causal condition for a strong TEA level or evolution is a strong closeness attribute among EE actors. Whatever the size of EE is, its most basic and important attribute to conduct Entrepreneurial Dynamics is tight ties between its actors. It emphasizes the importance of a proper collaborative and cooperation mindset among EE actors, rather than competition mindset that would undermine related entrepreneurial dynamics, confirming recent micro-levels results ([Xu, Yan and Xiong, 2019; Purbasari, Wijaya and Rahayu, 2020b](#)). The ability of an ecosystem to distribute its nurturing components has a key role in entrepreneurial dynamics. It allows entrepreneurs to pick, or not, the appropriate resources for their project. Recent research indicates that treatment design is more crucial than selection for innovative firms to achieve growth ([Buffart et al., 2020](#)), meaning in EE context that natural selection among entrepreneurial projects produces higher entrepreneurial dynamics rather than forced selection. But to produce its full effect, this approach must be supported by highly collaborative EE. Such a collaborative environment allows entrepreneurs to find more accurate resources to their project, in shorter delays, which explains why this attribute is a foundation of a performing Entrepreneurial Ecosystem.

Cohesiveness among EE actors is a causal condition of strong TEA level. It is also interesting to see that Cohesiveness is not a causal condition of strong TEA evolution, meaning that the related capabilities are secondary to sustain a strong TEA evolution. Cohesiveness is the sign that an EE has an average number of ties per actor that allows the overall network to be cohesive. The direct impact of such network attributes is the easiness of knowledge and information to flow. Indeed, information and knowledge are key elements to sustain a strong TEA level, as those attributes allow -when closeness is high- to offer entrepreneurs the proper level of information needed to recognize the appropriate nurturing component to look forward to when they need it. But high cohesiveness has another impact. It is a sign that circulation of information, knowledge, and entrepreneurs themselves, is operated with uniformity across the EE, making its every “corner” useful for the entrepreneur, which is a key asset for low income and resource countries, where full use of resources is essential.

Strong TEA level ecosystems are sustained by a financial central actor, who provides the stability, coherence and consistency of available financial resources dedicated to new businesses. In those low income countries, the Financial actor also contributes to stabilize the Entrepreneurial Ecosystem itself by maintaining life conditions for actors, but probably does not contribute to creating good conditions for high growth entrepreneurship. Their central position, measured by Weiner, Closeness and Barycentric centralities, underline proximity and accessibility attributes of this central actor to the other EE actors. The ability, in those EEs, for other actors to quickly and easily interact with or through the EE actor sustains the overall EE performance regarding its other attributes.

Managerial implications

We identified EE attributes related to strong TEA levels and evolution. Full presence of appropriate attributes have a sustaining effect on related EE. Absence or mitigated presence of those attributes will have a discontinuity effect, by slowing down the distribution of existing nurturing components within the EE. Policy makers willing to sustain a strong TEA level will promote closeness and cohesiveness among EE actors, and will place a Financial actor at its crossroads. This research is also providing useful EE indicators to predict its effects on entrepreneurial dynamics, and the EE success factors to follow. Based on the actual research,

we can deploy an EE audit framework, based on Network measures, to identify its attributes, and critical configuration pattern.

Limitations and further research

In this research we are limited by the low number of studied countries (5), but the methods deployed which required a high investment in coding the web scraping and network measurement protocol, can now be easily and quickly replicated in any given country. Such a campaign to expand our research cases will provide interesting new results to refine the actual research, for instance to qualitatively compare low income countries to other kinds of countries, for instance applying to all actors their main attribute and research their spread over the network, clustering effects, structural holes, and other related network properties. We are also limited by secondary data, by using online media big data, but we do not predict to get better data sources soon.

There is a consistent potential for future research, first with building a proper research canvas, and also exploring the definition and criterias of EE actors and Entrepreneurial Nurturing Components, the role of the EE central actor, as well as new network measures to be sought. This research also opens a strategic research perspective on various ways to stimulate entrepreneurship in a given territory, may be through a resource based view approach applied to EEs with a modularity perspective ([Baldwin and Clark, 2000](#)).

Ch. 3 : Revealing Entrepreneurial Ecosystem Configurations

This third chapter explores configurational and processual analysis of Entrepreneurial Ecosystems, made possible by leveraging a longitudinal and an ecologic analysis approach. Doing this we raise interesting perspectives and contributions both in Entrepreneurial Ecosystem and Network Research. Those results unleash the potential of our research program to come.

Leveraging a mix method research conducted in a non-african territory in an intermediary research paper (Appendix 1), in the city of Lyon - France, which present interesting results regarding Entrepreneurial Ecosystem Structural Configuration pattern through a qualimetric analysis, we conducted two new researches in Africa, leveraging a longitudinal network analysis. This new phase in our research allowed us to explore interesting new aspects of our method.

In the first papers, we faced validity issues, and given network theory specificities, we reached statistical robustness through longitudinal analysis. In addition, longitudinal analysis opens an evolutionary perspective which particularly fits with the ecosystem metaphor. To go further, we adopted a species oriented approach to evaluate inter-species behaviors among Entrepreneurial Ecosystem type of actors.

Those two last researches allowed to reveal interesting interorganizational processes occurring in entrepreneurial ecosystems, as well as topology archetypal configurations which feeds the discontinuity perspective detected in our first research

Those complementary articles continue to demonstrate the power of network analysis applied to Entrepreneurial Ecosystems.

Article 4 : Sticky Ties : Quest for structural inter-organizational configurations in Entrepreneurial Ecosystems

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Keywords : entrepreneurial ecosystem, process, network, configuration, africa

ABSTRACT

Entrepreneurial Ecosystem (EE) research requires a better understanding of its various configurations and processes, at its whole scale, in order to open its black box and create new theoretical opportunities. We designed an exploratory research to observe longitudinally network behaviors between EE ‘species’, in four territories (3 in Africa, 1 in France) over a period of 2017 to 2021, by observing ties formation between 685 actors and 155 470 observations. We found convincing evidence that despite the heterogeneity of our cases, the configuration attributes of those EE are correlated with the same spillovers in terms of Entrepreneurial Activity, opening to theoretical generalizations. We also found evidence of ties persistence, and an interesting discontinuity factor in EE when birth stage and mature stage supportive actors are insufficiently connected to practical support actors. This underlines the importance of the accessibility of the various ‘entrepreneurial nurturing components’ to entrepreneurs, for them to fulfill their purpose. Those findings provide interesting insights both at a theoretical and practical level in terms of network strategies to operate within EEs.

1. INTRODUCTION

EE research has become an increasing hot topic since Van De Ven (1993) and Isenberg (2010) research, leading to a comprehensive research program (Wurth, Stam and Spigel, 2021), with promising results regarding metrics (Leendertse, Schrijvers and Stam, 2021), or new longitudinal perspectives (Audretsch *et al.*, 2021).

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But scholars underline that the ‘Black Box’ of the Entrepreneurial Ecosystem, which could open to social science analysis (Audretsch *et al.*, 2018), still remains unexplored, which suggests that organizational, configurational and processual analysis of EEs as a whole system remains unknown. But research provides clues to start it up, as EE is defined as ‘a set of interdependent actors and factors that are governed in such a way that they enable productive entrepreneurship within a particular territory’ (Stam, 2015).

EE are perceived as relational by nature (Spigel and Harrison, 2018a). However very few studies address this point, and we surprisingly face a void related to the analysis of intra-EE Collaborative Networks (Camarinha-Matos and Afsarmanesh, 2018), to understand the strength of ties between EE ‘species’, in our case type of actors identified in EEs (Authors, 2021) in order to start this analysis. Though, deep diving in the understanding of EE sociality configurations as causal conditions of their spillovers in terms of Entrepreneurial Dynamic is expected to provide interesting insights to EE theories regarding its networks, configurations and archetypes, entrepreneurial process, and practical indications to stimulate un-efficient EEs in various territories.

In this paper we propose an exploratory analysis using an innovative method to identify EE actor’s network dyadic associations (Authors, 2020, 2021). We conducted an analysis in four territories between six types of actors, and -considering Ecological Network Analysis methods (Morris, Weissburg and Bras, 2021)- we propose a longitudinal analysis of ties between those EE types of actors in order to observe network processes occurring in those EEs. Based on a population of 685 EE actors, we collected 155 470 observations. We found indications that the most performing EE relies on strong ties with practical supportive actors, a proper distribution of ties allows a proper access of nurturing resources by Entrepreneurs. It leads to an inter-organisational network persistence perspective within EE which, considering Modularity research, indicates the importance of developing Capacity Building and Practical Support for Entrepreneurs, and their accessibility.

2. THEORETICAL FRAMEWORK

2.1 Entrepreneurial Ecosystem Black Box

Core theories on Entrepreneurial Ecosystems are econometric based (Stam and van de Ven, 2019). Research focus also on local and targeted phenomenon, specifically on small group of actors, such as on Incubators (Klofsten *et al.*, 2020), Universities (Fuster *et al.*, 2019), and also Place-centric analysis (Adams, 2020), Measures (Liguori *et al.*, 2019), or the role of Digital (Elia, Margherita and Passiante, 2020). As a result, we miss a global picture on EE as a whole, under social science perspective. EE theoretization weakness appears on various topics such as EE behavior as a whole ensemble, its transversal configurations and processes. Actually, we mainly observe EE in pieces. Scholars (Audretsch *et al.*, 2018) underlines the necessity to fill this void.

The term ‘black box’ is recently leveraged in EE research to point the underlying configurations and processes occurring in EEs, like the understanding the ‘strategic interactions between ecosystem actors and factors’ (Theodoraki, Messeghem and Audretsch, 2020). To our best knowledge, configurational analysis of EE does not exist yet, as well as EE whole scale organizational processes, even if focused research provides sometimes some good clues.

Meanwhile, researchers also acknowledge EE are a relational ensemble (Spigel, 2017b) leading to leverage particularly Network Theory (Shipilov and Gawer, 2020) as an interesting perspective to understand EE actors ties (van Rijnsoever, 2020) or their relations with entrepreneurs (Purbasari, Wijaya and Rahayu, 2020b). But -again- none of those researches addresses EE as a Network super-structure of inter-organisational ties between its actors at a whole scale. However, following (Moore, 1996), interesting analysis on interorganizational ties (Ring and van de Ven, 1994; Belso-Martínez, Mas-Verdu and Chinchilla-Mira, 2020) and on network archetypes (Tatarynowicz, Sytch and Gulati, 2016), there is strong indication that coevolution of actors is a core phenomenon happening within EEs that should be further analyzed.

In parallel, referring EE to ecology raises also an Evolutionary perspective that met recent attention (Audretsch *et al.*, 2021), which strongly indicates the necessity of a longitudinal analysis within EEs, and which could open to processual analysis. But very little research

adopts those lenses, most of the time to focus on entrepreneurial dynamics (Amorós and Cristi, 2008; Delanoë-Gueguen and Fayolle, 2018), or to understand resilient EEs (Ryan *et al.*, 2020). Nevertheless, those research acknowledge the interest of evolutionary perspective in EE research.

Evolution refers also to ‘species’ (Domínguez-García and Muñoz, 2015) which in EE are the various types of its actors. Scholars underline EE actor’s role in its performance (Franco-Leal *et al.*, 2020), or the importance of the analysis of EE from internal actors themselves (Boutillier, Carré and Levratto, 2016). Commonly, we can identify six groups of types of actors (Figure 25.) having a dedicated activity regarding Entrepreneurship within the EE’s territory (Authors, 2021) : universities, schools and training centers ; birth stage support actors (incubators), birth stage ressource providers (gov. programs and local institutions), mature stage support actors (accelerators), mature stage ressource providers (business angels and venture capitalist), support actors (solidarity based economy actors, co-working spaces, enablers and third places, fablabs, culture spaces, medias, events, clusters and competitiveness centers).

Previous research present insights on EE actor’s roles, particularly in term or resource acquisition (Spigel, 2017a) and working processes occurring between actors (Spigel and Harrison, 2018a) suggesting that they act as ‘nurturing components’ distribution actors to entrepreneurs, without describing empirically how this phenomenon occurs. Nevertheless, the supportive role of EE to Entrepreneurial Process has been previously debated (Agarwal, Audretsch and Sarkar, 2010) and detailed at a micro level of analysis (Peters, Rice and Sundararajan, 2004), without providing empirical evidences of theses at the whole level of EEs.

This descriptive presentation of type of actors EEs and their roles, seen under network perspective (Figure 26.), is an unknown territory in EE theory (Camarinha-Matos and Afsarmanesh, 2018), but strongly refers to life science (Powell *et al.*, 2005) that indicates an Ecological Network Analysis (ENA) perspective (Morris, Weissburg and Bras, 2021) as a research framework. Such an approach is required to understand EE network’s shape, its local specific configuration based on territorial and cultural specificities, but also is able to reveal interesting configurations regarding accessibility of various forms of resources dedicated to Entrepreneurship.

2.2 Network measures and typology of actors

Considering the mobilized EE Type of Actors layered model used in this research, we can observe four core roles in EEs (Dedehayir, Mäkinen and Roland Ortt, 2018) : knowledge and capacity builders, social capital providers (Theodoraki, Messeghem and Rice, 2018) and practical support providers. Those four fundamental roles occurring in EE interact and evolve over time. The analysis of the interaction of those roles is a dead angle in EE at a whole scale research, but represents a strong explanation power to better understand EE configurations and their impact on EE performances. In this paper we propose an explanatory study on EE six actors types, ties strength and the interaction between their four roles. Taking in consideration the modularity perspective (Baldwin and Clark, 2000) we are led to observe how practical support providers sustain other EE actors to sustain Entrepreneurial Dynamics. Based on this assumption, our hypothesis is that a tie disruption between Capacity Building and/or Social Capital providers with Practical Support providers is associated with lower Entrepreneurial Dynamics in the observed territory. We predict that the availability of entrepreneurial nurturing components proposed by practical support providers, more than financial resources, facilitate the rise of Productive Entrepreneurship, especially within the weakest places.

h1 : Strong ties between 'capacity building' and 'practical support' actors is a causal condition of high 'Entrepreneurial Dynamics'

h2 : Strong ties between 'social capital providers' and 'practical support' actors is a causal condition of a high 'Entrepreneurial Dynamics'

h3 : Strong ties between both 'capacity building' and social capital provider's with 'practical support' actors is a causal condition of a high 'Entrepreneurial Dynamics'

3. FIELD OF RESEARCH AND METHOD

3.1. African low income countries

We focused our research on three African countries that present interesting variations of their Entrepreneurial Dynamics, measured through GEM's TEA levels : Madagascar¹⁹, Morocco²⁰ and Tunisia²¹. As an interesting comparison, we chose also to compare these Cases (Fuster *et al.*, 2019) of 3 African countries to 1 European territory in the Lyon, France, Area, which is known to be a dynamic EE (Setti, 2019). Beside the many and various biases that could lead to avoid this kind of comparison, we wanted to test heterogeneous samples to verify if our theory can be generalized. If the same phenomenon can be observed, it could encourage deep dive in larger scale observations. In these four territories we listed, though local institutions, online repositories, foreign embassies 685 actors²², and verified that no other study or repository would be more complete to validate our final list of actors. We checked the boundaries of this research by meticulously verifying the actual role of each actor within the related EE by qualitatively checking their effective role to support nascent entrepreneurship. We verified each actor's name, and main attribute to enlist each one in our 14 roles and 6 types (Fig 25.). This could be done by checking each actor website and social media page to verify how each actor defines itself.

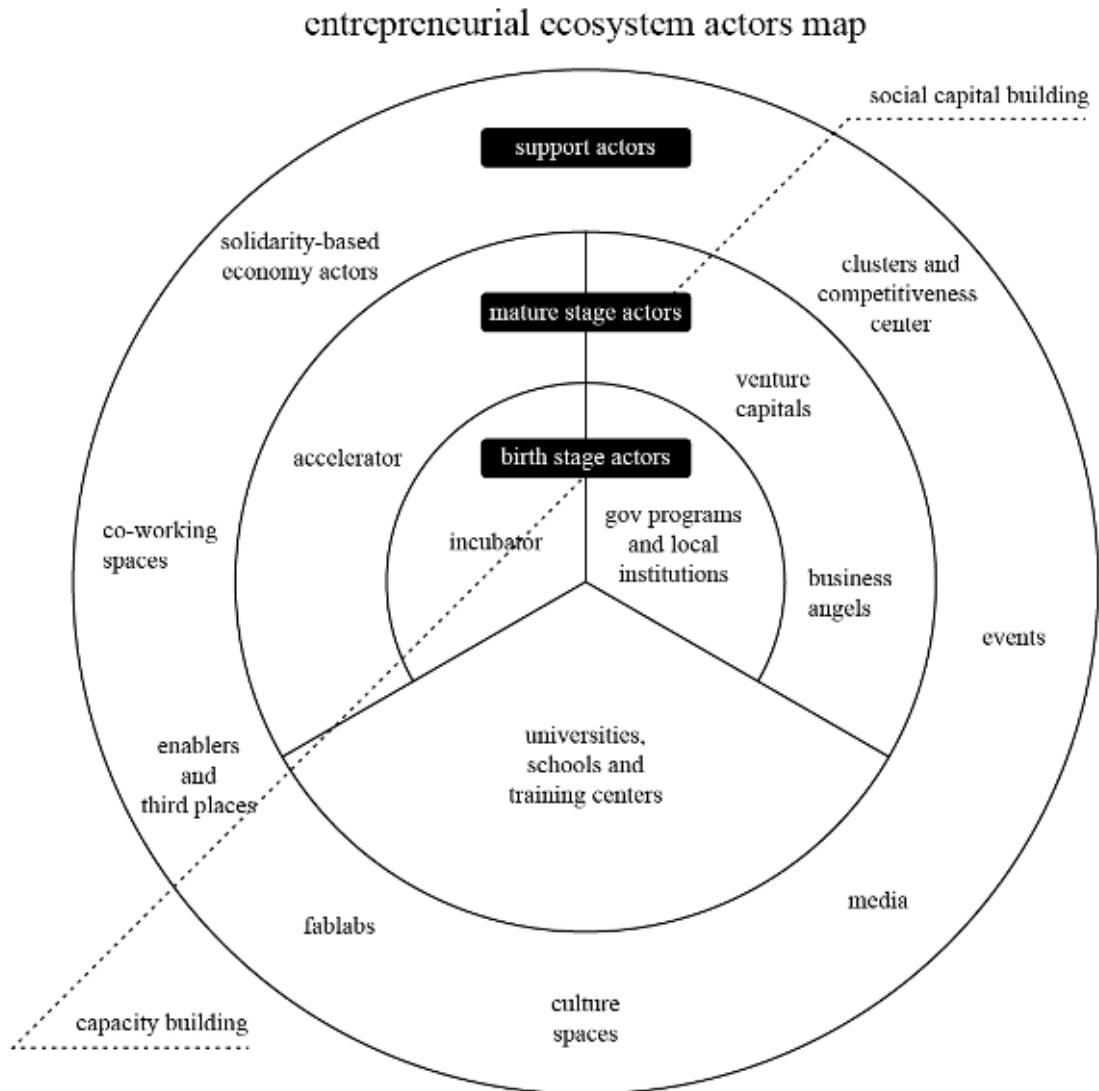
¹⁹ 2018 : 20,74 ; 2019 : 19,4

²⁰ 2018 : 6,65 ; 2019 : 11,4 ; 2020 : 7,1

²¹ 2015 : 10,1 ; 2018 : 4,78 ; 2019 : 10,3

²² Madagascar : 56 ; Morocco : 167 ; Tunisia : 211 ; Lyon : 251

Fig 25. Entrepreneurial Ecosystem Type of Actors (Authors, 2021)



3.2. Research design

EE actors are organizations. To measure their ties we need to identify their dyadic associations. In low income countries, as well as in the most developed countries, we do not know a repository which registers partnerships, or any other forms of ties between EE actors. Social networks neither represent a reliable data source to form ties, as they are mainly people oriented. People, in EEs, can move from an organization to another, some of them are freelancers, and their ties do not necessarily represent active collaborations between actors. EE actors, at least most of them, do not have substantial resources to advertise their value proposition, but they need to be known by their targets : entrepreneurs. Based on recent research on data sources (Von Bloh *et al.*, 2019), online media is perceived as a valuable information

source to observe Entrepreneurship phenomenons. EE actors frequently either distribute press releases, or journalists report various forms of events involving EE actors, such as Hackatons, Pitches, Challenges, etc. As a consequence, in online articles naming EE actors, we often identify their active partners, whatever the kind of their collaboration. We also checked that we could never observe any article naming antagonisms between EE actors, or destruction of their ties (end of a collaboration). We only identify positive ties, especially the event of formation of their ties.

We decided to measure EE actors' ties identified in online media articles within the most representative media in a given territory. This research extracts for the observed period all articles naming each of EE actors in a given territory, and identifies dyadic association through co-occurrence techniques, in order to leverage network measures. In order to be able to identify type of actor strength and ties, we factorized all actors belonging to each type of actor.

3.3. Data collection

Scholars have recently suggested that big data leads to new research methods that can improve our ability to enhance rigor in quantitative research related to Entrepreneurial Ecosystems (Schwab and Zhang, 2019; Maula and Stam, 2020). Here we decided to follow the line opened by (Guéneau, Chabaud and Sauvannet, 2022). Based on our rigorous listing of actors, we created an original R Studio²³ script using rvest, tidyverse and RSelenium packages. First we prepared the variables : identify the online media in which the WebScraping will occur²⁴ ; for each one identify its HTML structure to specify our web scraping loop, to collect for each observation the title, the body of the article and the time of publication ; and create the database of correspondence between the actors names, their roles and types. Then we tested the web scraping loop before running it completely in order to verify the integrity of the web scraping procedure. For each territory, we recorded up to 72 hours of continuous attention to the running script safely. This procedure allowed us to collect 155.470 longitudinal observations²⁵ recorded in four separate databases. Next we identified dyadic associations within each observation. This was made possible by cleaning each observation, then tokenized

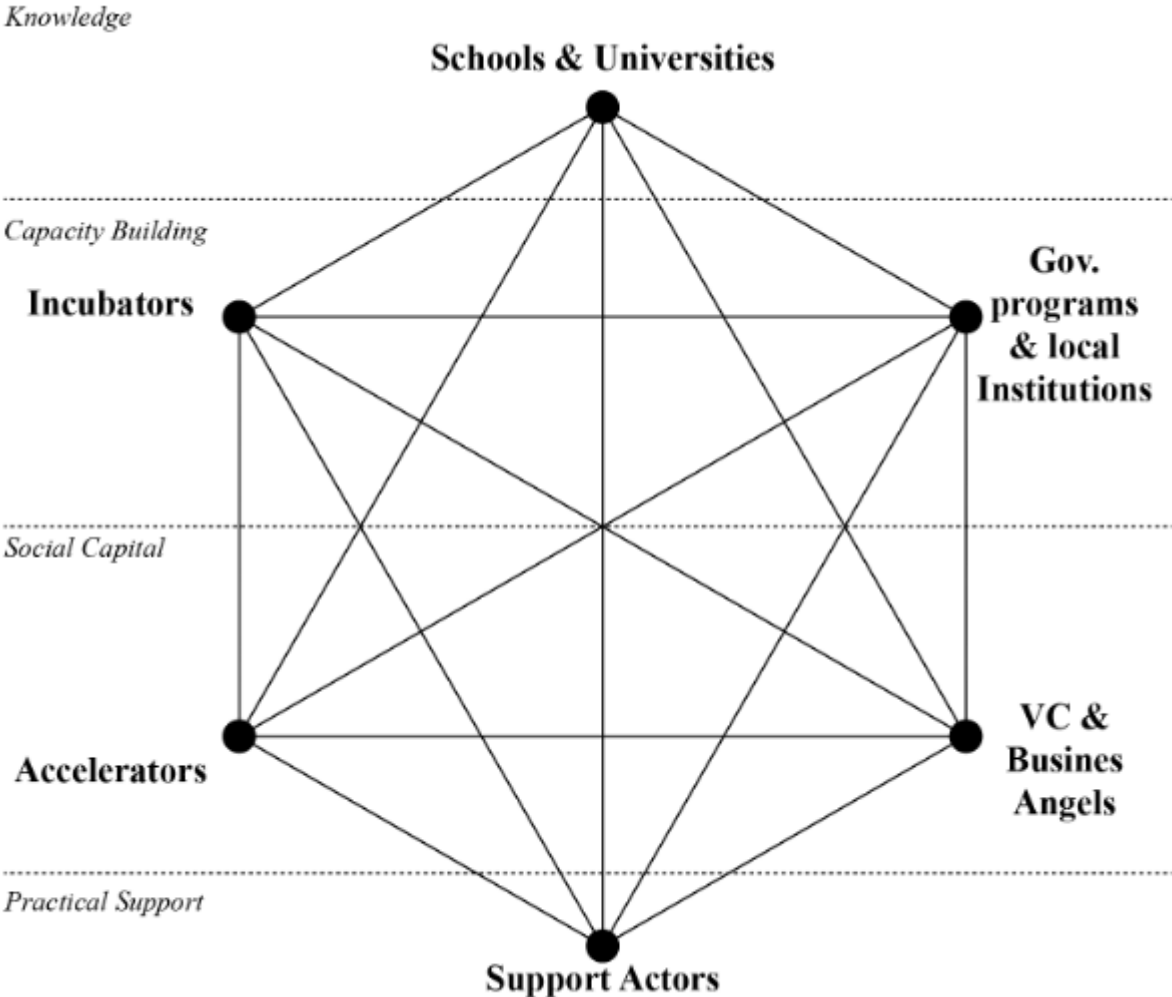
²³ <https://www.rstudio.com/>

²⁴ Madagascar : midi-madagasikara.mg ; Morocco : leconomiste.com ; Tunisia : leconomistemaghreb.com ; Lyon : le-tout-lyon.fr

²⁵ Madagascar : 5888 ; Morocco : 6552 ; Tunisia : 5 448 ; Lyon : 137 852

the name of each actor within. Next, -using the R package `quanteda`²⁶- we created a dyadic association matrix, representing ties between EE actors in each territory. We runned this procedure for each EE, each year. Next, leveraging Quantitative Graph Theory [\[Updating\]](#) methods, we produced not less than 528 tables and graphs, 22 per territory and per year. At last, we extracted the dyadic association table, and converted each actor's name to its type name, and runned in Gephi²⁷ a plot trace and network calculations. This tool allows us to control the spatial representation of each plot, to align its representation to our model (Fig 26.).

Fig 26. Entrepreneurial Ecosystem Networking between its type of actors



²⁶ Function : `t(object) %*% object`

²⁷ <https://gephi.org/>

4. FINDINGS

4.1. Data

Our network modeling tool -Gephi- embed a limited number of network measures, but relevant ones. We chose to expose six measures represented in Table 15. for Lyon, Table 16. for Madagascar, Table17. for Morocco and Table 18. for Tunisia. On the scale of the five observed years, we only presented the results of three years, 2017, 2019 and 2021, as we saw in our dataset that those EE configurations were quite stable over time.

We present in this data extraction the following measures, each one having its own meaning. We have centrality measures such as Weighted Degree, Closeness Centrality, Harmonic Centrality, Eigen Centrality. The Weighted Degree Centrality is the sum of weights assigned to the actor's type direct connections. Closeness Centrality is calculated as the reciprocal of the sum of the length of the shortest paths between the Actor's types and all other types. Harmonic Centrality, a variant of closeness centrality, is invented to solve the problem the original formula had when dealing with unconnected graphs. Eigen Centrality measure of the influence of an Actor type.

Table 15. Lyon

Year	Actor Type	Weighted Degree	Closeness Centrality	Harmonic Closeness Centrality	Authority	Eigen Centrality	Clustering
2017	Schools & Universities	0	0	0	0	0	0
	Incubators	7	0,75	0,833333	0,522712	0,854024	1
	Accelerators	0	0	0	0	0	0
	Gov. programs & Local Institutions	3	0,75	0,833333	0,522712	0,854024	1
	VC & Business Angels	1	0,6	0,666667	0,281831	0,46142	0
	Support Actors	9	1	1	0,61165	1	0,333333
2019	Schools & Universities	0	0	0	0	0	0
	Incubators	19	0,8	0,875	0,523687	0,898353	0,666667
	Accelerators	5	0,666667	0,75	0,411905	0,706668	1
	Gov. programs & Local Institutions	9	0,666667	0,75	0,411905	0,706668	1
	VC & Business Angels	2	0,571429	0,625	0,216906	0,372908	0
	Support Actors	27	1	1	0,582557	1	0,333333

2021	Schools & Universities	0	0	0	0	0	0
	Incubators	28	1	1	0,547741	1	0,5
	Accelerators	5	0,666667	0,75	0,36513	0,666605	1
	Gov. programs & Local Institutions	9	0,666667	0,75	0,36513	0,666605	1
	VC & Business Angels	6	0,666667	0,75	0,36513	0,666605	1
	Support Actors	38	1	1	0,547741	1	0,5

Table 16. Madagascar

Year	Actor Type	Weighted Degree	Closeness Centrality	Harmonic Closeness Centrality	Authority	Eigen Centrality	Clustering
2017	Schools & Universities	2	0,6	0,666667	0,288675	0,577329	0
	Incubators	0	0	0	0	0	0
	Accelerators	0	0	0	0	0	0
	Gov. programs & Local Institutions	2	0,6	0,666667	0,288675	0,577329	0
	VC & Business Angels	9	1	1	0,866025	1	0
	Support Actors	5	0,6	0,666667	0,288675	0,577329	0
2019	Schools & Universities	5	0,8	0,875	0,565105	1	0,333333
	Incubators	1	0,5	0,583333	0,245395	0,434193	0
	Accelerators	0	0	0	0	0	0
	Gov. programs & Local Institutions	2	0,5	0,583333	0,245395	0,434193	0
	VC & Business Angels	10	0,8	0,875	0,565105	1	0,333333
	Support Actors	6	0,666667	0,75	0,49079	0,868386	1
2021	Schools & Universities	8	0,8	0,875	0,523687	0,898353	0,666667
	Incubators	8	0,666667	0,75	0,411905	0,706668	1
	Accelerators	0	0	0	0	0	0
	Gov. programs & Local Institutions	4	0,571429	0,625	0,216906	0,372908	0
	VC & Business Angels	18	1	1	0,582557	1	0,333333
	Support Actors	6	0,666667	0,75	0,411905	0,706668	1

Table 17. Morocco

Year	Actor Type	Weighted Degree	Closeness Centrality	Harmonic Closeness Centrality	Authority	Eigen Centrality	Clustering
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2017	Schools & Universities	24	0,714286	0,8	0,303271	0,677534	1
	Incubators	226	1	1	0,447623	1	0,8
	Accelerators	325	1	1	0,447623	1	0,8
	Gov. programs & Local Institutions	401	1	1	0,447623	1	0,8
	VC & Business Angels	120	0,833333	0,9	0,391745	0,874999	1
	Support Actors	152	0,833333	0,9	0,391745	0,874999	1
2019	Schools & Universities	25	0,833333	0,9	0,364508	0,850705	1
	Incubators	302	1	1	0,428447	1	0,9
	Accelerators	375	1	1	0,428447	1	0,9
	Gov. programs & Local Institutions	454	1	1	0,428447	1	0,9
	VC & Business Angels	156	0,833333	0,9	0,364508	0,850705	1
	Support Actors	182	1	1	0,428447	1	0,9
2021	Schools & Universities	33	1	1	0,408248	1	1
	Incubators	332	1	1	0,408248	1	1
	Accelerators	407	1	1	0,408248	1	1
	Gov. programs & Local Institutions	509	1	1	0,408248	1	1
	VC & Business Angels	170	1	1	0,408248	1	1
	Support Actors		1	1	0,408248	1	1

Table 18. Tunisia

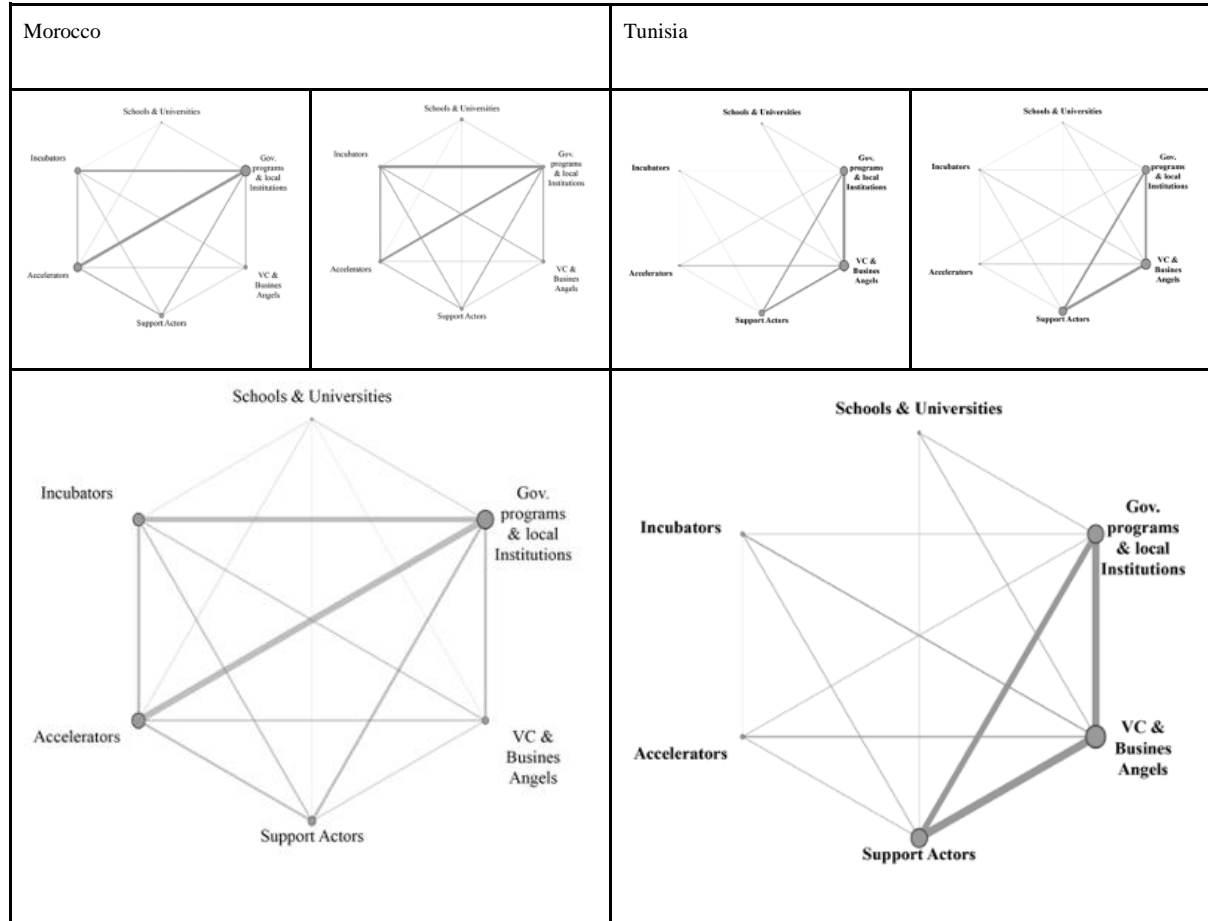
Year	Actor Type	Weighted Degree	Closeness Centrality	Harmonic Closeness Centrality	Authority	Eigen Centrality	Clustering
2017	Schools & Universities	9	0,625	0,7	0,219511	0,476464	1
	Incubators	7	0,833333	0,9	0,418935	0,907955	1
	Accelerators	17	0,833333	0,9	0,418935	0,907955	1
	Gov. programs & Local Institutions	83	1	1	0,461138	1	0,7
	VC & Business Angels	103	1	1	0,461138	1	0,7
	Support Actors	59	0,833333	0,9	0,418935	0,907955	1
2019	Schools & Universities	13	0,833333	0,9	0,364508	0,850705	1
	Incubators	19	1	1	0,428447	1	0,9
	Accelerators	20	0,833333	0,9	0,364508	0,850705	1
	Gov. programs & Local Institutions	118	1	1	0,428447	1	0,9
	VC & Business Angels	150	1	1	0,428447	1	0,9

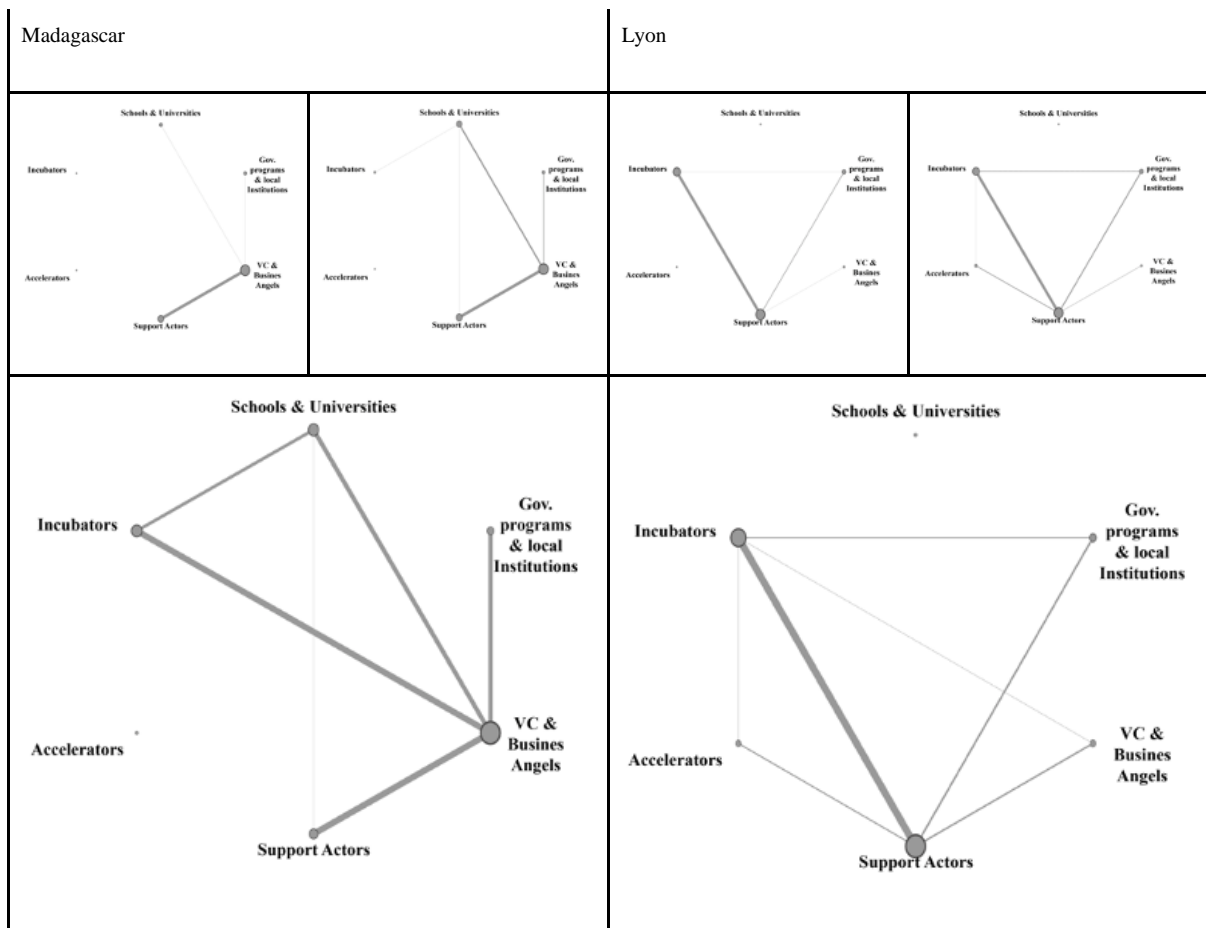
	Support Actors	122	1	1	0,428447	1	0,9
2021	Schools & Universities	15	0,714286	0,8	0,303271	0,677534	1
	Incubators	22	0,833333	0,9	0,391745	0,874999	1
	Accelerators	25	0,833333	0,9	0,391745	0,874999	1
	Gov. programs & Local Institutions	138	1	1	0,447623	1	0,8
	VC & Business Angels	174	1	1	0,447623	1	0,8
	Support Actors	142	1	1	0,447623	1	0,8

4.2 Network Plots

As for the tables, we chose to extract only three years (2017, 2019, 2021) plots, to observe these Evolutionary Networks (Figure 19.). The size of Nodes (circles) of these plots represent their weighted degree (Tables 15 to 18). More a type of actor creates ties, intra or inter ties, the bigger the circle is. The Vertices (lines) represent the weight of ties between the types of actors, the thickness of the line represents the quantity of ties that exist between two types of actors.

Fig 19. Morocco, Tunisia, Madagascar and EE types ties (2017-2019-2021)





The obtained plots validate our hypothesis as every territory presenting strong ties with ‘practical support’ actors present a robust level of Entrepreneurial Dynamics. The detailed implications are debated below.

5. DISCUSSION

5.1. Theoretical implications

The qualitative observation of those plots indicates, beside the growth of the network itself, its tendency to complete: the structural holes in terms of actor types representation and inter-type of actors' ties tend to disappear in time. For example, in 2017, Madagascar presented only three inter-types of ties, which tends to be completed over time. Same phenomenon can be observed in the three other EEs. We see also that in other territories inter-types of ties tend to be created or strengthened over time. This indicates that EE tends to complete itself over time. EE actors tend to make more connections with more various kinds of actors over time, which itself demonstrates the evolutionary attribute of EEs.

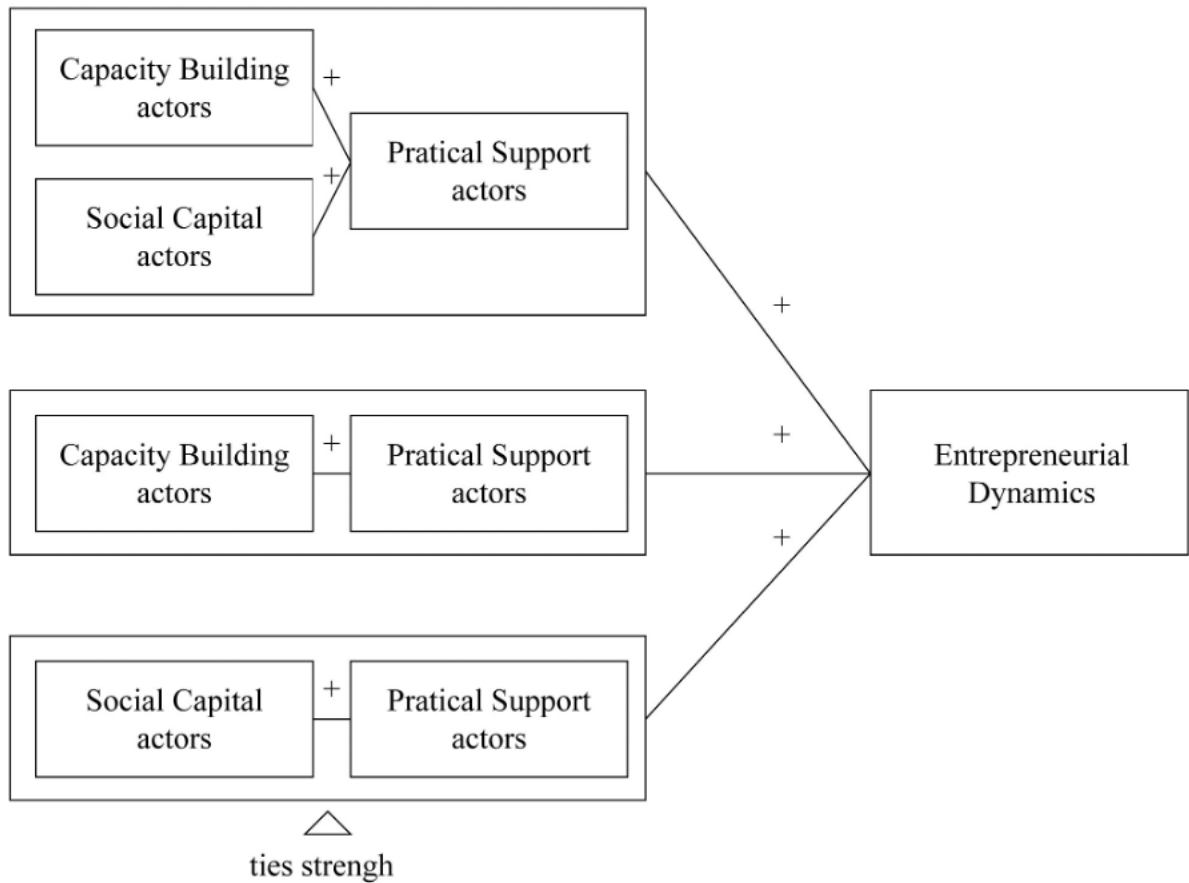
Another interesting phenomenon refers to Network Persistence (Dahlander and McFarland, 2013). The EE network inter-type of actors attributes tends to reinforce itself over time. We see clearly in those four territories that their EE inter-type ties pattern stays stable over time. In Morocco the Incubator - Accelerator - Gov.Programs triangle reinforces itself over time. In Tunisia it's its Private Funding - Public Funding - Support Actors triangle that is reinforced. The same pattern can be observed in the other territories. There is stickiness in EE Network inter-types configuration, and this process is general in those four territories.

Third, we observe EE evolution regarding its spillovers on Entrepreneurial Dynamic. If Madagascar or Tunisia are presenting TEA levels above average, Morocco is known to present one of the weakest Entrepreneurial Dynamics in the African continent. This indicates that unproductive EE does not change its configuration and, at the opposite of Learning Organizations (Cook and Yanow, 1993), these EEs appear to be non-learning inter-organizational networks, regardless of their own performance or lack of performance.

Fourthly we can deduct from this exploratory research optimal attributes of EEs. We observe that an efficient EE Network presents strong ties to its Practical Support Actors. This reinforces and specifies previous findings (Authors 2021) regarding the Entrepreneurial Capacity Building processus, that can not occur without access to Entrepreneurial Resources. Through its inter-organizational ties, an EE can facilitate -or not- access to Entrepreneurial Nurturing Resources. Entrepreneurs see their efforts to fulfill their entrepreneurial project facilitated if they access easily to 'entrepreneurial nurturing components', and at the opposite unease to access to these resources have a negative effect on Entrepreneurial Dynamics.

Finally, based only on those four cases study, we observe that the observed phenomena are the same in our four territories, which can open to generalization of EE behaviors though a larger scale observation. The model extracted from our observations suggests an EE modularity effect on Entrepreneurial Dynamics (Fig. 31).

Fig 31. EE Modularity effect on Entrepreneurial Dynamics



5.2 Practical implications

EE Network configuration informs on low performance causes. In our cases Practical Support actors seem to play a major role in the Entrepreneurial Dynamic stimulation. We also find indications that knowledge spread represents an Entrepreneurial Dynamic boost in Madagascar. This research confirms previous findings regarding some configurations that reduce or hinders access to critical resources for Entrepreneurs, crushing their efforts. For public policy makers it indicates the attention to strongly fill the gaps in EEs, both in terms of Practical Support Actors development, as well as to make sure they are particularly well networked with Capacity Building actors.

More specifically, any effort to dynamize an EE should take into account the necessity to connect birth stage and mature stage actors to practical support actors, and also to increase the offer of those practical support actors in order to provide a large and deep portfolio of resources

for entrepreneurs. Those measures should quickly play positively on Entrepreneurial Dynamics.

Another point, which is not specifically demonstrated in this research, is the importance of Knowledge actors. Research acknowledges, through the Knowledge Spillover Theory of Entrepreneurship, that knowledge stock and absorptive capacity are causal conditions of Entrepreneurial Dynamics development. As a consequence, active strategies to connect knowledge actors to birth stage and mature stage actors in EEs should play positively on Entrepreneurial Dynamics, but more at medium and long term scale.

5.3. Research limitations

Taking in consideration this research limits, which does not take into account interpersonal ties, the various territory-linked bias, the ‘invisibility’ of tie destructions, and that this model is not geographically refined to understand how space affordance plays with interorganizational ties ; we are led to define a research program based on our findings. Another limitation is that this type of research has never been attempted before, which does not allow us to validate, based on previous research, our approach. But the various tools provided by Network Theory, and Quantitative Graph Theory are duly validated, which gives us confidence in the accuracy of our approach. In order to increase the significativeness of this research, we should in the future collect data from more territories, run the same method to refine our results with actor’s roles, and through measures better understand how resources are distributed in EEs.

6. CONCLUSION

Litterature invites the EE black box opening. This research contributes to this effort by the longitudinal observation of EE actors ties at a whole scale, in four distinct territories. As itself, this contribution opens new perspectives in EE, using a simple and straightforward method to measure EE actors' ties formation.

To the best of our knowledge the analysis of ‘species’ as defined in this research, has never been tested, even less longitudinally, which on one side does not provide comparison

models with past research, but on the other side opens many research possibilities in the near future, as the method leveraged here is quite accessible.

Our research provides several implications for both scholars and practitioners. First we contribute to the continuous effort to provide observations and theoretical analysis on EE as a whole, providing elements to build new theories in that field of research. We also provide new analysis angles to EE various phenomena, which are commonly either analyzed under econometric lenses, or qualitative observations, more rarely under organizational science quantitative methods.

Our observations provide interesting insights about EE various forms of configuration, in our case between knowledge, capacity building, social capital and practical support actors. Those observations show that whatever are the specific local configurations between knowledge, capacity building, social capital actors, if they are insufficiently connected to practical actors, it is correlated with lower Entrepreneurial Dynamics levels. This leverages that if Practical Support actors can be considered as kind of ‘business process outsourcing’ actors for Entrepreneurial projects, if those actors are not well enough connected to the EE, Entrepreneurs can not access those critical resources to build their projects and accelerate them. In our understanding, this refers to the modularity perspective, in this sense that exists ‘nurturing components’ in EEs, and the well distribution of those components, their accessibility, is a critical asset for an EE. Further research should allow us to understand the optimal configuration attributes of EEs.

Article 5 : Goats and Crocodiles : African Entrepreneurial Ecosystems Network Archetypes, the cases of Madagascar, Morocco, Senegal and Tunisia

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Abstract

Entrepreneurial Ecosystem is now a growing research field which aims to explore how Entrepreneurship is nurtured in the world. But as this phenomenon produces interesting economic and micro level contributions, only recent research explores its configurational patterns. But EE remains undertheorized under organizational lenses. This research proposes an EE processual analysis in four low incomes countries in order to identify , mobilizing network theory on 410 actors, archetypal configurations. Using web scraping methods, we collected 38 233 observations, allowing us a multi-case holistic analysis. We detected two types of EEs, Goats and Crocodiles, unveiling a continuity perspective .

Keywords : Entrepreneurial Ecosystem, Network Theory, Web Scraping, Big Data, Processual Analysis

INTRODUCTION

Entrepreneurship is known to be a core factor of economic development, especially in the lowest income countries (Wennekers *et al.*, 2005). As a consequence, the analysis of the *‘interdependent actors and factors that are governed in such a way that they enable productive entrepreneurship within a particular territory’* (Leendertse, Schrijvers and Stam, 2021), also known as Entrepreneurial Ecosystem (EE), is crucial to propose proper Entrepreneurship stimulation strategies in those territories. EE research has become a prominent topic in literature (Theodoraki, Dana and Caputo, 2022) but regularly faces critics as this field is considered undertheorized under social science perspectives (Audretsch *et al.*, 2018; Cao and Shi, 2020). Initially seen as an organizational ensemble (Van De Ven, 1993), EE is also considered as an economic concept (Isenberg, 2010). Since then, most EE definitions are hybrid (Malecki, 2018), but its conceptual framework remains built with economic elements (Stam and van de Ven, 2019; Wurth, Stam and Spigel, 2021) such as Leadership, Finance, Talent, Knowledge,

Support Services & Intermediaries, Demand, Physical Infrastructure, Culture, Formal Institutions and Networks. Nevertheless, EE are also known as a relational ensemble (Spigel, 2017b) but Network perspective, rarely mobilized (Purbasari, Wijaya and Rahayu, 2020b; van Rijnssoever, 2020), does not actually capture EE as a whole structural and processual observations which could lead to organizational oriented theoretical and managerial contributions. Scholars also suggest EE can embed various forms of relationships such as cooperation, competition and cooptation (Theodoraki and Messeghem, 2015) having impacts on related Entrepreneurial Dynamics. It also questions how research can mobilize the Ecosystem Theory perspective applied to social science (Roe, 1996; Müller, 1997) in order to better understand this field of research. Such orientation could lead to interesting topological analysis and suggest EE optimal structure (Mateo *et al.*, 2019), archetypal configuration (Tatarynowicz, Sytch and Gulati, 2016), or ecological network analysis (Morris, Weissburg and Bras, 2021). Recent literature suggest interesting research canvas under both inter-organizational network and ecosystem perspective (Shipilov and Gawer, 2020) which was recently mobilized (Gueneau, Chabaud and Chalus-sauvannet, 2021; Guéneau, Chabaud and Sauvannet, 2022) demonstrating the methodological possibility to analyze EE organization as a whole. Based on that research we propose to open an interesting longitudinal network analysis (Snijders, 2005) with the intent to unveil processual patterns occurring in EE and propose a first archetypal analysis in this field of research. This research aims to contribute to understanding how, through its structure and process, EE presents continuity or discontinuity of its resources distribution to entrepreneurs.

1. THEORETICAL BACKGROUND

Core theories on Entrepreneurial Ecosystems are econometric based (Stam and van de Ven, 2019) since Isenberg's seminal paper (2010). Research focus also on local and targeted phenomenon, specifically on small group of actors, such as on Incubators (Klofsten *et al.*, 2020), Universities (Fuster *et al.*, 2019), and also Place-centric analysis (Adams, 2020), Measures (Liguori *et al.*, 2019), or the role of Digital (Elia, Margherita and Passiante, 2020). As a result, we miss a global picture analysis on EE as a whole, under social science perspective. EE theoretization weakness appears on various topics such as EE behavior as a whole ensemble, its structure and processes. Actually, we mainly observe EE in pieces. Scholars (Audretsch *et al.*, 2018; Cao and Shi, 2020) underlines the necessity to fill this void. The term 'black box' is recently leveraged in EE research to point the underlying structure and processes occurring in

EEs, like the understanding the ‘strategic interactions between ecosystem actors and factors’ (Theodoraki, Messeghem and Audretsch, 2020). To our best knowledge, configurational analysis of EE does not exist yet, as well as EE whole scale organizational processes, even if focused research provides sometimes some good clues.

Meanwhile, researchers also acknowledge EE are a relational ensemble (Spigel, 2017b) leading to leverage particularly Network Theory (Shipilov and Gawer, 2020) as an interesting perspective to understand EE actors ties (van Rijnsoever, 2020) or their relations with entrepreneurs (Purbasari, Wijaya and Rahayu, 2020b). But -again- none of those researches addresses EE as a Network super-structure of inter-organisational or inter-personal ties between its actors at a whole scale. However, following Moore’s thesis on Ecosystems (1996), interesting analysis on interorganizational ties (Ring and van de Ven, 1994; Belso-Martínez, Mas-Verdu and Chinchilla-Mira, 2020) and on network archetypes (Tatarynowicz, Sytch and Gulati, 2016), there is strong indication that coevolution of actors is a core phenomenon happening within EEs that should be further analyzed.

In parallel, referring EE to ecology raises also an Evolutionary perspective that met recent attention (Audretsch *et al.*, 2021), which strongly indicates the necessity of a longitudinal analysis within EEs, and which could open to processual analysis. But very little research adopts those lenses, most of the time to focus on entrepreneurial dynamics (Amorós and Cristi, 2008; Delanoë-Gueguen and Fayolle, 2018), or to understand resilient EEs (Ryan *et al.*, 2020). Nevertheless, those research acknowledge the interest of evolutionary perspective in EE research. Evolution refers also to ‘species’ (Domínguez-García and Muñoz, 2015) which in EE are the various types of its actors. Scholars underline EE actor’s role in its performance (Franco-Leal *et al.*, 2020), or the importance of the analysis of EE from internal actors themselves (Boutillier, Carré and Levratto, 2016). Commonly, we can identify six groups of types of actors having a dedicated activity regarding Entrepreneurship within the EE’s territory : universities, schools and training centers ; birth stage support actors (incubators), birth stage resource providers (gov. programs and local institutions), mature stage support actors (accelerators), mature stage resource providers (business angels and venture capitalist), support actors (solidarity based economy actors, co-working spaces, enablers and third places, fablabs, culture spaces, medias, events, clusters and competitiveness centers).

Previous research present insights on EE actor’s roles, particularly in term or resource acquisition (Spigel, 2017a) and working processes occurring between actors (Spigel and Harrison, 2018a) suggesting that they act as ‘nurturing components’ distribution actors to entrepreneurs, without describing empirically how this phenomenon occurs. Nevertheless, the

supportive role of EE to Entrepreneurial Process has been previously debated (Agarwal, Audretsch and Sarkar, 2010) and detailed at a micro level of analysis (Peters, Rice and Sundararajan, 2004), without providing empirical evidences of theses at the whole level of EEs. This descriptive presentation of type of actors EEs and their roles, seen under network perspective, is an unknown territory in EE theory (Camarinha-Matos and Afsarmanesh, 2018), but strongly refers to life science (Powell *et al.*, 2005) that indicates an Ecological Network Analysis (ENA) perspective (Morris, Weissburg and Bras, 2021) as a research framework. Such an approach is required to understand EE network's topology (Liu, Pellegrini and Wang, 2015), its local specific configuration based on territorial and cultural specificities, but also is able to reveal interesting configurations regarding accessibility of various forms of resources dedicated to Entrepreneurship.

If research theoretically acknowledges that a network structure and process can present an interesting continuity attribute of its resources distribution, it hasn't been observed within Entrepreneurial Ecosystems. Though, it can be observed using longitudinal network analysis techniques (Snijders, 2005) which has also the interest to increase validity of results (Stadtfeld *et al.*, 2020), particularly using network measures proposed in the Quantitative Graph Theory framework (Dehmer, Emmert-Streib and Shi, 2017). There are three groups of measures, which can be factorized. First one is the Information spread factor, made of centrality (Bloch and Jackson, 2016; Pittz, White and Zoller, 2019) and density (Marsden, 1993; Liu, 2011) measures. Information and Knowledge (van der Borgh, Clodt and Romme, 2012) are key elements for entrepreneurs to accelerate their project, make them more accurate to the market, identify the proper resources in their environment, auto-evaluate their innovation, or gather precious knowledge to complete the various holes in their project. The second one is the Proximity factor made of reversed distance metrics (average shortest path, diameter, clustering coefficient, mean distance) (Bienstock and Györi, 1988). Distance reduces the opportunity to reach the proper components for an entrepreneurial project, and an Entrepreneurial Ecosystem having high distance rates reduces its modularity potential. The last factor is inter-connectivity (Barnes, 1969). Inter-connectivity is the most basic measure that indicates the ability of an Entrepreneurial Ecosystem to deliver its services effectively, it reduces the time and efforts for entrepreneurs to gather the proper and specific material or immaterial resources dedicated to their project.

This research aims to describe a specific phenomenon, Entrepreneurial Ecosystem, through the analysis of sub-units. We propose to compare the same phenomenon and the same sub-units in various contexts, leveraging an exploratory descriptive case study (Yin, 2003,

2013; Cassell, Cunliffe and Grandy, 2017). To strengthen our results and identify key processual mechanisms, we also leverage longitudinal observations. This research design allows us to analyze this EE complex phenomenon (*The SAGE Handbook of Evaluation*, 2022) through explanation building as an analytic strategy.

2. METHOD

When all you have to do is bend down to find resources, the Entrepreneurial Ecosystem can play a role, but weaker compared to low resources and income countries. We chose to target four low income Entrepreneurial Ecosystems, in comparable environments in Africa : Madagascar, Morocco, Senegal and Tunisia. Those countries are comparable in terms of infrastructure (Abiad, Debuque-Gonzales and Sy, 2017), research, education (Chua Kenn, 2016), and other factors such as institutional organization, multiple use of language, colonization history, level of development. We chose also those countries due to their similarity in their EE elements analysis²⁸ produced regularly by the Global Entrepreneurship Monitor, and their unexplained gaps in terms of Entrepreneurial Dynamics, presented by the TEA metric.

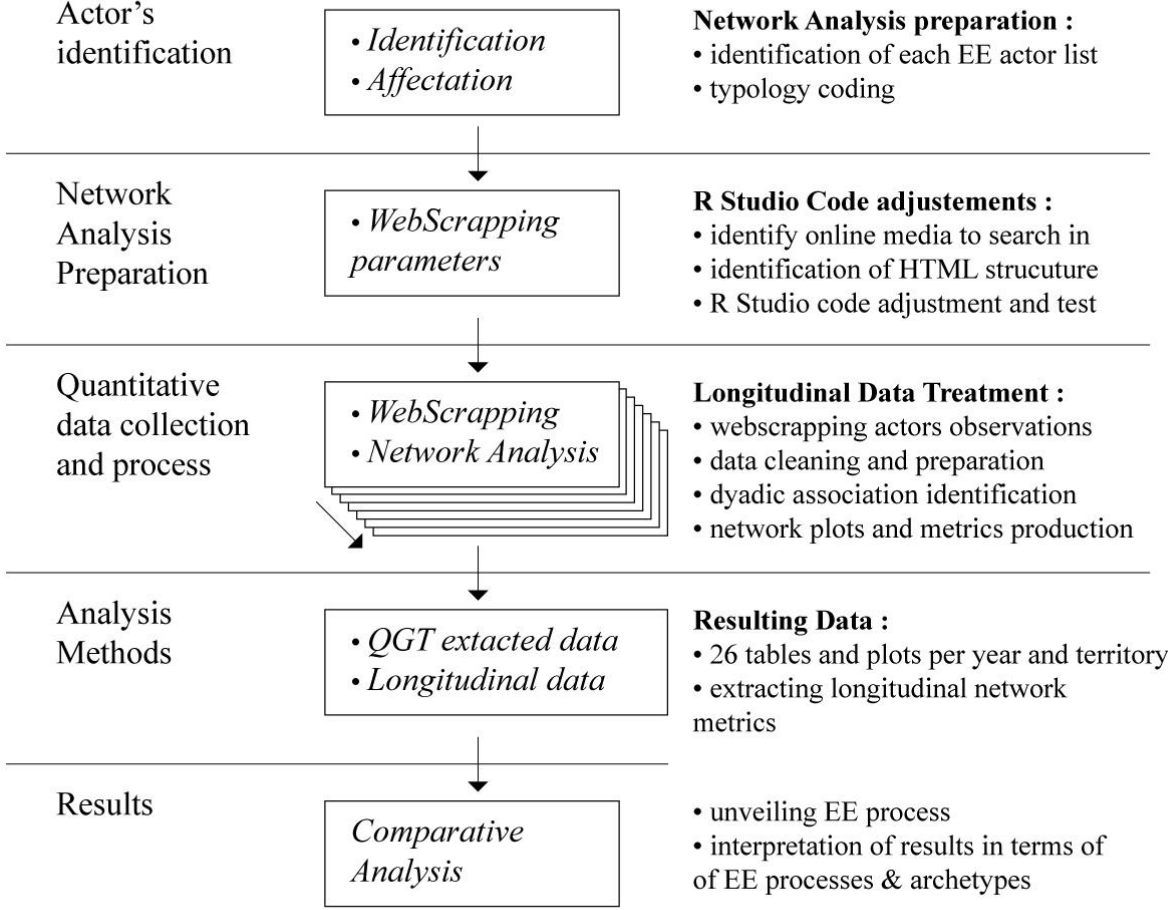
We developed an innovative research method to study interorganizational ties in a network, using big data from online media. This method is interesting to study Entrepreneurial Ecosystem as a whole, as for now we only have macro-level analysis data with econometric measures, and micro-level analysis qualitative and quantitative methods but that does not allow us to theorize properly under social science perspectives. The network measures and plots results of this method can allow to better establish the link between causes and effects regarding Entrepreneurial Ecosystems.

Our genuine research protocol is designed to perform a rigorous and relevant analysis of the EE within targeted territories, and to conduct a comparative analysis between them (Figure 1). We defined five methodological steps. The first step consists in each analyzed territory actors identification, which includes to assemble a complete list of EE actors within each country, verify that list and qualify it. The second step consists in setting up the web scraping parameters by the identification of the appropriate online media that contains the most EE actors' information in each studied territory, identify its web CSS codes and adjust the RStudio web scraping code. The third step consists in actually web scraping all observations about our EE actors, process co-occurrence techniques to identify dyadic association, run network

²⁸ <https://www.gemconsortium.org/economy-profiles>

calculation, and plots. The fourth step consists in extracting longitudinal network metrics as results. The last step consists in running a network metrics comparative analysis to unveil EE processes and archetypal behaviors.

Figure 1 : Research protocol
Entrepreneurial Ecosystem
Inter-organizational network
analysis protocol



To identify all the EE actors (incubators, accelerators, fablabs, institutions, business angels, etc.) we decided to mobilize economic services from French and German embassies to identify the proper source(s) to list the EE actors. We verified the robustness and accuracy of the given repositories of actors by checking social networks and web pages of each actor, corrected typographical errors in their names, and removed some actors that appeared not to belong to EE, such as accountants or communication agencies. The final list presents a total of 410 actors: 141 for Morocco; 50 for Madagascar; 56 for Senegal; and 163 for Tunisia. For

further analysis, we build an extensive EE actors database including each actor address, typology of their activity, and descriptive attributes.

To analyze ties between actors we used online media coverage. EE actors advertise their partnerships and ties through press releases; journalists directly report them, making media coverage relevant for detecting positive dyadic associations. They indicate strong and positive inter-organizational ties, as none of the actors would publicly communicate an existing negative or weak tie, or the end of a partnership. Other forms of communication, such as social network posts, embed noisy messages or negative ties, making these sources of information irrelevant. Partnerships among EE actors are neither always contractually formalized, nor reported in existing EE repositories. This makes press releases the only available and the most significant secondary data source to track positive, and known, inter-organizational ties among EE actors.

To identify EE actors' inter-organizational ties, we used big-data from online media coverage (Von Bloh *et al.*, 2019) in the targeted country's top economic online journals, employing web scraping. We chose the open-source R Studio software packages²⁹ to run web scraping protocols, and various network measures, plots, and analyses. To operate this protocol, we developed a genuine R code of 1300+ lines to run the web scraping loop and treatments, and QGT calculations, plots and statistics. In order to develop the code, we prepared a cleaned list of actors, as well as identified the target HTML page web structure to operate and target the web scraping method.

We analyzed the network properties of the EE. We used the QGT measurements to quantify structural information of networks (Dehmer, Emmert-Streib, and Shi, 2017), as well as various forms of comparative analyses, based on isomorphism-based measures, graph edit distance, iterative graph similarity methods, string-based measures, and graph kernels. Its characterization for determining the complexity of a given network can be obtained through distance-based graph measures, degree-based measures, eigenvalue-based measures, or information-theoretic measures. For this exploratory research, we chose to longitudinally extract cohesiveness, inter-connectedness, and closeness measurements (Tables 1, 2, 3, 4). In order to build explanations, we build a graphic representation of our longitudinal network analysis measures (figure 2) and analyze for each country and each year its context and ingredients, the apparent sequences, engines of attribute changes, measures bifurcations. For each country we summed our results with a processual analysis to run a cross cases explanation build.

²⁹ Main R packages used: rvest, ggraph, netrankr, tnet, and CINNA

3. RESULTS

Malgasi EE (Table 20), even if relatively stable in number of actors, saw its interconnectedness and proximity attributes increase over time, and sustain its strong Entrepreneurial dynamics. This dynamic can be correlated to the economic dynamic in this low income country. In 2016, the country presents stable WBGES levels correlated with stable numbers of actors in this EE, but their ties are growing. In 2017, the country's GDP per capita dropped 1,17%, which corresponds to a cohesiveness decrease. In 2018 the country presented a strong 20,7 TEA level, with no apparent effect on its network attributes. In 2019 TEA level has slightly dropped to 19.5, due to economic context, but remains strong compared to a regional average of 12.10, but we observe a 9% GDP per Capita Growth since 2015. In 2020, the country presented an interesting raise of its EE ties and proximity, but presented a 5,8% GDP per capita drop due to Covid crisis.

Table 20. Madagascar EE Longitudinal Network Analysis

Madagascar	Year	2016	2017	2018	2019	2020	2021
	Actors - a	43	44	47	47	48	48
	Articles - ar	2086	2702	3353	3353	5193	5888
	Nodes - N	6	8	9	9	11	11
	Vertices - M	8	11	14	14	25	26
Cohesiveness	Density - d	0.38	0.31	0.21	0.21	0.21	0.19
	Centrality -c	1.00	1.00	0.74	0.74	0.64	0.60
	Cohesiveness factor (c*d)	0.38	0.31	0.16	0.16	0.13	0.12
Inter-connectedness	Interconnectivity (N/a) - in	0.14	0.18	0.19	0.19	0.23	0.23
	Average Weight	18.91	20.47	19.95	19.95	17.70	18.21
	Inter-connectedness factor (in*aw)	2.64	3.72	3.82	3.82	4.06	4.17
Closeness	Average Shortest Path	1.71	1.78	2.08	2.08	2.22	2.27
	Clustering Coefficient	0.00	0.00	0.00	0.00	0.13	0.12
	Mean Distance	1.71	1.78	2.08	2.08	2.22	2.27
	Proximity factor $_{((1-asp)*(1-md))}$	0.51	0.60	1.16	1.16	1.48	1.62

Morocco presents a different EE face. This country presents one of the lowest TEA levels in Africa, which presents difficulties to find a growing curve. This is a very big EE compared to its spillovers, with interesting strong network attributes. We observe in 2017 a forming EE. In 2018 the country presented a 21% GEM's New Entry increase since 2014, parallely with an interconnectedness raise. In 2019 the Country presents a 11,4 TEA level, and a 11,8% GDP per capita continuous growth since 2015. In 2020 the Country presents a TEA level of 7,10 (regional average 24,8), which is a 38% decrease, and a 8% decrease of GDP per capita probably due to Covid 19 crisis. Cohesiveness measure fall generates less possibilities for entrepreneurs to circulate, access to social capital and knowledge of its EE.

Table 21. Morocco EE Longitudinal Network Analysis

Morocco	Year	2016	2017	2018	2019	2020	2021
	Actors - a	104	111	113	123	127	133
	Articles - ar	6552	7536	8577	9856	11718	14956
	Nodes - N	58	61	65	70	73	75
	Vertices - M	766	865	945	1035	1101	1145
Cohesiveness	Density - d	0.35	0.28	0.28	0.27	0.25	0.25
	Centrality -c	0.52	0.46	0.47	0.47	0.43	0.46
	Cohesiveness factor (c*d)	0.18	0.13	0.13	0.13	0.11	0.12
Inter-connectedness	Interconnectivity (N/a) - in	0.56	0.55	0.58	0.57	0.57	0.56
	Average Weight - aw	36.70	63.28	69.41	65.02	72.68	75.09
	Inter-connectedness factor (in*aw)	20.47	34.77	39.93	37.00	41.78	42.34
Closeness	Average Shortest Path	1.98	2.12	2.08	2.06	2.10	2.08
	Clustering Coefficient	0.42	0.40	0.41	0.40	0.39	0.40
	Mean Distance	1.98	2.12	2.08	2.06	2.10	2.08
	Proximity factor $_{((1-asp)*(1-md))}$	0.96	1.25	1.16	1.11	1.22	1.17

Senegal's both Entrepreneurial Dynamics context and GDP per capita growth engine stimulate inter-organizational ties, generating a more suitable environment for Information and Knowledge to flow. But collaboration culture seems not to be impacted (proximity), which is probably an indication of stronger interpersonal ties in that EE. In 2015 Senegal presented a 38.6 TEA level, near the double of the regional average (19.8), but its Entrepreneurial

Framework Conditions -even if in a negative evolution- present a significantly higher rate compared to regional average. This context seems to be encouraging for the growth of its EE. In 2017 Senegal presented an EE actor quantity growth. In 2018 WBGES presented a 12% growth of its New Business Density Index between 2015 and 2018. Its EE is presenting then stable of Cohesiveness & Closeness measures, and a constant growth of ties creation generating an interconnectedness growth. In 2019 GDP per capita increased by 19% compared to 2015. In 2020, we observe a strong rebound of cohesiveness factor while COVID crisis impacted negatively (-1%) Senegal's GDP per capita. The clear growth in terms of cohesiveness shows that this EE is highly resilient.

Table 22. Senegal EE Longitudinal Network Analysis

Senegal	Year	2016	2017	2018	2019	2020	2021
	Actors - a	1	27	31	34	34	35
	Articles - ar	1	276	690	1041	1753	2298
	Nodes - N	1	4	4	4	6	8
	Vertices - M	4	11	11	11	29	44
Cohesiveness	Density - d	0.40	0.39	0.39	0.39	0.44	0.48
	Centrality -c	1.00	0.54	0.57	0.54	0.70	0.60
	Cohesiveness factor (c*d)	0.40	0.21	0.22	0.21	0.31	0.29
Inter-connectedness	Interconnectivity (N/a) - in	1.00	0.15	0.13	0.12	0.18	0.23
	Average Weight	10.92	5.97	13.13	18.17	16.51	14.07
	Inter-connectedness factor (in*aw)	10.92	0.88	1.69	2.14	2.91	3.22
Closeness	Average Shortest Path	1.60	1.96	1.96	1.96	1.91	1.86
	Clustering Coefficient	0.00	0.18	0.18	0.18	0.46	0.40
	Mean Distance	1.60	1.96	1.96	1.96	1.91	1.86
	Proximity factor $_{((1-asp)*(1-md))}$	0.36	0.93	0.93	0.93	0.83	0.73

Tunisia, overall, presents a very low cohesiveness compared to other territories, correlated with atone Entrepreneurial Dynamics. In this EE, we do not see any sign of Covid crisis impact. In 2016, its TEA presented a strong evolution, with a 10,1 level (4,8 in 2012). The country presents a very low cohesiveness level compared to other territories. In 2018 we observe a Tie formation period, creating more interconnectedness, the other EE attributes are stable. In 2020 we observe

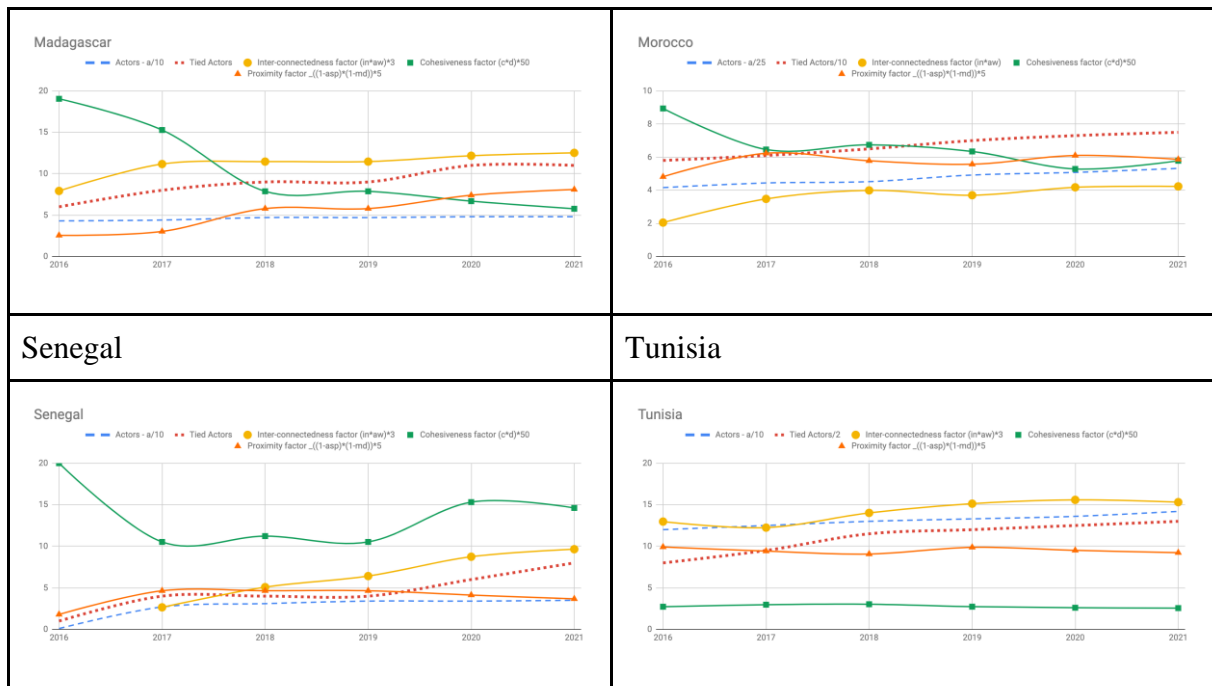
that this country presents a stable New Business Entry on all the periods ($\pm 6\%$ variation 2016-2020), and a 9,8% GDP per capita growth since 2015, followed -in 2021- by an impressive GDP per capita drop (-8,5%).

Table 23. Tunisia EE Longitudinal Network Analysis

Tunisia	Year	2016	2017	2018	2019	2020	2021
	Actors - a	120	125	130	133	136	142
	Articles - ar	5448	6557	7910	9854	12565	15091
	Nodes - N	16	19	23	24	25	26
	Vertices - M	151	209	268	331	366	384
Cohesiveness	Density - d	0.15	0.16	0.16	0.15	0.14	0.14
	Centrality -c	0.36	0.38	0.39	0.38	0.36	0.36
	Cohesiveness factor (c*d)	0.05	0.06	0.06	0.05	0.05	0.05
Inter-connectedness	Interconnectivity (N/a) - in	0.13	0.15	0.18	0.18	0.18	0.18
	Average Weight - aw	32.43	26.85	26.41	27.95	28.26	27.87
	Inter-connectedness factor (in*aw)	4.32	4.08	4.67	5.04	5.19	5.10
Closeness	Average Shortest Path	2.41	2.37	2.35	2.41	2.38	2.36
	Clustering Coefficient	0.30	0.31	0.31	0.34	0.33	0.33
	Mean Distance	2.41	2.37	2.35	2.41	2.38	2.36
	Proximity factor $_{((1-asp)*(1-md))}$	1.98	1.88	1.81	1.97	1.90	1.85

Figure 2. Entrepreneurial Ecosystem network evolution in Madagascar, Morocco, Senegal and Tunisia

Madagascar	Morocco
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4. FINDINGS

Based on our results, we built an explanation building matrix, in order to qualitatively compare our results and propose exploratory explanations (table 24.).

Table 24. Explanation Building Matrix

	Entrepreneurial Ecosystem (EE)	Entrepreneurial Dynamics (ED)	Analysis
Madagascar	Rise of Inter-organizational Ties Cohesiveness degradation Interconnectedness & Closeness increase	Moderate Growth, Stable & Robust ED	Malgasi's EE stimulates ED (interconnectedness & closeness)
Morocco	Large EE, continuous EE actors creation, and interorganizational ties, but declining cohesiveness. Low inter-connectedness	Robust Economic Growth, weakest ED	Morocco's EE is less conducive to ED (low interconnectedness & closeness)
Senegal	EE number of actor growth, stable cohesiveness & closeness, constant inter-connectedness growth	Growing economy, significant ED	Senegal's EE Inter-organizational ties strength stimulates ED

Tunisia	Abundant EE, low cohesiveness, but high inter-connectedness & closeness	Growth and robust level of ED	Tunisia's high level of inter-connectedness & closeness are correlated with its ED
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These four cases invite us to consider two kinds of Entrepreneurial Ecosystems. Goats Ecosystems (Madagascar, Senegal and Tunisia), made of actors tied together and nurturing Entrepreneurs in various ways. Those ecosystems present through its network structure and process an efficient combination of information spread and resource accessibility. Crocodiles Ecosystems (Morocco), organized in a way that Entrepreneurs navigate less easily in the Ecosystem, in the benefit of its actors that act like predators, taking more resources for themselves rather than for Entrepreneurs. It raises the concern of EE network attributes in the benefit of entrepreneurs, such as a proper combination of interconnectedness and closeness attributes, to sustain resources accessibility and distributivity across the EE for Entrepreneurs. But most of the time cohesiveness falls when those two other attributes are rising, meaning mobility is probably at the price of weak information and knowledge spread.

We also observe that there is no apparent structural and processual impact of Covid-19 crisis on those ecosystems, despite the measured economic impact. But further observations in the near future should verify if they met late impact.

5. DISCUSSION

This research contributes to longitudinal network analysis research by mobilizing quantitative graph theory framework and measures. In addition, we mobilize a processual analysis as a case study of EE evolution in four low income countries. Finally, by using an explanation building matrix, we extract interesting results. This combination of methodologic approaches seems to be required to analyze a complex phenomenon such as the Entrepreneurial Ecosystem. We understand this methodologic barrier is one of the reasons why EE research under organizational science perspective has been considered, since now, as an undertheorized field.

Another contribution is an exploratory processual archetypal analysis, presenting those EE in two types, Goats and Crocodiles. Through this analysis we observe interesting EE behaviors. First, we notice that the EE evolutionary perspective can be observed with the use of longitudinal network analysis. Second, we see an apparent correlation between those network processes and EE outcomes. It conducts, yet, to understand that some EE

configurations and processual mechanisms makes some EE more conducive to Entrepreneurial Dynamics than another. Research on Entrepreneurship and Entrepreneurial Process present interesting evidence about how Entrepreneurs collect and use resources found in their environment. But if their Entrepreneurial Ecosystem makes difficult the access to those resources, Entrepreneurial Dynamics in that environment is negatively affected. On the contrary, this research does not demonstrate a positive impact on EE outcomes.

Continuity in EE structure and processes can then be considered critical in order, for an Ecosystem, to produce its outcomes. In this research, continuity can be observed through network processes, but previous research also presented other attributes as key continuity factors, such as some network attribute levels which are causal conditions of TEA levels (Guéneau, Chabaud and Sauvannet, 2022). That evidence converges in a EE discontinuity theory which should be further investigated and theoreticized. This theory aims to consider various resource distributivity factors generated by EE network attributes.

This research also underlines the important role of EE in low resources environments. In those environments, EE continuity plays a major role in EE remaining resources effective distribution. If, in more abundant EEs, its Economic Elements complementarity can play a bigger role, EE efficient organization in a low resources environment is key. This also points out that entrepreneurial stimulus strategies can incorporate quick wins through network strategies, to ensure that medium- to long-term policies are not dampened by poor EE organization.

As this research presents an exploratory analysis in four low income countries, a first limit comes from the limited number of cases. Future research should run similar research based on a larger number of similar territories, and later on, to other kinds of territories, in order to verify if archetypal patterns detected in this research are reproduced. The second limit comes from our comparative analysis which should be strengthened in the future with a larger number of cases. Though, the longitudinal network analysis leveraged in this research should be further more investigated with topology analysis, ecological analysis of EE inter-species of actors behaviors, and also to leverage the power of natural language processing that can be mobilized in the big data collected for this paper.

CONCLUSION

Opening the Entrepreneurial Ecosystem Black Box is demanding, as it leads scholars to explore unknown territories, in terms of theoretical framework, method and contribution. This

particular paper opens new interesting theoretical and methodological contributions, as we deep dive in the ecosystem evolutionary perspective powered by a longitudinal network analysis. This contributes to a demanding research program which aims to systematically explore EE inter-organizational network analysis in low income countries. We are convinced that in the near future, new complementary research will feed the interesting EE continuity theory drafted in the present paper.

General Conclusions

Entrepreneurial ecosystem is a burgeoning field in entrepreneurship research, which is considered an under-theorized area of research in social sciences due to a decade of economic focus and micro-level observations (Cao and Shi, 2020; Audretsch et al., 2018). This explains why we do not have a theory of entrepreneurial ecosystem organization. Given this observation, we have attempted throughout this doctoral journey to explore a new measurement approach in order to capture the structure and configuration of entrepreneurial ecosystems. Doing so we provided interesting answer to the question :

Can we measure the structure of an entrepreneurial ecosystem, and what can we learn from it?

To address this topic, based on the literature, we were led to address our topic in three distinct steps, as the foundation of our research program.

The first part, addressed in Chapter 1 of this thesis, consisted in validating our research method, in order to evaluate its feasibility and the relevance of the obtained results. It allowed us to build the foundations of quantitative graph theory applied to Entrepreneurial Ecosystems, and its various methodological challenges. We showed that entrepreneurial ecosystems could be structurally studied using network theory. This perspective led us, for the first time, to study the inter-organizational ties between Entrepreneurial Ecosystem actors, and to identify network attributes such as proximity, centrality or inter-connectivity.

The second part of this research, discussed in Chapter 2 of this thesis, involved mobilizing a comparative analysis between similar entrepreneurial ecosystems to identify causal effects on entrepreneurial dynamics. This research allowed us to test a comparative analysis, evaluate its relevance, given actual knowledge in Entrepreneurial Ecosystem research. This led to methodological improvements in systematic data collection, the meaning of network attributes, and minimizing bias between data from different entrepreneurial ecosystems. We were also able to understand the explanatory power of network theory applied to entrepreneurial ecosystems.

The third part of this research, discussed in Chapter 3 of this thesis, has allowed us to longitudinal network analysis potential. By doing so we explore the dynamics of entrepreneurial ecosystems using longitudinal network observations, and to further explore its structural and topological characteristics. This research, further exploiting ecological concepts, has allowed us to identify interesting observations regarding interdependencies within entrepreneurial ecosystems, and its essential attributes to sustain entrepreneurial dynamics.

The doctoral work that we have carried out presents theoretical and empirical contributions that can be translated into recommendations for academics, actors in entrepreneurial ecosystems and practitioners in the field of consulting and coaching.

1) Theoretical contributions

Previous research has shown that Entrepreneurial Ecosystems can be considered also as structured inter-organizational ensembles which produce entrepreneurial dynamics as an outcome. Accordingly, we propose an integrated description of entrepreneurial ecosystems, embedding within the economic understanding of the elements of the entrepreneurial ecosystem (Stam and van de Ven, 2019) an organizational understanding of the relationships between its actors, highlighting the interest of studying their interdependencies and structural dynamics.

By doing so, this research participates in the Entrepreneurial Ecosystem Black Box opening providing interesting contributions regarding its descriptive model, and structural dynamics.

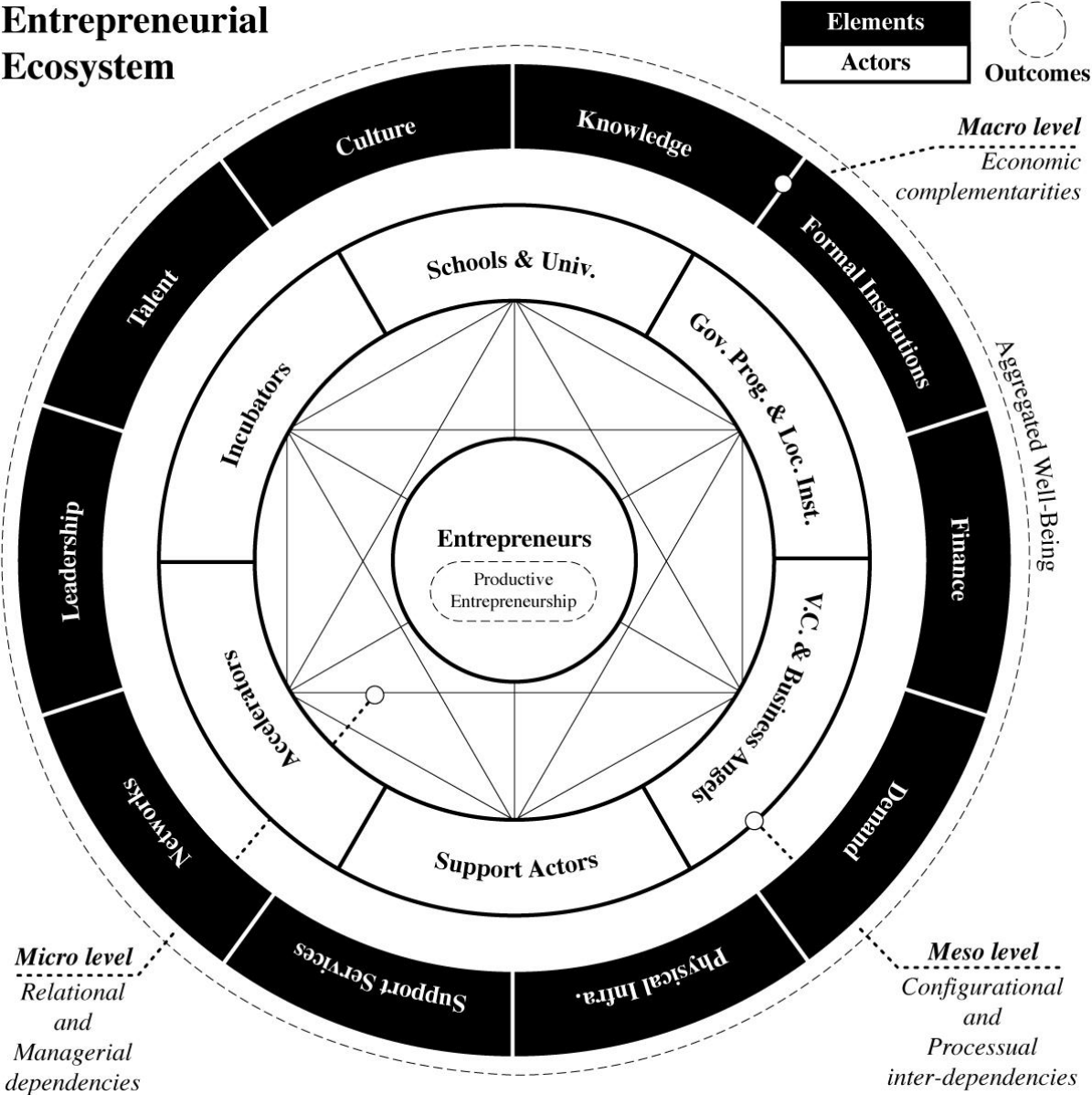
a) Proposition of a descriptive model clarification

A first fundamental contribution of this thesis consists in the clarification of the Entrepreneurial Ecosystem descriptive model. This model, which embeds the ten economic elements, and their complementarities (Wurth et al., 2021), proposes to consider underlying layers. At a meso level of analysis, we consider the inter-organizational network of entrepreneurial ecosystem's actors, which allow to leverage configurational and processual inter-dependencies analysis. This level of analysis, which is also called the Entrepreneurial Ecosystem black box, opens very interesting perspectives and possibilities to build entrepreneurial ecosystem organizational theories, their archetypal configuration, under various environmental and economic factors. At a micro-level of analysis, this model proposes to study the relational and managerial

dependencies between Entrepreneurs and the Entrepreneurial Ecosystem they evolve in. This level of analysis embeds influential literature which observes how incubators, accelerators, venture capital, business angels, and other actors, structure their action to support entrepreneurs and their processes, and deliver various forms of resources. As proposed by actual literature (Wurth et al., 2021), we position Aggregated well-being as an external and global outcome of Entrepreneurial Ecosystems. We propose to position Productive Entrepreneurship as an internal outcome of Entrepreneurs activity (Fig. 32).

Our research is focused on Inter-organizational network observation, but Entrepreneurial Ecosystems also embeds inter-personal ties at meso and micro level of analysis.

Fig 32. EE Elements and Actors



b) Entrepreneurial Ecosystem Structural dynamics influence on its internal outcome

The research conducted in this thesis has allowed us to identify two important Entrepreneurial Ecosystem structural factors that may have a causal impact on its related outcomes : its network attributes, and topological configuration (Fig. 33).

i) Information Spread and Proximity attributes conducive to Entrepreneurial Dynamics

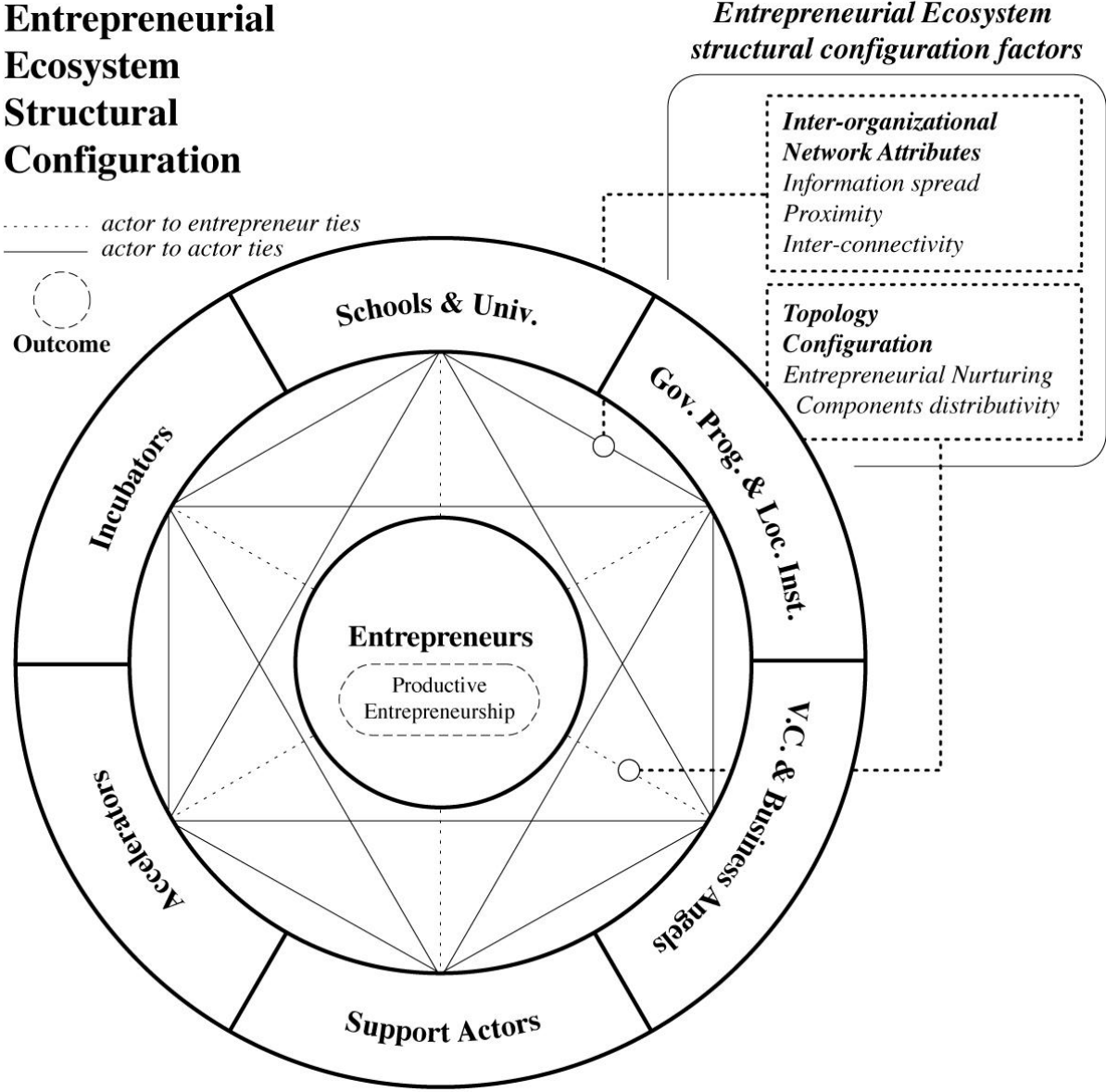
Our research revealed three main Entrepreneurial Ecosystem configurational attributes : Information and Knowledge spread, Proximity and Inter-Connectivity. Those attributes can be measured with Quantitative Graph Theory means. Each of these attributes is independently considered in literature as a key factor, either in Entrepreneurial Ecosystem research itself, such as Knowledge or Information Spread, or in Organizational Network research, such as proximity or inter-connectivity. Various observations revealed the importance of those attributes related to network performance, but never applied specifically to the Entrepreneurial Ecosystem as a whole organizational ensemble. Their levels and dynamics can be studied independently, or factorized, in order to understand the various roles those attributes play regarding the growth, structuration, evolution of the Entrepreneurial Ecosystem itself, its dependencies with its macro-environment, or its impact on its outcomes. In our exploratory research, we underlined the specific impact of Information and Knowledge Spread attribute, and Proximity attributes, as the two most influential Entrepreneurial Ecosystem factors on Entrepreneurial Dynamics.

ii) Topology Configuration to unleash access to Entrepreneurial Nurturing Components

Taking the Ecologic metaphor seriously, and considered the complexity to analyze network plots of hundred of actors, we chose to simplify the the Entrepreneurial Ecosystem structure visualization, with a mesh-oriented view, based on six distinctive 'species' living in Entrepreneurial Ecosystems : education actors, incubators, accelerators, government programs & local institutions, private funding actors, and practical support actors (Fig. 33), and of course entrepreneurs themselves. This distribution of Entrepreneurial Ecosystem actor roles, under this perspective, offers interesting configurational analysis of Entrepreneurial Ecosystem topology, which can lead in the near future to an optimal Entrepreneurial Ecosystem configuration analysis (Mateo *et al.*, 2019).

Topology also allows a better understanding of how resources are distributed within Entrepreneurial Ecosystem, how they circulate, to the benefit -or not- of Entrepreneurial Dynamics. In this perspective we propose a modularity analysis, considering Entrepreneurs as Lego players, using available resources proposed and provided by Entrepreneurial Ecosystem actors, to compose their venture.

Fig 33. EE Organizational perspective



iii) Entrepreneurial Ecosystem Structural Dynamics outcomes

Both Entrepreneurial Ecosystem attributes and configuration were observed in this research (Fig. 34). We observe, in a low resource environment, how proximity and information spread

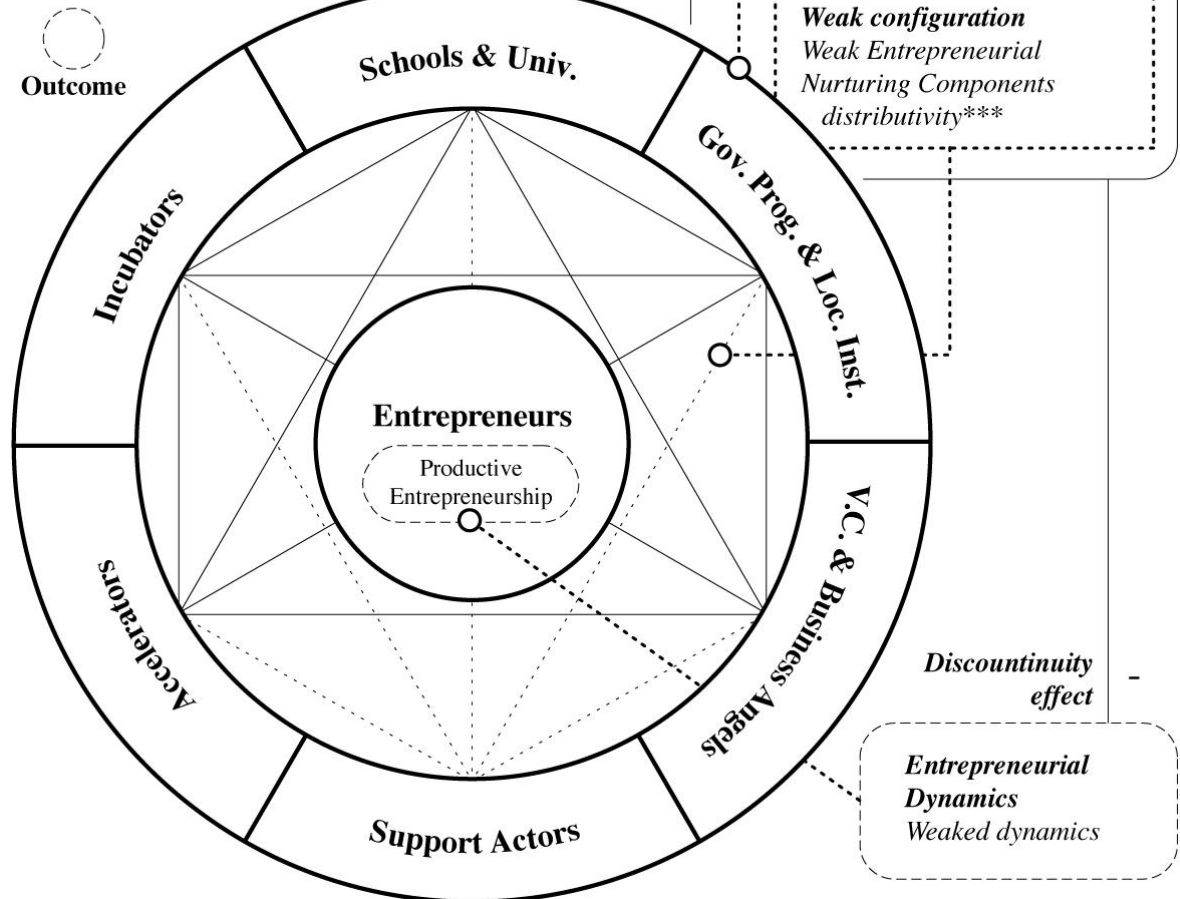
attributes are causal conditions of entrepreneurial dynamics. We also observed how distributivity of Entrepreneurial Ecosystem Nurturing Components are affected by its Topology.

Our preliminary observations tend to indicate that if the attributes and configuration of the entrepreneurial ecosystem are weak, this is likely to lead to a weakening of entrepreneurial dynamics, so called the Entrepreneurial Ecosystem Process of Discontinuity (Fig. 34). Our actual observations and measures present two engines of discontinuity. First is the Entrepreneurial Ecosystem network attributes weakness, which embeds three network factorized measures : information spread, proximity and interconnectivity. Our preliminary research underlines the importance of proper proximity and information spread attributes in an Entrepreneurial Ecosystem to avoid a discontinuity effect. Second is Entrepreneurial Ecosystem structure weak configuration, which can be measured through . We did not yet observe a process of stimulation, which is the opposite of Discontinuity, which is likely to be observed at a macro or micro level of analysis.

Fig 34. Entrepreneurial Ecosystem Discontinuity theory

Entrepreneurial Ecosystem Process of Discontinuity

..... weak ties to practical support actors



2) Managerial contributions

b) Practical Support as a key Entrepreneurial Nurturing Component providers

If research acknowledged Incubator and Accelerator roles and processes to stimulate Entrepreneurial Dynamics, as well as Public or Private financial actors, almost no research identified practical support actors as key Entrepreneurial Nurturing Components providers, mainly caused by the methodological void we underline in this thesis. Policy makers most often concentrate their attention on support and financial resources distribution programs to sustain Entrepreneurial Dynamics, but less on supporting those actors which deliver the components which Entrepreneurs count on to compose their ventures. When an environment is full of resources, it does not count much, Entrepreneurs only have to reach out to grab a given

resource. But in low resources environments, the capacity of an Entrepreneurial Ecosystem to produce and effectively distribute those components, is a key attribute. Especially in low resource environments, this research indicates policymakers should stimulate the emergence of a wide and deep portfolio of those Entrepreneurial Nurturing Components.

b) Oriented inter-organizational ties to avoid any discontinuity effect

As suggested by our theoretical contributions, an Entrepreneurial Ecosystem topological configuration should facilitate the circulation and accessibility of available resources. Policy makers, and more generally Entrepreneurial Ecosystem actors, should create the conditions of such accessibility to available resources, through a proper collaboration and co-competition culture, quality and quantity of inter-organizational partnerships and ties. That kind of mindset switch conducted by policymaker actors, such as in the Lyon Metropole (appendix 1) area since 2017, demonstrated its accuracy, by an integrated public-private policy for instance. The core aspect is a proper “nurturing component” offering, the available portfolio has to be wide and deep enough to support entrepreneurship in a given territory, this offering has to fit the expectations of Entrepreneurs, but also have the minimum characteristics to allow entrepreneurs to elaborate productive ventures. The only complementary effort would be then to connect the dots, allowing Entrepreneurs to grab the resources they need, regardless of who provides those resources. To properly perform such policy, an accurate analysis of a given Entrepreneurial Ecosystem should be conducted, in order to analyze its topology, identify where essential Entrepreneurial Nurturing Components are, and propose to orient ties stimulation to avoid any discontinuity process.

c) Managerial recommendations

Based on our research, we elaborated a managerial framework to observe, analyze and recommend lines of actions regarding any Entrepreneurial Ecosystem. This framework is called LAMAA (table 26), as an acronym of List, Associate, Measure, Analyze and Act. We build this framework as we observe most of the actual policy makers use the Entrepreneurial Ecosystem 10 Economic elements to elaborate diagnosis about their Entrepreneurial Ecosystem. The result is most of the time to propose a wide number of costly actions on all the spectrum of those elements, which have the hypothetical potential to stimulate Entrepreneurship on the medium to long term. Based on our research we felt it was necessary to propose a complementary framework for Entrepreneurial Ecosystem quick wins.

Table 26. LAMAA method

Phase	What	How
List	A complete list of Entrepreneurial Ecosystem Actors, including descriptive attributes	Establish a list of Entrepreneurial Ecosystem actors, including the 6 types of actors, and analysis about their activity
Associate	List the ties between Entrepreneurial Ecosystem actors	Create a network matrix, listing the various collaborations of any kind between entrepreneurial ecosystem actors (partnership, subsidiary, cooperation in programs, etc.), ideally including timestamps
Measure	Extract from your data network measures	Using data science tools such as R Studio, calculate your Entrepreneurial Ecosystem measures and plots
Analyse	Run a processual analysis on the collected measures	Based on an deep knowledge of your environment and collected measures, build a processual analysis table and analyze it during collaborative workshops
Act	Produce recommendations and action plans for your Entrepreneurial Ecosystem for the 1 to 3 years	Run a serie of collaborative workshop with various kind of Entrepreneurial Ecosystem actors in order to build general recommendations for your Entrepreneurial Ecosystem, and action plans

Phase 1 : List

In this phase, you are led to establish a list of Entrepreneurial Ecosystem actors, including the 6 types of actors, and analyze their activity. To list the actors you can contact the actors themselves, such as institutional actors, as they all have their own list of Entrepreneurial Ecosystem Actors, you shall then merge all the lists you collected. You can also search on the internet Actors by type (Incubator, Accelerators, etc.) to check if no one is missing. You can also publish a form inviting all Entrepreneurial Ecosystem actors to list themselves. When you have collected all this data, you have to check each actor one by one, in order to correct the autograph of their names, fill in the missing information such as physical address, phone number, social network profiles, description of their activities. Then you are led to structured

data such as : type of actor, main activity, proposed services. In our research, we used this structured data profile :

Table 27. Actors listing criterias

Criteria	Attributes
Type	Education, Incubator, Accelerator, Government Programs and Institutions, V.C. and Business Angels, Practical Support
Sub-Type	School, University, Training Center, Incubator, Accelerator, ESS, Co-Working spaces, Nursery, Third place, FabLab, Cultural Space, Media, Event, Cluster, Competitivity Pole, Business Angel, Venture Capital, National Institution, International Institution, Local Institution, Bank
Status	Public, Association, Private, Public-private
Stage (of the Startup for first Action)	Ideation, Conception, Seed, Scaling, Expansion
Counterpart	Invoice, Capital Shares, Label or Logo Display, Refund, Unknown, None
Scale (of activity)	International, National, Local Mono Site, Local Multi Site
Activity (boolean)	FundBoost (Fundraising support), InnovBoost (Innovation support), MarketBoost (Marketing support), BuizPlanBoost (Business Plan support), HumanBoost (HR & organizational support), LawBoost (IP & legal support), ProtoBoost (Prototyping services), TestBoost (Testing services), SalesBoost (Commercial support)

Phase 2 : Associate

Once you have properly listed the most exhaustive number of Entrepreneurial Ecosystem actors within your territory, and validated its accuracy, it is necessary to build an association matrix, in order to have the ability to calculate its network . To do this you have to list all kinds of partnerships happening in your Entrepreneurial Ecosystem, in a un-directional manner. Those

partnerships, or ties, can be of any kind, such as : co-operate on a program, share resources, subsidiaries, share of capital, etc. You can identify the kind of partnership, the date those partnerships start, and when they end. It is necessary to operate a longitudinal analysis. You can also calculate the number of ties or collaborations between actors (table 28) which contributes to evaluate the strengths of ties between actors.

Table 28. Example of an association matrix

Actor to Actor # of ties	A	B	C	D
A				
B	3			
C	2	1		
D	4	5	2	

Phase 3 : Measure

Once you have completed those two first phases, you shall use the services of a data analyst in order to run longitudinal network analysis. The following measures shall be leveraged.

Table 29. Network measures

Number of Actors (a)	Total number of actors within your Entrepreneurial Ecosystem
Observations (o)	Total number of observations in order to identify collaboration and partnership ties
Nodes (n)	Total number of tied Actors
Vertices (v)	Total number of ties between Entrepreneurial Ecosystem Actors
Density (d)	Network density measure at the Entrepreneurial Ecosystem whole scale
Centrality (c)	Network centrality measure at the Entrepreneurial Ecosystem whole scale. You might have to choose one of the centrality measures. There are many centrality measures (table 30) you might be tempted to use.
Cohesiveness Factor (c*d)	This factor allows us to evaluate the overall cohesiveness of an Entrepreneurial Ecosystem. The longitudinal analysis
Interconnectivity (n/a) - (in)	This ratio indicate the proportion of interconnected actors

Average Weight (aw)	This measure allows us to understand the average number of ties between Entrepreneurial Ecosystem actors. It is a very interesting indicator of interconnectivity strength.
Inter-connectedness Factor (in*aw)	This factor allows us to understand the overall inter-connectedness of an Entrepreneurial Ecosystem, by factoring interconnectivity and average weight.
Average Shortest Path (asp)	Defined as the average number of steps along the shortest paths for all possible pairs of actors. It is a measure of the efficiency of information or mass transport on a network.
Clustering Coefficient (cc)	Entrepreneurial Ecosystem actors tend to create tightly knit groups characterized by a relatively high density of collaborations ; this likelihood tends to be greater than the average probability of a tie randomly established between two Actors.
Mean Distance (md)	In an Entrepreneurial Ecosystem, the mean distance is the average shortest path between two actors.
Proximity factor ((1-asp)*(1-md))	This factor allows us to understand the overall proximity between Entrepreneurial Ecosystem actors. It is calculated by factoring average shortest path and mean distance measures.

All those measures shall be calculated longitudinally for statistical robustness and analysis relevance. You shall also run all the measures based on actors, or by summing types of actors or sub-types of actors, in order to have a topology oriented analysis.

Table 30. Network Centrality measures for Entrepreneurial Ecosystems

Definition	Meaning	Use	Comments
Degree centrality assigns an importance score based simply on the number of ties (vertice) held by each actor (node).	How many direct connections each actor has to other actors in the network.	For finding very connected actors, popular actors, actors who are likely to hold most information or actors who can quickly connect with the wider network.	Degree centrality is the simplest measure of actor connectivity. Sometimes it's useful to look at in-degree (number of inbound links) and out-degree (number of outbound links) as distinct measures, for example when looking at transactional data or account activity.
Betweenness centrality measures the number of times an actor (node) lies on the shortest path between other actors.	This measure shows which actors are 'bridges' between actors in an Entrepreneurial Ecosystem. It does this by identifying all the shortest paths and then counting how many times each actor falls on	For finding the actors who influence the flow around within an Entrepreneurial Ecosystem.	Betweenness is useful for analyzing communication dynamics, but should be used with care. A high betweenness count could indicate someone holds authority over disparate clusters in a

	one.		network, or just that they are on the periphery of both clusters.
Closeness centrality scores each actor based on their ‘closeness’ to all other actors in an Entrepreneurial Ecosystem.	This measure calculates the shortest paths between all actors, then assigns each actor a score based on its sum of shortest paths.	For finding the actors who are best placed to influence the entire Entrepreneurial Ecosystem most quickly.	Closeness centrality can help find good ‘broadcasters’, but in a highly-connected Entrepreneurial Ecosystem, you will often find all actors have a similar score. What may be more useful is using Closeness to find influencers in a single cluster.
Like degree centrality, EigenCentrality measures an actor’s influence based on the number of links it has to other nodes in the Entrepreneurial Ecosystem. EigenCentrality then goes a step further by also taking into account how well connected an actor is, and how many links their connections have, and so on through the Entrepreneurial Ecosystem.	By calculating the extended connections of an actor, EigenCentrality can identify actors with influence over the whole Entrepreneurial Ecosystem, not just those directly connected to it.	EigenCentrality is a good ‘all-round’ network analysis score, handy for understanding human social networks, but also for understanding networks like malware propagation.	Many statistical tool, especially in R Studio packages, deliver EigenCentrality measures and plots.

Phase 4 : Analyse

Once you have produced all the Entrepreneurial Ecosystem network measures, you are led to elaborate a processual analysis. To do this, you shall establish a table, for each year with description of the contexts and ingredients of each phase, the sequences, the driving forces, turning points, as described in reference Processual Analysis research (Nayak, 2008) (table 31).

Table 31. Entrepreneurial Ecosystems processual analysis framework

Contexts and Ingredients	Every Entrepreneurial Ecosystem is embedded in a context that is structured by a number of elements. Describe this specific context, and identify the ingredients that are crucial to Entrepreneurial Ecosystem development. The context and ingredients have to be specific to the Entrepreneurial Ecosystem and the analyzed phase.
Sequences	Sequences are ‘temporal segments of a process that link together a specific set of ingredients’. To describe sequences, you shall describe how context, ingredients and Entrepreneurial Ecosystem measures are tied together.

Driving Forces	'A process is characterized by movement. To understand a process is to explore its development over time, that is to analyze how the various ingredients and their configurations evolve and recombine in the course of the process.' (Bidard et al., 2013). You shall here analyze the 'movement' and 'acceleration' (or decelerations) you identify in your Entrepreneurial Ecosystem.
Turning Points	You might identify radical shifts of directions in your Entrepreneurial Ecosystem. Describe them.

Once you have produced your Entrepreneurial Ecosystem processual analysis, you shall propose learning about the specific structure, configuration and dynamics of your Entrepreneurial Ecosystem, a diagnosis which is a condition before entering in a recommendation phase.

Phase 5 : Act

Now it is time to act and establish your action plan. Under this structural and configurational perspective, a one to three years action plan shall be proposed, using all the data collected through the previously presented protocol. You can use previously introduced measures as KPIs to propose Entrepreneurial Ecosystem monitoring means.

3) Methodological contributions

Methodological contributions made possible this research, as such inter-organizational network analysis were never conducted in Entrepreneurial Ecosystem research, and in our best knowledge Topological Inter-Organizational analysis neither, even at a larger research scale.

a) Quantitative Graph Theory applied to Entrepreneurial Ecosystem

First of all, we demonstrated the accuracy of Quantitative Graph Theory (Dehmer et al., 2017) application to Entrepreneurial Ecosystem research, leveraging co-occurrence techniques (Jackson et al., 1989) in online media contents to detect inter-organizational ties (Evan, 1965). From that point, any scholar just has to systematically and rigorously run network analysis means, to extract interesting network attributes, structural configurations and processes. In the case of Entrepreneurial Ecosystem, the challenge resides in the fact that such analysis has never been attempted before, and we do not have reference measures to evaluate our own

results. As a consequence, beyond the interest of this exploratory research, further similar measures shall be runned in the future in order to refine the proper understanding of those measures. Complementary qualitative analysis shall be as well runned to evaluate to what grounded reality those measures are refering.

b) Longitudinal Network Analysis

Beyond the obvious longitudinal interest in order to identify temporal dependencies occuring in Entrepreneurial Ecosystem, Longitudinal Network analysis allows to increase the statistical validity, which is weakened by the usage of secondary data through webscrapping. Temporal dependencies are interesting to analyze as independent variables in order to understand entrepreneurial dynamics gaps, or as dependent variables of Entrepreneurial Ecosystem elements specific configurations. It is also particularly interesting to leverage longitudinal entrepreneurial ecosystem analysis to take its evolutionary particularity. Using Online Media datasource allows us to date the data, and means provided by quantitative graph theory method, we can follow the evolution of Entrepreneurial Ecosystem, and with measures, understand the behavior of Entrepreneurial Ecosystems much further than the actual research we propose in this thesis.

c) Ecological Network Analysis

Entrepreneurial Ecosystem are understood as relational ensemble (Spigel, 2017), in an evolutionary perspective (Kantis and Federico, 2020). In that extend we shall understand Entrepreneurial Ecosystem as a 'small world' (Xiao Fan Wang and Guanrong Chen, 2003) which can be observed through an ecological network analysis. To do so we shall observe the topology of Entrepreneurial Ecosystem, as a model allowing us to understand how resources (Entrepreneurial Nurturing Components) are distributed, and if the flow of their distribution allows -in a particular territory- to stimulate properly the Entrepreneurial Dynamics. This interesting approach leverages also the Quantitative Graph Theory means, which also provides the richness of its set of measures, and opens many interesting research perspectives in Entrepreneurial Ecosystem research, as well as in other inter-organizational research.

4) Limits and perspectives

b) Place, Ties, Time and Scale

Various limits were encountered in our research. First is the comparability of the Entrepreneurial Ecosystem, and its related dimension of analysis. Entrepreneurial Ecosystem is a place based concept which should be analyzed at a regional or city level. But even if we can select actors based on their location to target our research, the actual measures of entrepreneurial dynamics are mainly available at a national level. Our actual research targeted low income African countries, which have only one centralized Entrepreneurial Ecosystem, it limits the lack of validity, and makes our research accurate, even if not precise as it should be. The second limit concerns how ties are detected. Actually we run an undifferentiated co-occurrence identification in online articles. Our research showed that the articles always name positive ties between actors. Future research should use Natural Language Processing technique to deep dive in those ties evaluation, thematics, in order to frame a more qualitative evaluation of those ties. Third, as we only detect positive ties, we never could identify when those ties last. We know that most often, partnerships in those Entrepreneurial Ecosystems are framed for a period up to 5 years. In future research we should address this issue and propose a statistical model to evaluate those ties duration. At last, we underline that, even if we manipulated a big amount of data, we could only -in Africa- study five countries, which is not sufficient to address a proper statistical understanding of archetypal structure and dynamics of those Entrepreneurial Ecosystem. In the future, we propose to more systematically study African countries, and run comparative analysis also on other territories.

b) Unseen networks

An important limit of this research is the unseen networks, the ones that can not be identified with the means we used yet. Those networks are made of personnel and informal ties, which are not published by any means. With this kind of ties, we might face agency effects. Those unknown networks might hide where performance comes. We shall in the future identify how to mitigate our results facing this “dark matter”, and look forward to observing the unseen.

c) Perspectives and Research Program

This thesis allowed us to frame a research program which aims to observe and propose theoretical and empirical understanding of Entrepreneurial Ecosystem organizational configuration and dynamics. In the near future we will propose an Africa wide analysis on 19 countries, using all the techniques mobilized in this thesis, and to explore Natural Language

Processing analysis as well. We will deepen our understanding of the Entrepreneurial Ecosystem Process of Discontinuity, and open a deeper understanding of its distributivity of Entrepreneurial Nurturing Components, and their effect on related Entrepreneurial Dynamics.

This doctoral work represents only a starting point, or rather a step that marks the beginning of a research program: there are many research opportunities based on our actual results. To do so, we are led to the following action plan. First we shall look forward to adding new Countries and New Actors to our research, by developing a more complete and exhaustive EE & EE actors repository, using the same means as before. We have actually listed 19 African countries, and 1 506 actors in those countries. Then we shall detail the roles and attributes of each of these actors, by detailing this repository with a deeper understanding of each actor's role and value proposition. Actually 78% of our database is actually qualified. In addition, we shall also include data from other territories in order to run more quantitatively comparative analysis, by adding to the repository other EEs (south america, asia, etc.). We actually did this in the area of Lyon in France. Based on this completed repository, we shall run Systematic Data Collection using our web scraping method, in order to grab longitudinal data. This task is planned for Autumn 2022. This will allow us to run Structural and Processual Analysis on our dataset, by running a systematic and longitudinal network calculation. The next phase consists in running Structural and Processual Analysis, by running structural and processual analysis at the pan african level, country level, local level, with sub analysis per type of actor (incubator, accelerators, VCs, etc.), or other attributes (ex : analyze EE actors from bilateral cooperation, their network power at the pan african, national or local level). This task is planned starting autumn-winter 2022. We shall also expand the analysis to other kind of Ecosystems, by evaluating our research method in Innovation Ecosystem, Industrial Ecosystems, etc. and analyze the results. We should also explore more Network structural analysis methods, tools, and theoretical power, by deep diving in the sub-methods, results, which can be leveraged. We also planned to leverage Natural Language Processing in order to include in our framework Topic analysis in the WebScrapped Data, and applicability to network analysis. This is planned early 2023.

Challenge. This thesis was a challenge : a theoretical, methodological, and temporal challenge, which has conducted us to our limits. But we hope, by doing this, that we have contributed to push back the limits of Entrepreneurial Ecosystem research. Thank you.

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APPENDIX

Article : Structural and Processual Approach of Entrepreneurial Ecosystems, the case of Lyon Area

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ABSTRACT

Rising Entrepreneurial Ecosystem (EE) research is important to better understand how Entrepreneurial Dynamics are locally supported. But it presents many dead angles, such as the empirical understanding of its inter-organizational network of actors' structure and processes. The evolutionary nature of EEs indicates to go beyond econometric analysis. In the case of the Lyon area, we conducted a qualimetric analysis, combining qualitative analysis associated with an innovative interorganizational longitudinal network analysis among its 251 EE actors. We observed interesting interpersonal and interorganizational interactions and their impact, an hyper-centrality actor, the identification of an evolutionary pattern, and the positive impact of governance.

Key Words : Entrepreneurial Ecosystem, Entrepreneurial Dynamics, Longitudinal Network Analysis, Qualimetric Analysis

INTRODUCTION

Entrepreneurial Ecosystem is a rising field of research mainly understood under economic lenses (Wurth, Stam and Spigel, 2021), with recent new perspectives on its econometric measures (Leendertse, Schrijvers and Stam, 2021), international context (Theodoraki and Catanzaro, 2021), or micro-level analysis on EE actors or group of actors (van Rijnsoever, 2020). Beside those and many other perspectives (triple-helix, complexity, context, governance, agency, geography, network), the diversity of entrepreneurship research (Yezza, 2022), scholars underline an undertheorized field of research (Cao and Shi, 2020) and the weakness of structural analysis of Entrepreneurial Ecosystems (Theodoraki, Dana and Caputo, 2022)). There here remains lots of dead angles in EE research, particularly the understanding

of EEs structural attributes, such as its organizational behaviors and archetypes, typology and attributes of their actors, configuration of their mutual ties that form an EE, structural topology of its network (Liu, Pellegrini and Wang, 2015), and a processual approach. Due to relational nature of Entrepreneurial Ecosystems (Spigel, 2017b) and recent propositions under Network Theory perspective (Purbasari, Wijaya and Rahayu, 2020b), we surprisingly see that no analysis were conducted -under those lenses- to understand EE as a whole scale, neither under a longitudinal approach which would fill the gaps under an Ecosystem Theory and Evolutionary perspective applied to social science (Roe, 1996; Müller, 1997). Only recent research (Cloutier and Messeghem, 2021) began to clear this evolutionary research perspective. This resonates with recent debates that indicate the need to produce more social science oriented research in EEs. To fill this gap, we are led to question the profound nature of relations between Entrepreneurial Ecosystem actors and its structural configuration and dynamic. Research acknowledges that Entrepreneurial Ecosystem acts as a capacity building factor for Entrepreneurs (Nwazor, 2012; Towers *et al.*, 2020) through networking mechanisms (Elfring, Klyver and van Burg, 2021) which allow Entrepreneurs to rationally, or notn provision their resources (Degeorge, 2017; Fisher and Neubert, 2022).

As a consequence, a proper combination of both network (Granovetter, 1985) and longitudinal approach (Snijders, 2005), a longitudinal network analysis (Walker and Stohl, 2012), which has never been tested in that field of research would be a proper angle to identify EE inter-organizational attributes and their evolution in time. Beside this point, Network Theory and related Quantitative Graph Theory (Dehmer, Emmert-Streib and Shi, 2017) offers abundant measures that can open those perspectives and beyond. To investigate and answer the question of *'How Entrepreneurial Ecosystems are structured, configured and do evolve'* and open EE black box, we chose a qualimetric approach (Savall and Zardet, 2011), using both qualitative (participant observation and interviews) and quantitative analysis (longitudinal network analysis approach using big data techniques), in a case study of the Lyon EE area, second EE in size and impact after Paris one in France. Our observations made it possible to extract EE actors' typology and main attributes, as well as its EE longitudinal behavior, and observe how attributes of capacity building and social capital are delivered across the EE.

In the first section we provide a reminder of the theoretical context. In the second section we present our methodology which proposes to combine an original quantitative method using

graph theory and R software and an exploratory qualitative method. In the last part, the results are presented and discussed.

1. THEORY

1.1. A dead angle in Entrepreneurial Ecosystem theory

Taking its roots in *'infrastructure for entrepreneurship'* (Van De Ven, 1993), under organizational lenses, and early scholar proposition (Isenberg, 2010), under economic lenses, analyzing successful entrepreneurial places such as Silicon Valley, Boulder Colorado or Route 128. EE has become an important topic for researchers (Velt, Torkkeli and Laine, 2020) and practitioners. The concept is an attempt to understand how entrepreneurial dynamics (eg. nascent and active) arise in a given territory, and is defined as *'set of interdependent actors and factors coordinated in such a way that they enable productive Entrepreneurship'* (Stam, 2015). But, despite recent debates (Cloutier, Cueille and Recasens, 2014; Audretsch *et al.*, 2018), social science oriented research on EE remains unexplored, as Entrepreneurial Ecosystems are mainly analyzed -as a whole- with economic means, despite the theoretical hybridization of the concept.

Scholars raised concerns about the evolutionary nature of EEs (Mack and Mayer, 2016; Kantis and Federico, 2020), mainly at a theoretical level. But Ecosystem applied to social science (Yli-Renko and Autio, 1998; Simmie and Martin, 2010; Amati *et al.*, 2019) strongly indicates the interest of such an approach crossed with a network perspective, through the analysis of the ties between ecosystem actors. Longitudinal analysis is also a requirement to enter a processual research (Langley *et al.*, 2013), which allows an archetypal oriented analysis (Tatarynowicz, Sytch and Gulati, 2016) on EEs. Proper analysis requires also to better understand the *'spices'* living in the EE, and raise a typology of EE actors such as those raised for Innovation Ecosystems (Autio *et al.*, 2018; Shipilov and Gawer, 2020) with -for example- the analysis of co-authorship of patents, regarding their respective roles (Acs, Anselin and Varga, 2002).

Scholars produced many attempts to study small groups of EE actors, at a micro-level of analysis, such as on Incubators (Busch and Barkema, 2020), accelerators (Del Sarto, Isabelle and Di Minin, 2020), funding (Cavallo *et al.*, 2019), or education (Fuster *et al.*, 2019), but none of those researches managed to understand interorganizational ties between those actors at a whole scale.

To deep dive into EE actors interdependencies analysis, we propose in this paper to mobilize Network theory with a longitudinal perspective in order to better understand processes occurring in EEs.

1.2. How Entrepreneurial Ecosystems conducts Productive Entrepreneurship ?

This research acknowledges Entrepreneurial Ecosystems act as resource providers for Entrepreneurs by various means, allowing them to assemble those resources to build their venture. The understanding of Entrepreneurial Ecosystem's structural and processual attributes having the power to explain how those resources are identified by entrepreneurs, and how they are distributed to them. Such research leverages the understanding competition and cooperation behaviors between all EE actors (Burt, 1995; Moore, 1996; Hannah and Eisenhardt, 2019), how information and knowledge attributes are spread in EEs (Audretsch and Lehmann, 2005; Audretsch and Belitski, 2020; Beynon, Jones and Pickernell, 2021), and how connectivity evolves (Barnes, 1969) within an Entrepreneurial Ecosystem.

All these elements feed an analysis that, due to its Complexity nature (Larsen-Freeman, 2012), EE research can lead to a processual approach (Nayak, 2008) to better understand EEs dynamic configurations. That approach, considering a Modularity perspective (Baldwin and Clark, 2000; Bouncken, Lehmann and Fellnhofner, 2016) can inform us on how EE actors distribute complementary resources to entrepreneurs through interorganizational ties, to fill the specific means required to build their venture. Under this perspective, we are led to observe how Entrepreneurs can access Social Capital (Schumpeter, 1942; Theodoraki, Messeghem and Rice, 2018; Cavallo, Ghezzi and Balocco, 2019) and Capacity Building (Karmokar, 2019) components for entrepreneurs.

This article builds on previous work by scholars who have developed an original method for mapping EEs in developing countries (Gueneau, Chabaud and Chalus-sauvannet, 2021). It is presented in the next section. In order to go further and answer our research question, the choice was made to complement this quantitative method with qualitative methods in order to study and understand in depth the topology of the Lyon's EE. We present in the next section our methodological choices and the context of this research, an in-depth study of the EE of the city of Lyon, a tie analysis between its actors, the factors that make it dynamic and their evolution over time.

2. METHOD

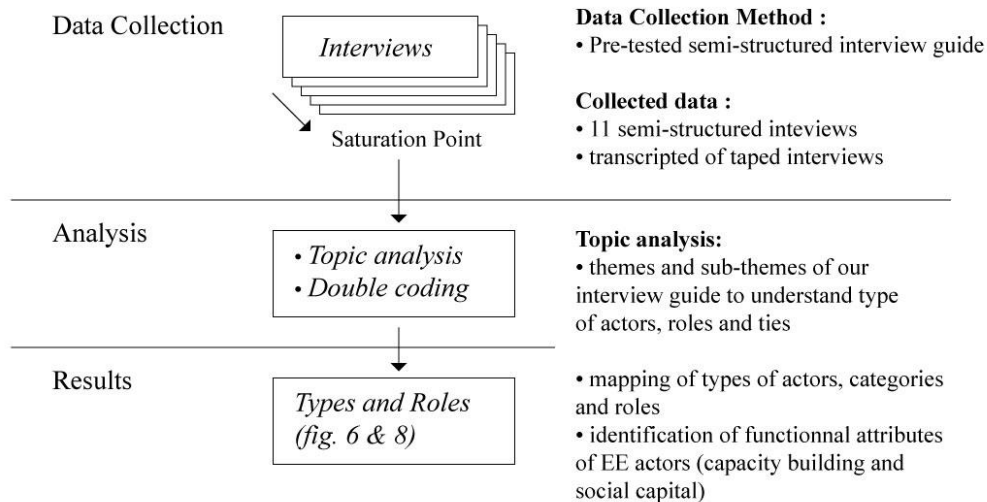
This paper is a continuation of previous quantitative research on EEs (Gueneau, Chabaud and Chalus-sauvannet, 2021) which allowed to identify EE network attributes in five low income countries are causal effects of Global Entrepreneurship Monitor's Total early-stage Entrepreneurial Activity (TEA) levels and evolution. But this research faced limits due to incomplete knowledge of EE actors' roles and attributes. To fill this gap, we decided to design both a qualitative and quantitative analysis that is required to better understand the roles and interactions between the different actors in this EE, and empirically observe them through network analysis. The qualitative research was targeted to understand, in a known and abundant Entrepreneurial Ecosystem, how its actors represent their respective roles and attributes. We also decided to open a longitudinal analysis of EE network attributes of EEs, which can unlock processual analysis, open other new interesting perspectives (Figure 1.), and increase the validity of results (Stadtfield *et al.*, 2020).

The epistemological orientation towards interpretivism seems to correspond to the contours of the present research aimed at describing the social phenomenon that constitutes the entrepreneurial ecosystem. This posture allows us to develop a heuristic understanding of its interactions and roles as experienced by the actors studied (Allard-Poesi and Marechal, 2014). It only makes sense if it shows and analyzes the intentions, discourses, actions and interactions of concrete actors, from the point of view of the actors themselves but also from the point of view of the researcher (Dumez, 2013). We chose a case study, here Lyon's EE (France) since it is an empirical research which studies a contemporary phenomenon in a real context, when the boundaries between the phenomenon and the context are not clearly apparent and in which multiple empirical research is mobilized (Yin, 2013).

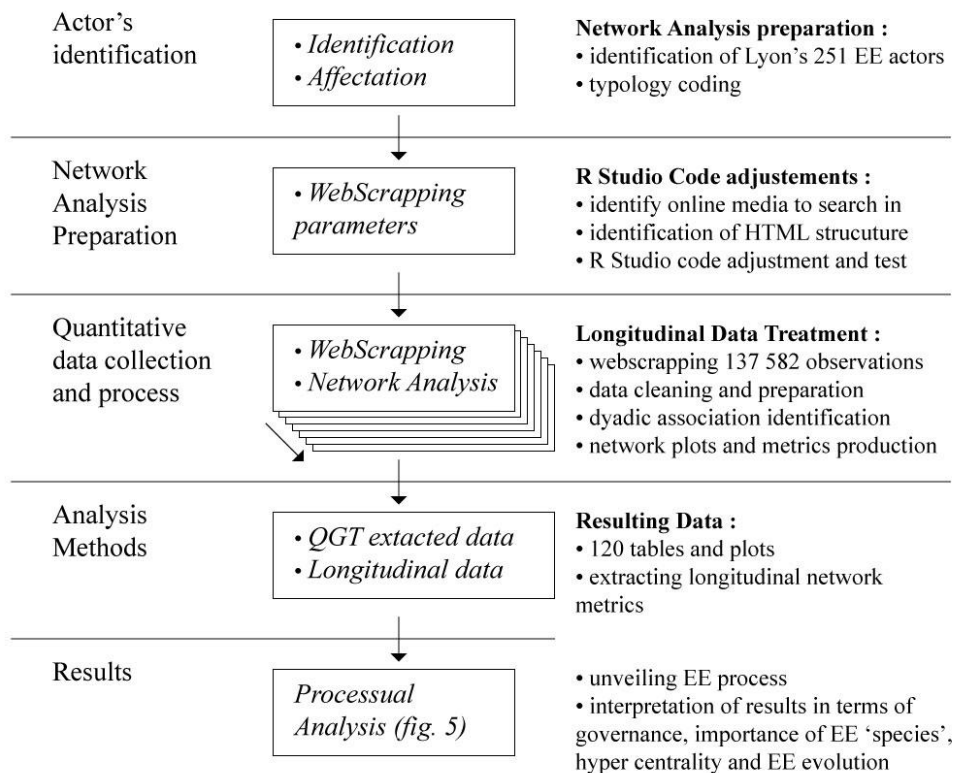
Figure 1: Research design

Study Context - organizational patterns in Lyon's EE

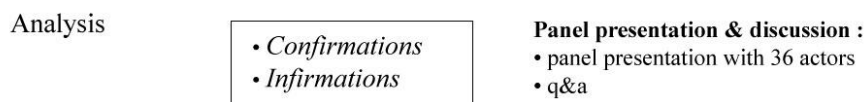
Exploratory qualitative Stage - identify typology of actors and roles



Exploratory quantitative Stage - revealing inter-organizational processes



Qualimetric analysis stage - confirming results and unveiling network interactions



2.1. A exploratory qualitative study

In order to gain an in-depth understanding of Lyon's EE, its actors, their perceptions, their roles and their dynamics, we decided, first of all, to conduct a qualitative exploratory study to provide a better understanding of the issues involved (Sekaran and Bougie, 2019). To our knowledge, there is no research that studies in depth the role of the actors in an EE from the following angles : How do they perceive their role in this ecosystem? Who do they identify as major actors in this EE ? And how do they perceive the role and contributions of the identified actors in this EE ? Indeed, qualitative research is recommended to gain insight into complex phenomena and to offer understanding and get to the heart of what exactly happened to the participating individuals and what led them to decisions that they made and how the choices they made came to take the form that they eventually did (Curry, Nembhard and Bradley, 2009; Yin, 2013; Kalu, 2017) and to provide initial answers to our research question about the dynamic characteristics of our case study. Previously, our researches about EE were quantitative and it appeared necessary to deepen the understanding of EE dynamics with a qualitative study that will provide additional elements and comparisons.

The collection of data was spread out over a period of three months during which we conducted twelve interviews, at this stage of our research. The interviewees were selected to best represent the major ecosystem actors identified in the literature (Isenberg, 2010; Spiegel, 2017b; Wurth, Stam and Spiegel, 2021).

The interviews, which lasted from an hour to an hour and half, were recorded and transcribed on the basis of the coding grid constructed at the end of our literature review. Based on the theoretical framework, the original interview guide was made up of four parts : 1. characteristics of the structure interviewed (budget, staffing, influence, governance,...), 2. EE roles and key services 3. Lyon's EE vision (qualities, attractiveness, specificities,..) 4. other EE actors (number, role, activities, qualification, legitimacy,...). The point of view focuses solely on the actors, the vision of their role and the nature of their interactions with the other EE actors.

We identified, in the Lyon's E, the major actors as defined by the literature and we targeted key persons representing them to conduct our interviews (Table 1.).

Table 1. Overview of Data Collection

Actors	Element	Type	Interview	#	Code
Public Bank	Finance	Private Funding Org.	Director	1	BK
University Entrepreneurship center	Education, Talent	Education	Director Deputy Director	2	ED
Public incubator	Support	Incubator	Director	1	PB
Chamber of Commerce	Formal Institutions	Local Institution	Networks developer	1	CC
Economic Journal	Culture, Networks	Practical Support	Development Head	1	EJ
Firms association	Networks, Formal Institution	National Institution	Vice President	1	NW
Crowdfunding platform	Finance	Private Funding Org.	Director	1	CP
Business Angels	Finance	Private Funding Org.	Network Board Member	2	BA
Private incubator	Support	Incubator	Director	1	PI
Foundation for Entrepreneurship Networks	Network	Practical Support	Member of the network, coach.	2	FO
Place	Physical Infrastructure, Support	Practical Support	Director	1	PL
Institution	Formal Institutions	Local Institution	Director	1	IN

This research also benefits from a five year ethnographic study in immersion in the EE studied for one of the authors. Ethnographic research, a method derived from sociology, is mainly based on participant observation. It seeks to develop in-depth knowledge about individuals' cultures, beliefs, values in a natural environment of the people (Rolfe, 2013; Wolf, 2012; Spradley, 2016; Creswell & Poth, 2017; Kalu & Bwalya, 2017).

This method, as its name indicates, consists of immersing oneself in an environment for a long period of time and collecting data concerning the social life of the group studied through

observation, meetings, interviews and participation in activities (Chanlat, 2005). Depending on various meetings or events within Lyon’s EE, we could be either : ‘the complete observer’, ‘the observer as a participant’, ‘the participant as an observer’ and ‘the complete participant’ (Table 2.).

Table 2. Participant observation roles (Chanlat, 2005)

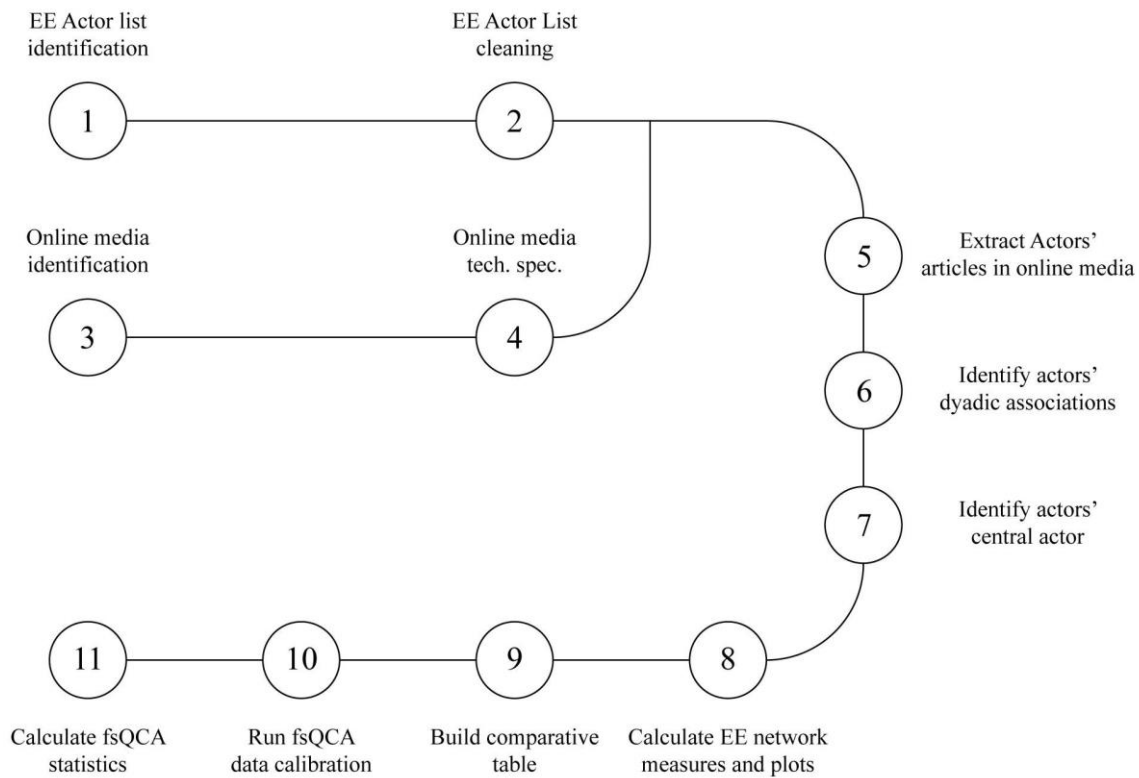
Type	Role
The observer as a participant	As part of a meeting or event from the ecosystem
The participant as an observer	As part of juries, think tank, conferences
The complete participant	As organizer of think tank, pitch, etc
The complete observer	All roles

Participant observations allow us to grasp the relationships in the entrepreneurial ecosystem as a whole and to begin to identify the various links between actors, including informal ones. This immersion made it possible to keep a logbook on the roles, characteristics and interactions of the EE actors in action. It also allowed for the selection of twelve representatives of an ecosystem actor. In parallel to this qualitative study, the quantitative part was conducted.

2.2. A original longitudinal quantitative methodology to apprehend inter-organizational ties in an EE at a whole scale

Previously experienced in low income countries (Gueneau, Chabaud and Chalus-sauvannet, 2021) we upgraded this Inter-organizational Network analysis method with an addition : Longitudinal Network analysis. This comprehensive method (Figure 2.), includes eleven steps. In the present study we only runned the eight first steps as we do not need to compare territories. But we added a longitudinal analysis to use the historical data collected.

Figure 2 : EE Quantitative Network Analysis Method (adapted from Gueneau, Chabaud and Chalus-sauvannet, 2021)



Based on Quantitative Graph Theory (QGT) (Dehmer, Emmert-Streib and Shi, 2017) and using big data from online media (Von Bloh *et al.*, 2019), based on webscrapping techniques (Haddaway, 2015; Zhao, 2017; Bradley and James, 2019) we runned the following process.

First we collected, from a local institution, the list of Lyon's EE 251 actors (Figure 2 : Step 1), and through our interviews we identified the most influential online media, namely 'LeToutLyon' (Figure 2 : Step 3). Based on those foundations, we started to run our process. We first cleaned the Actors list (Figure 2 : Step 2), by verifying each one's exact name in order to avoid any search error, and affected each one to its corresponding role and type, in a dedicated table.

To collect data related to our research, we chose the online media 'LeToutLyon' which has two important attributes : the media is the most complete and exhaustive media about the local economy events and news, and also this media spreads legal information about local ventures. It is known to be the reference media about entrepreneurship and business, locally.

The choice of the newspaper to be analyzed was made by elimination: an economic newspaper only, serious (no sensationalism in its articles) without political bias and finally very anchored

in the studied ecosystem for at least 10 years. The newspaper that best met these criteria was Le Tout Lyon (L'Essor Group).

As a consequence, in parallel to the EE actors repository preparation, we deep dived into 'LeToutLyon' website HTML structure in order to properly identify its specific search method³⁰, its search result page HTML structure, and its article page HTML structure (Figure 2 : Step 4). Those identification allowed us to feed and adapt our R Studio code, in order to properly script the research loop, and the web scraping loop of each result article. Due to the longitudinal upgrade, we also coded the publication date web scraping³¹ and transformation of each result article for further use. We tested and adjusted this web scraping code using RSelenium and rvest packages. This beta testing can take days as we have to be sure to properly manage any web scraping error that could occur in our loop.

On this foundation we extracted all the articles by running our web scraping loop (Figure 2 : Step 5). Doing so, we extracted 137 582 observations in 'LeToutLyon'.

First step before using the QGT method is to clean and prepare our result big data table. This procedure leads to creating a secondary table with tokenized actors' names, delete punctuation and stop words, lower the case of the content, and delete any remaining HTML structure elements that could have been webscrapped. On this basis we can now run the foundation procedure to identify interorganizational ties : run a co-occurrence extraction within our observations (Özgür, Cetin and Bingol, 2008; Feicheng and Yating, 2014; Li *et al.*, 2016) (Figure 2 : Step 6). This procedure is central, as it can make possible the identification of any dyadic association between EE actors that surfaced, through an online article, in the reference online media in this particular territory.

Using co-occurrence count, we can temporarily extract the most central actor of this network (Figure 2 : Step 7), and identify the size of the network for further calculations. We also extracted the number of co-occurrences, the number of actors involved, and other direct metrics to prepare our calculations, such as the mutual information significativeness table, the Dice Score (Jackson, Somers and Harvey, 1989), or Likelihood (Wiuf *et al.*, 2006), to produce basic

³⁰ recherche-articles.html?search=

³¹ using og:article:published_time meta

metrics. We then created a graph matrix (Rivest and Vuillemin, 1976) to go further and trace a first a network plot for each observed year (Figure 3.) using iGraph package in order to properly manage the network's display, and top level measures such as, for each year, network density, centrality, average path length, mean distance, closeness, betweenness, eigenvector, subgraph centrality, strength of ties, structural holes. We calculated all centrality measures significativeness with Heatmap, PCA and Pearson method, in order to identify Barycentric, Closeness, Harary, Subgraph, Topological and Weiner Centrality measures as relevant to this network. For each we extracted association and correlation measures to test their robustness. Then we produced various plots. A Dendrogram (Figure 4.), to visually identify clusters, and method oriented graphs such as Barycenter Centrality, Closeness Centrality, Harary Centrality, Latora Closeness Centrality, Weiner Centrality plots.

Using bottom line network measures such as Cohesiveness, Inter-connectedness and Closeness (Figure 5.) we produced a processual-oriented representation of Lyon's EE network measures.

2.3. Results collective analysis

In order to verify and compare our results, a feedback session was planned with key actors that emerged from the quantitative study. A two-hour session was organized: presentation of the results in the first hour and exchange with the actors present on their reaction. These interactions allowed us to confirm the validity of some of our analyses, and to confront some of them with limitations, such as the fact that some incubators belong to educational actors. But above all, these discussions allowed us to better understand the interactions of interpersonal and inter-organizational networks, and to feed the theory on this subject.

3. RESULTS

A qualimetric approach is demanding, it requires a cross understanding of both qualitative and quantitative results. Our method integrated a last phase of putting together the both results and analyze them parallelly in a cross-result analysis. This approach allowed us to both better understand qualitative and quantitative results, and be able to propose a cross-result presentation and discussion, presented below in a discursive mode. The following results present the evidence of strong power of interpersonal and persistent ties, the attractiveness of the hyper-central actor, as a consequence the limited inter-organizational ties occurring in this

EE, but the visible impact of governance, revealing a process occurring in this EE and the related clarification about EE actor's roles.

3.1. Strong power of interpersonal and persistent ties

As our quantitative research applies to inter-organizational ties, the following perspective has been revealed by our qualitative research. Lyon Area in France is watermarked by strong interpersonal relationships “*it is a set of interpersonal ties*” - ED-PP caused by ancient and strong ties “*the turnover in the EE as a whole is low*” - ED-PP due to stability of individuals in that EE, but with high mobility of people across the EE “*interpersonal collaborations allow bridges in the EE*” - PI-CC. Beside the confirmation of the relational nature of EEs (Spigel, 2017b), those results suggests that those interpersonal ties are related to the necessity to raise a confident environment with Entrepreneurs (Huang *et al.*, 2016) to face the challenges of their entrepreneurial quest as well as a National and local tendency to develop personal ties (Doney, Cannon and Mullen, 1998) and that those ties tend to last over time (Dahlander and McFarland, 2013). The EE personal actors play, in this EE, can have different objectives. Individual interests seem, in this EE, to be different from inter-organizational interests, raising a tension between the two that we have sought to analyze under network perspective. If these actors are driven by individual interests, they are linked by common values (membership in networks, associations, families, ...). Indeed, these actors have been established in Lyon for one or more generations, and this city and its influence are at the center of their interests.

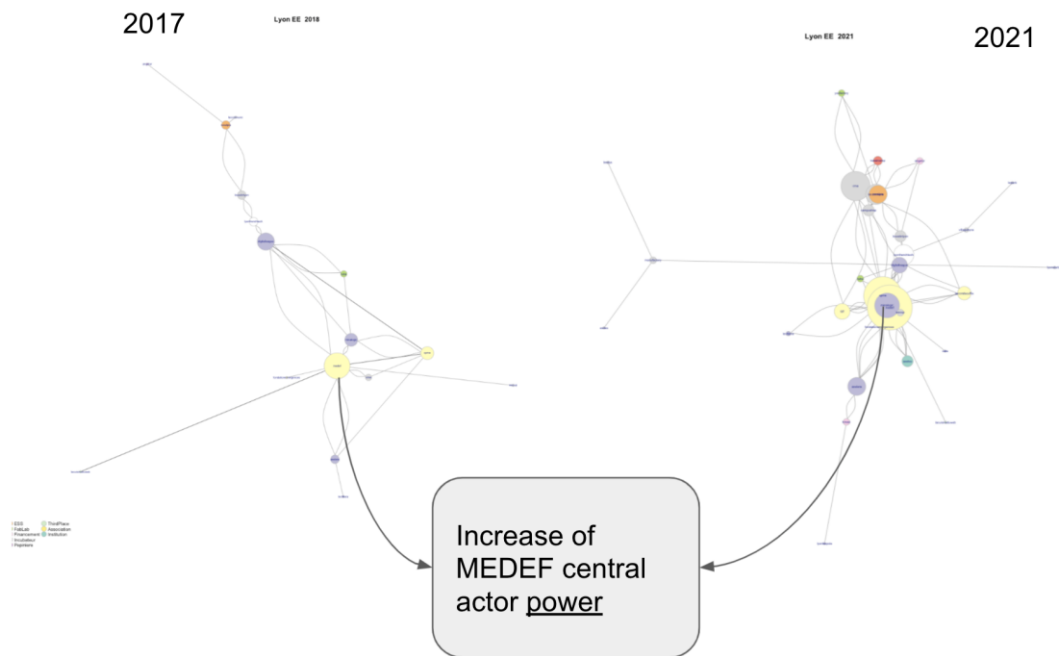
Nevertheless, the stability of people evolving might benefit its inter-organizational learning attributes (Beeby and Booth, 2000) and may also explain why this EE is known for its quality.

3.2. The attractiveness of an hyper-central Actor

One of the surprises of the quantitative study was the emergence of a very strong central actor: the Medef³². This actor is the representative of companies but its main role is not to develop, strictly, entrepreneurship.

Figure 3 : Power of the Central Actor over Time

³² <https://medef-aura.fr/fr/>



The EE central actor (MEDEF), which is the major national level federation of organizations, in the Lyon Area (Figure 3.) collects over the highest rate of interorganizational ties, and reinforces its centrality power over time but is not noticed by actors themselves in the interviews. This hyper-centrality of MEDEF can be surprising due to its limited role regarding the entrepreneurial ecosystem and nascent entrepreneurship locally. But, even if ‘under the radar’, the power of this central actor can refer to local power building strategies (Benson, 1975) or specific inter-organizational ties generations to manage conflict related to Entrepreneurial Dynamics (Mizruchi and Potts, 1998), or maybe both. This hyper centrality can also refer to mimetism and neo-institutional theory, as a common practice for EE actors to raise their relations with MEDEF.

MEDEF central power Dice Score evolves from 8,0955 in 2016 to 10,377 in 2017, but its relative power decreases over time as the network expands (91 times more powerful than the 2nd actor in 2016, 22 times in 2021). Nevertheless, this actor centrality is intimidating, and he collects most of the interorganizational ties over time.

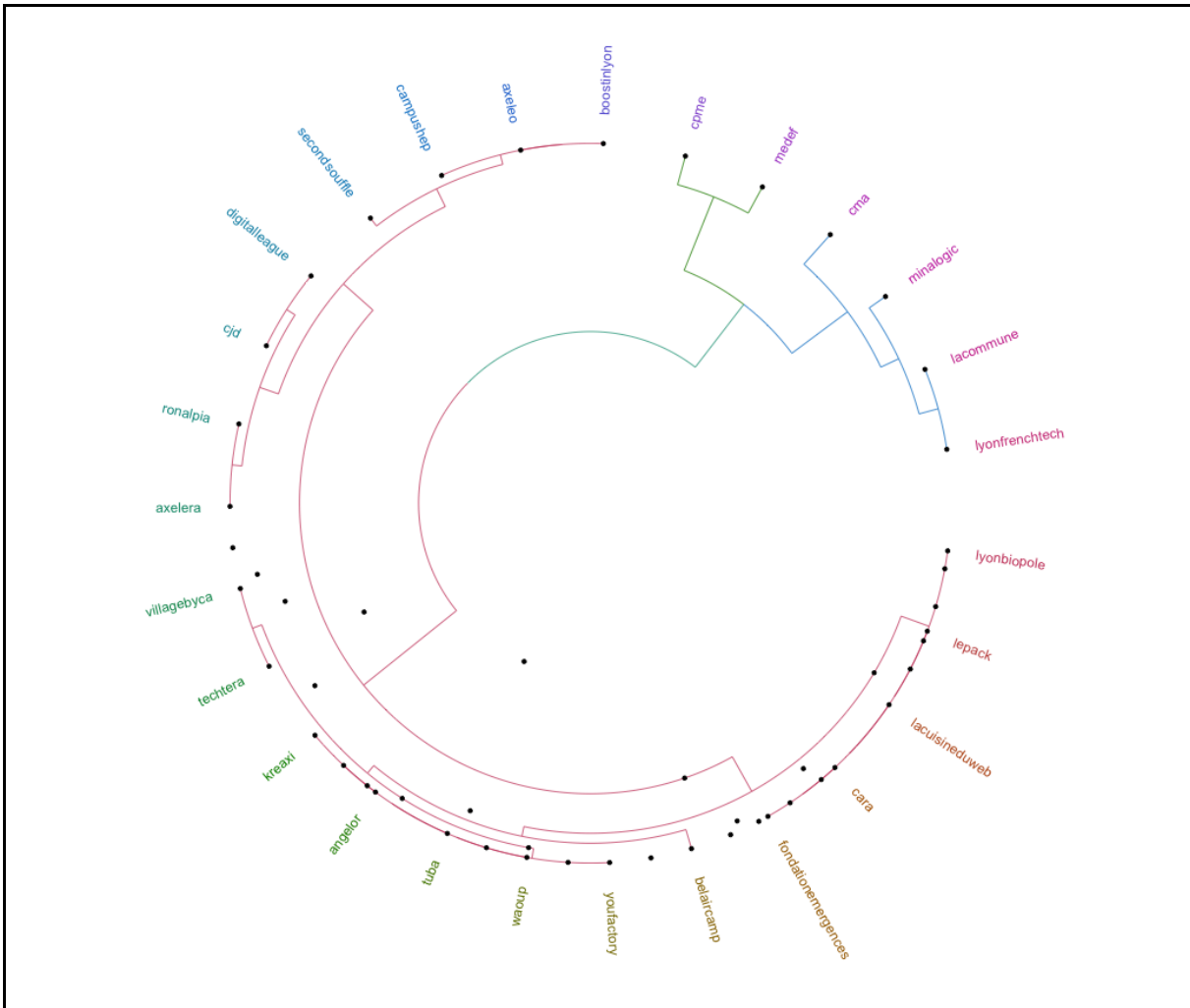
When presenting the results in the last part of our research design. This result generated a lot of discussion. The vice-president of Medef explained it by the large number of Medef representatives (all business leaders) in the ecosystem and their strong involvement through their different roles.

3.3. Limiting interorganizational ties

Another surprise arises here. The amount of actors in Lyon's EE is important (251), but compared with other known territories (Gueneau, Chabaud and Chalus-sauvannet, 2021), in which the quantity of EE actors -even at a national level- is much lower, the creation of known interorganizational ties in the area of Lyon appears to be very low, probably 'cannibalized' by interpersonal ties (Figure 4) "*organizational structures are weak compared to intuitu personae*" - BA-GT. Another perspective would consider that interpersonal ties play in favor of information and knowledge spread, making inter-organizational ties un-necessary. This is due to mobility of individuals "*there is little permeability between the structures, the Lyon EE is compartmentalised*" - PI-CC. But this situation raises the concern of a proper governance strategy for the territory "*there is a need for coordination and cooperation between structures, which is essential*" - PB-LR in order to guarantee a fair distribution of its resources, as critical resources are attributed by organizations and not individuals. Even if adaptive capability analysis has demonstrated their complementarity (Ma, Yao and Xi, 2009), research does not actually address the potential paradoxical effects of both interpersonal and inter-organizational networks potentially playing against each other, which could be the case in Lyon about the distributivity of its resources, but our actual data does not show this effect.

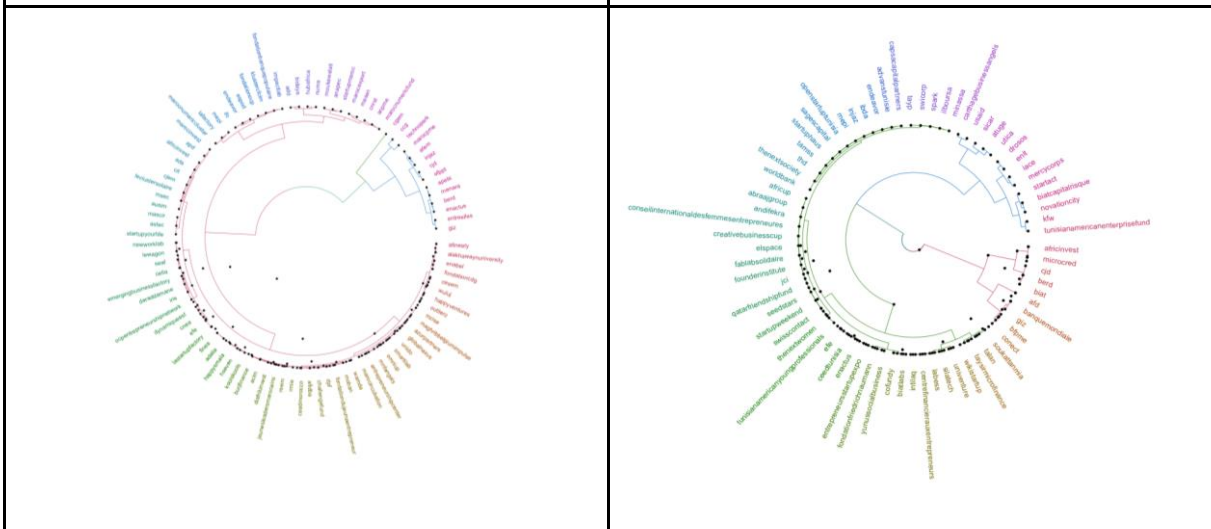
Figure 4 : Low interorganizational ties in the area of Lyon (2021) compared

Lyon's EE dendrogram (2021) showing low interorganizational ties



Morocco's EE Dendrogram (Authors, 2021)

Tunisia's EE Dendrogram (Authors 2021)



3.4. While governance demonstrated its impact

Exploring the reason why, beyond specific cultural attributes in this particular place, we explored governance action on its EE. Recent change in local governance “*in 2016-2017 we changed our strategy : from public only to public-private governance*” - *IN-RO* had visible impacts on EE network attributes (Figure 5) and a stimulating effect on ties creation. People realize the importance of interorganizational ties “*EE is more efficient if it works in network*” - *BA-GT* and as a result the local perception of their dynamic “*Lyon’s EE is particularly dynamic*” - *PB-LR*. As a result we observe a significant growth of interorganizational ties in the Lyon Area between 2016 and 2021 (+42%). These results show again the interest of both qualitative and quantitative analysis, one enlightening the other. This evidence resonates also with previous research on EE governance (Colombo *et al.*, 2019; Cunningham, Menter and Wirsching, 2019). But in the specific case of Lyon, we see that institutional legitimacy of this secondary actor -in network power- , deeply influences this EE.

3.5. Revealing a building process within that EE

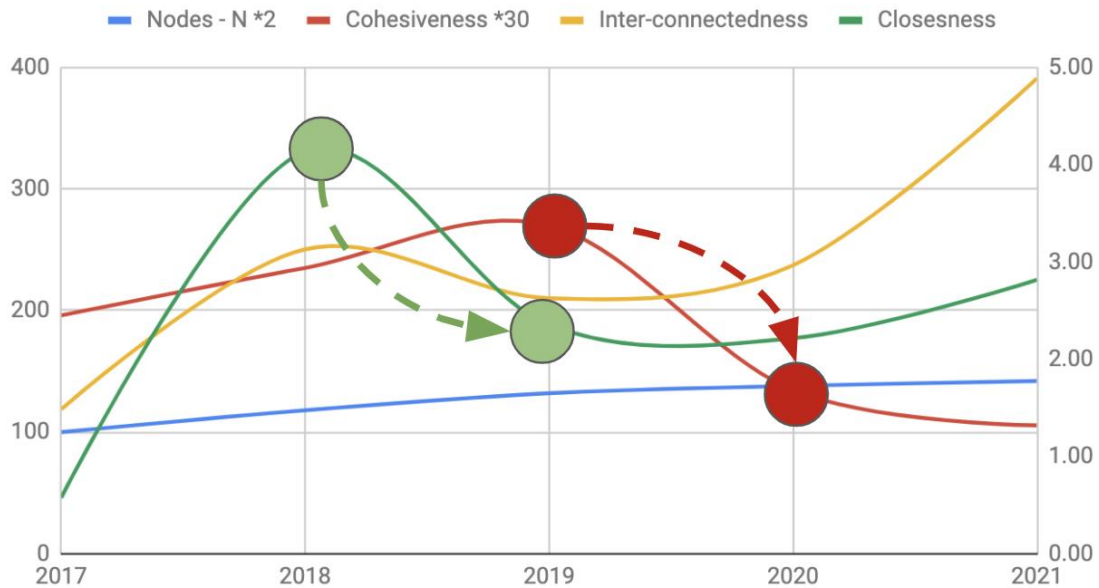
Longitudinal network analysis has the statistical power to both increase validity of results and to indicate processes occurring in a network. The evolution of Lyon’s EE reveals an interesting phenomenon (Figure 5). EE Network attributes seem to be tightly dependent (Table 3 and Figure 5). In this particular EE, closeness variation (collaborative culture) impacts cohesiveness (knowledge and innovation spread) attributes over time. Without knowing what is egg and what is chicken, we see dependent paths between those two attributes in Lyon’s EE. Governance might have stimulated the collaborative culture in this EE, which has structurally grown. For information and knowledge spread, the picture is not as clear. We see an evolutionary pattern which indicates that when collaborative culture evolves positively, the next phase sees an increase of information and knowledge spread. But as introduced before, we actually can not see the interdependencies between interpersonal and interorganizational networks which could explain in detail the variance of this particular attribute over time. Nevertheless, this process between those two factors could be generalized in the future. Quite independently, interconnectedness (degree of partnership) increased quite linearly due to its natural dynamic and also governance policy. This is an interesting pattern, similar compared to other territories (Gueneau, Chabaud and Chalus-sauvannet, 2021). It shows the growth and maturation of this EE over time. The actual data provided by this research does not clearly demonstrate the effect of Covid pandemic on that territory, as it seems to continually grow. We do not know if

closeness and cohesiveness variation during this period is due to its intrinsic processes, or impacted by various forms of external factors such as lockdowns in France in 2020 and 2021.

Table 3. Lyon's EE inter-organizational network metrics

	Year	2017	2018	2019	2020	2021
	Actors - a	251	251	251	251	251
	Articles - ar	26740	42772	73063	110176	137582
	Nodes - N	50	59	66	69	71
	Vertices - M	13	30	57	63	82
Cohesiveness	Density - d	0.24	0.25	0.27	0.19	0.18
	Centrality -c	0.35	0.39	0.41	0.29	0.25
	Cohesiveness factor (c*d)	0.08	0.10	0.11	0.06	0.04
Inter-connectedness	Interconnectivity (N/a) - in	0.20	0.24	0.26	0.27	0.28
	Average Weight - aw	596.35	1064.95	798.95	863.15	1381.58
	Inter-connectedness factor (in*aw)	118.79	250.33	210.08	237.28	390.80
Closeness	Average Shortest Path	1.76	3.03	2.53	2.49	2.68
	Clustering Coefficient	0.20	0.33	0.33	0.28	0.33
	Mean Distance	1.76	3.03	2.53	2.49	2.68
	Proximity factor $_{((1-asp)*(1-md))}$	0.58	4.13	2.35	2.21	2.82

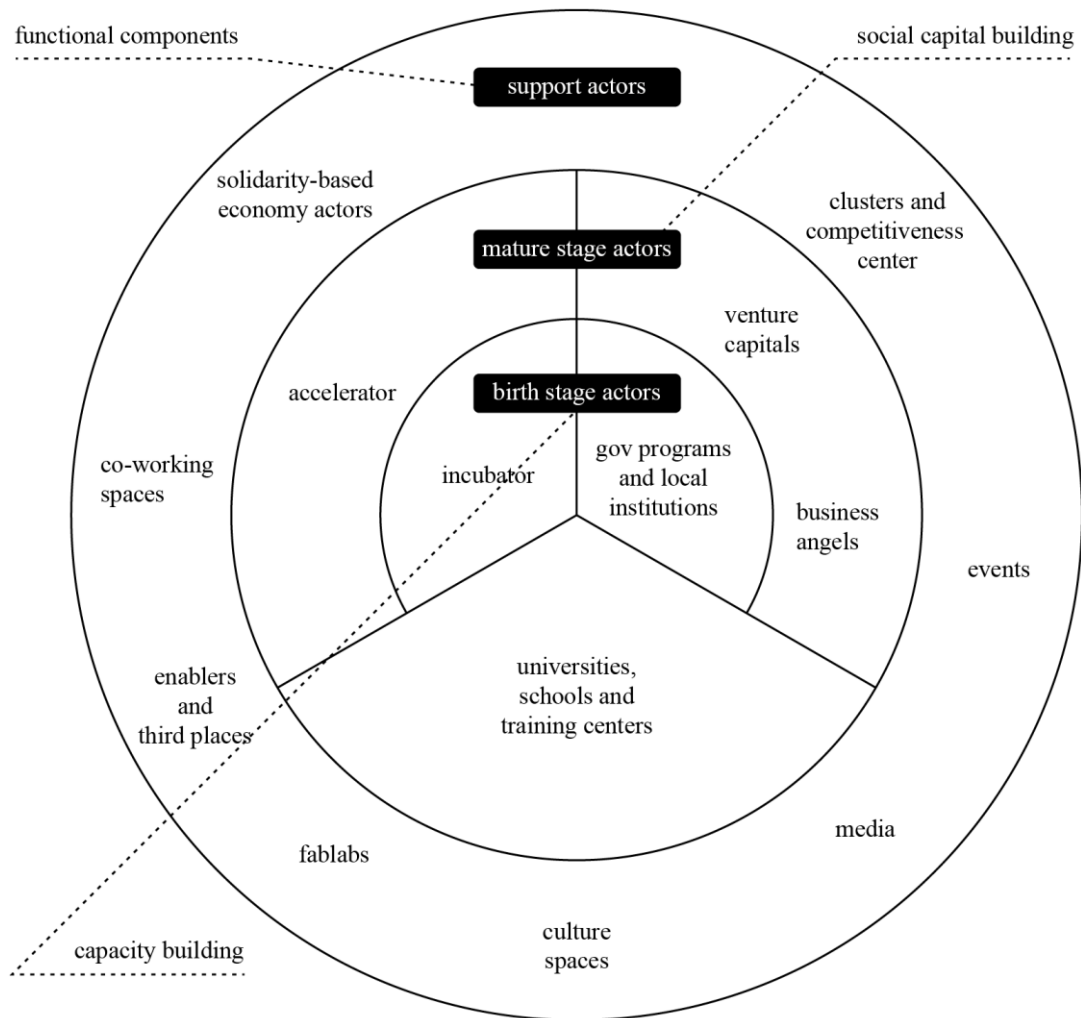
Figure 5 : evolution or EE network attributes



3.6. With clarification of typology of actors

Based on literature knowledge and this complementary research, we are led to propose clarifications on EE composition in terms of type of actors. Lyon's local segmentation of EE actors comes in 6 groups of actors, organized in layers (Figure 6). Birth stage actors with support (incubators) and funding actors (government programs and local institutions), Mature stage actors with support (accelerators) and funding actors (VCs and Business Angels), Education actors (Universities, Schools and Training Centers), and purely practical and business support actors (solidarity-based economy actors, co-working places, enablers and third-places, fablabs, culture places, medias, events, clusters and competitiveness organizations). We know many of them have several activities, but almost all of them have a central activity that responds to this typology.

Figure 6 : roles of group of actors in the EE

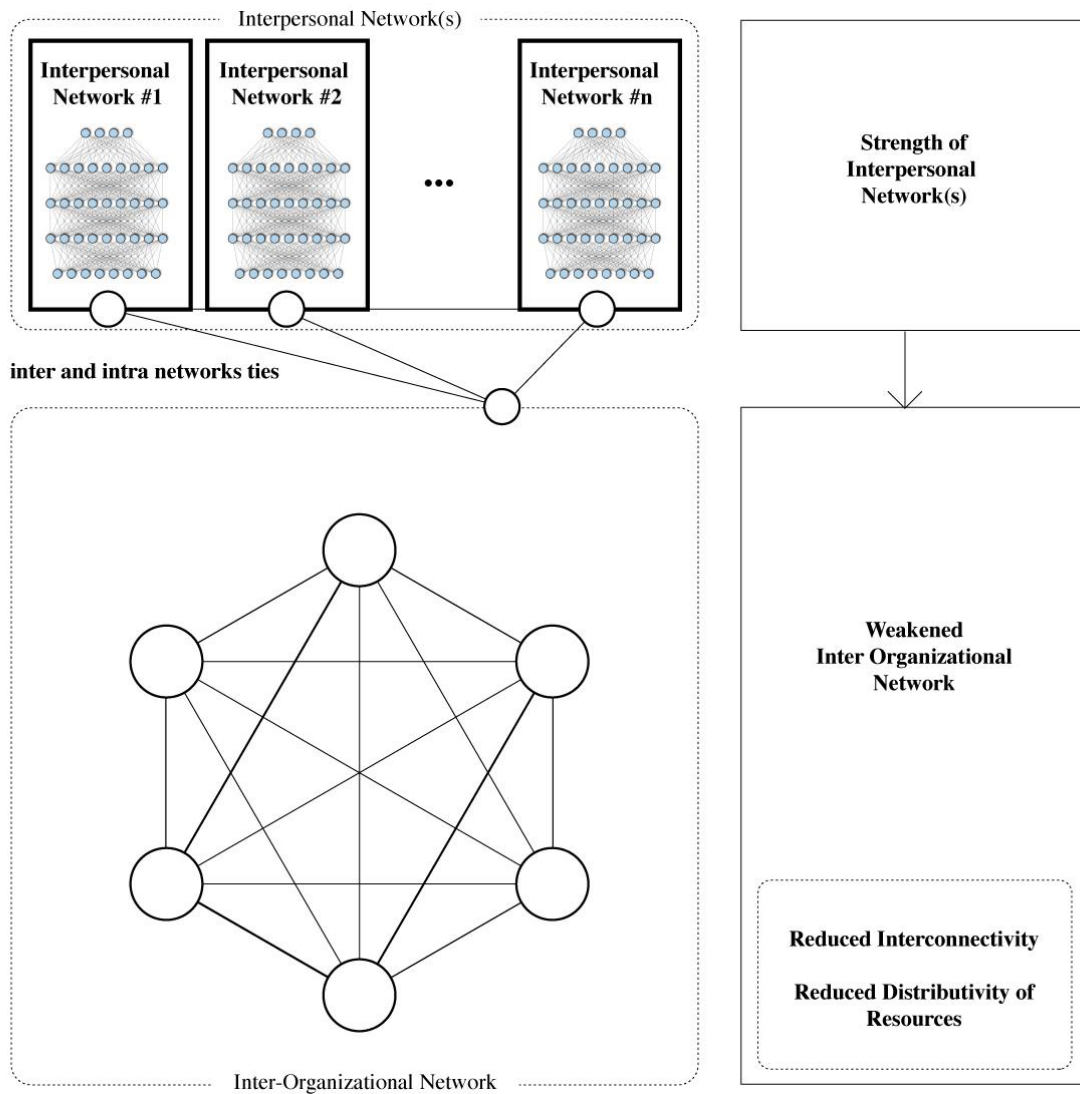


4. DISCUSSION

4.1. Layers of ties

In Lyon's area, we observe a two-layer network : the interpersonal and interorganizational ones, that seem to have different roles and impact on the EE that delivers various entrepreneurial nurturing components to entrepreneurs.

Figure 7 : Entrepreneurial Ecosystem Interpersonal networks disruption effect on Interorganizational network



The specificity of the Lyon area is the strength of the interpersonal network between actors that seems to limit the growth of the inter-organizational network in terms of interconnectivity (number of lateral partnerships between actors) and probably also the distributivity of its resources. It might indicate antagonist behavior between the interpersonal and interorganizational networks. In our best knowledge, this perspective has never been raised in literature. Previous research both on the dynamics of interpersonal and inter-organizational ties suggest also that the rise of inter-organizational ties in Lyon appear as a natural auto-regulation of this EE. We also suspect an Agency theory effect due to interpersonal ties which makes the development of interorganizational ties un-necessary, especially regarding knowledge and information spread (cohesiveness), but without any evidence regarding collaboration culture (closeness). There is a high probability that the social capital building in Lyon's area is mainly

feeded through interpersonal ties and ‘bouche a oreilles’³³, and not through interorganizational efforts, but this modality is largely insufficient to also allow a proper build of capacities for entrepreneurs.

During the presentation of the results, the actors agreed on the codes that govern this environment and that one must know in order to be integrated and to obtain resources. The culture of the city also permeates the practices *"in Lyon, business is done in the restaurant"* (CCI Representant).

We can also detect a multilevel networking perspective (Guan, Zhang and Yan, 2015) having a positive impact on this territory's innovation and entrepreneurial dynamics, probably one of the reasons why this territory is known to be so vibrant. This perspective also suggests a negative impact in the case of network structural holes or particular clustering configurations that should be further investigated (Brass *et al.*, 2004; Kilduff and Brass, 2010). Nevertheless, as Lyon's EE is known to be an efficient EE, we could in the future deep dive into its detailed configurations and their effects on various forms of Entrepreneurship in this particular territory, the question that should also be addressed regarding Lyon's EE concerns the natural conductivity of this EE due to the richness of its available resources vs. the effectiveness of its EE network. We suspect also that this EE, due to its abundance in resources, conducts naturally entrepreneurial efforts, regardless of its inter-organizational network attributes.

4.2. Hyper-centrality of the main central actor

Another interesting observation is the apparent strength of MEDEF as an hyper-central actor of Lyon's area EE, strength that increases over time. The fact that actors prefer to create ties with MEDEF, which is an institutional actor that does neither deliver support nor fundings, is -at itself- interesting. The apparent ‘tree’ topology of EE inter-organizational network (Liu, Pellegrini and Wang, 2015), rather than a ‘fully connected’ topology of the network, with MEDEF in the middle, has a meaning in terms of power plays, self-representation of EE organizations. Both the power of interpersonal ties and the hyper-centrality of Lyon's EE indicates a more competitive rather than cooperative EE, which is not the interest of the Entrepreneurs and could produce negative Entrepreneurial Dynamics effects. This hyper-

³³ word-of-mouth

centrality characteristic of Lyon's EE might be tied to cultural habits in France (Bourdeau-Lepage and Tovar, 2015). But given all our observations, MEDEF's hyper centrality seems to have a neutral role regarding the performance of this EE, but we might question this role and impact in the future. In that intention, we are led to propose a deeper study of this centrality impact on local entrepreneurial dynamics. For governance actors, a main concern can arise about the proper policy to develop in such a context. Our research indicates the importance of developing a fully connected EE network, especially to reinforce the distributivity of EE resources to entrepreneurs. Such policy met, in Lyon, a measurable success opening governance to both public and private actors, and should, in the future, may add some other incentives, such as a qualitative label for EE actors, or other distinctive attributes provided by governance actors.

4.3. Capacity Building and Social Capital

Social Capital is a known concern in EE research (Theodoraki, Messeghem and Rice, 2018) in this research we discover that mature stage actors have a specific Social Capital role for Entrepreneurs, to accelerate their growth. This perspective is confirmed by our observations. Deep-diving the understanding of the roles of the various types of actors, we see quite clearly the role of birth-stage actors is focused on Capacity Building, using internal resources, but also the resources delivered by the support actors (Figure 8). Functional nurturing components, delivered by support actors, are used to bring an entrepreneurial project to maturity in various ways all along the entrepreneurial process. Those components can be either activated directly by Entrepreneurs, but also proposed by birth stage and mature stage actors, depending on needs, to Entrepreneurs that need them. A typology oriented research would tell us if, in Lyon, the interorganizational ties balance the power of its interpersonal ties and how, specifically, functional components are tied in this particular EE. Larger scale research could also allow us to identify archetypal EE behaviors (Tatarynowicz, Sytch and Gulati, 2016). Nevertheless, to capacity building and social capital actors, we identify two other types of actors. First is education actors represented by Schools & Universities, a perspective addressed in triple helix research, which -in our model- are knowledge providers. The second type of actors are Practical Support actors, previously introduced (Fig. 6), which have a functional nurturing component provider role. The interaction of those types of actors, or 'species' if considered seriously the ecological metaphor, and roles are important to observe. Their interactions could have a measurable impact on the distribution of resources to Entrepreneurs.

The clarification of EE actors and roles allowed us also to propose an integrated descriptive model of EE (figure 9) embedding economic elements at a macro-level of analysis (Wurth, Stam and Spigel, 2021), organizational actors at a meso-level of analysis (Theodoraki and Messeghem, 2017), and relational and managerial dependencies between EE actors and Entrepreneurs at a micro-level of analysis.

Figure 8 : Entrepreneurial Ecosystem Typology of Actors and Roles

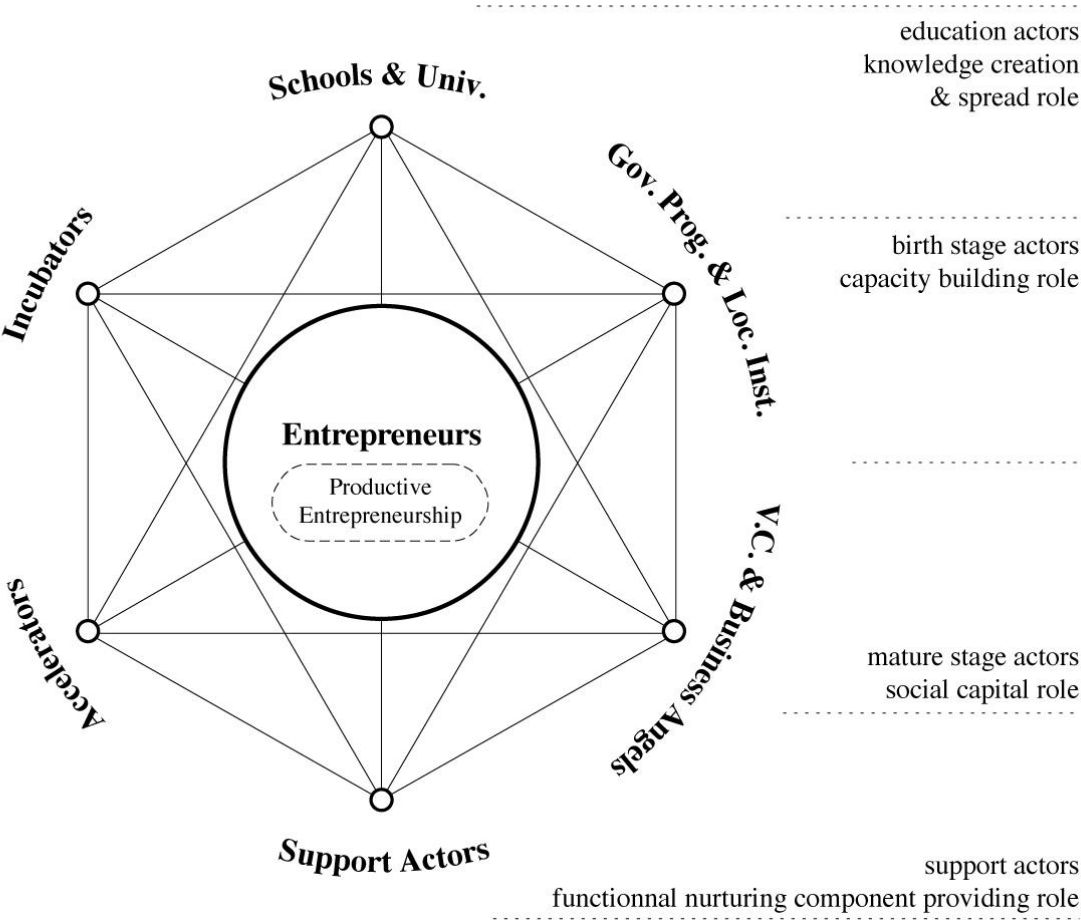
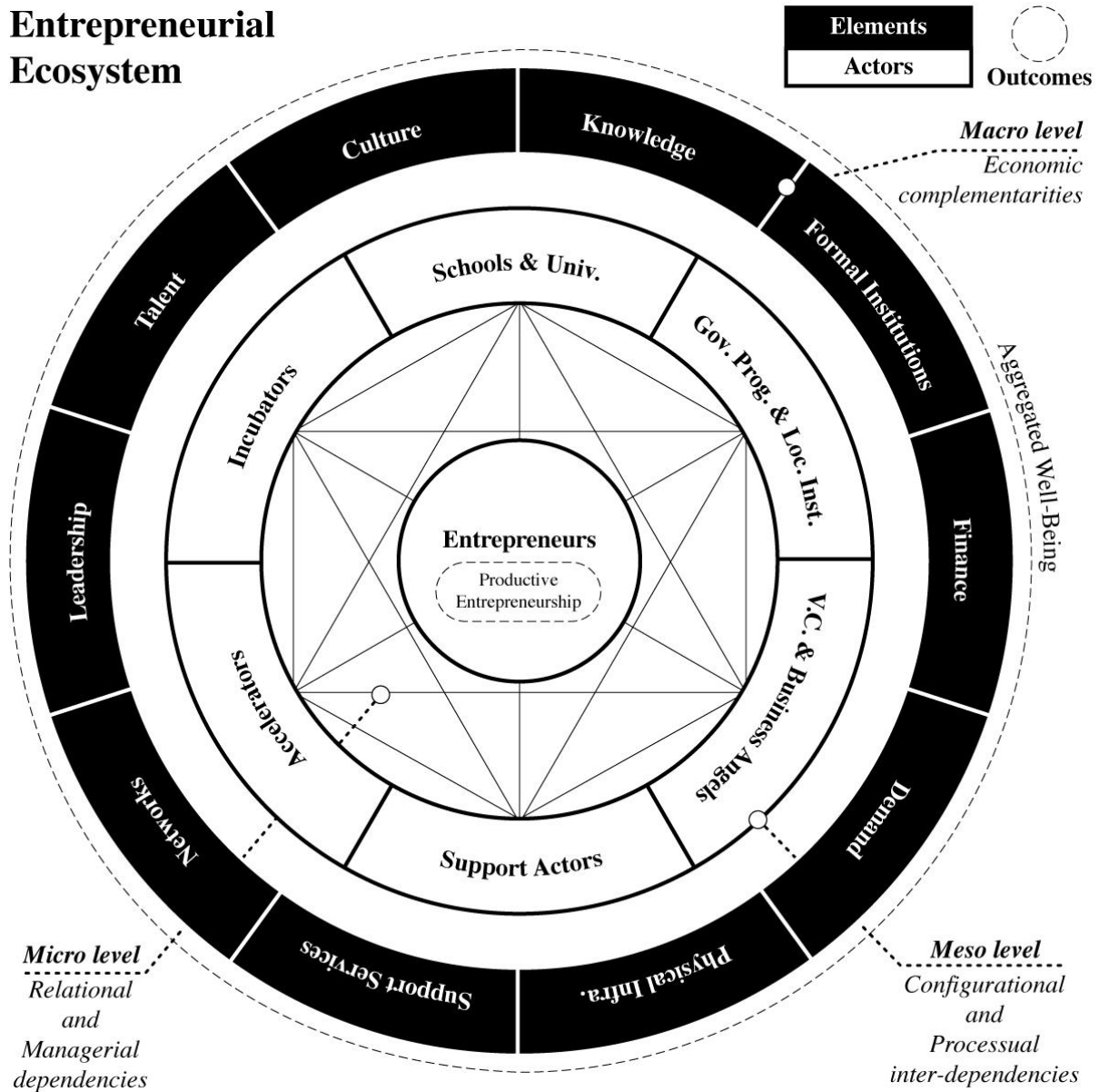


Figure 9 : Entrepreneurial Ecosystem Elements and Actors

Entrepreneurial Ecosystem



4.4. Evolutionary pattern of EE

This first longitudinal and qualimetric study, in the case of Lyon’s area, seems to present an evolutionary pattern between the information and knowledge spread attribute and the cooperation culture attribute of EE represented by Closeness and Cohesiveness measures. The first attribute seems to cause the evolution of the second, and is tightly dependent. The other known measures of this kind (Gueneau, Chabaud and Chalus-sauvannet, 2021) present the same pattern, indicating an archetypal behavior. Evolution is a known perspective in EE research (Kantis and Federico, 2020) but has never been empirically studied, with quantitative methods, to understand organizational patterns in EEs. In itself, this research open new

interesting perspectives. This one only case evaluation has to be completed with larger studies, to understand with a larger number of cases, how EE evolves over time, depending on their respective maturity and lifecycle. In the case of Lyon, we can observe its interorganizational emergence and how its network attributes evolve over time. But besides the evolution of individual organizations, future research should allow us to understand how EE organizational ‘species’ evolve over time, how their mutual ties reveal performance oriented configurations, and what network attributes can produce negative Entrepreneurial Dynamic impact. This research contributes also to identify governance impact in that EE. Opening its arms to private actors, and leading a visible effort to create cohesion in this EE, governance has a real ‘big-bang’ impact on inter-organizational ties creation linked to this initiative. The development of this Collaborative Culture in the EE encouraged the creation of new EE actors.

CONCLUSION

Theoretical Implications

First we emphasize the interest of a qualimetric approach on EE to fill various theoretical gaps, as well as a longitudinal analysis to fit the required evolutionary perspective regarding the ecosystemic nature of EEs. None of our findings in this research would have been reached without a comparative analysis between our qualitative and quantitative results.

This research feeds the debate to refine the characterization of the typology of EE actors (birth stage vs mature stage, supportive vs financial actors), their roles (capacity building vs social capital), general attributes of the EE (information and knowledge spread attribute impact on collaborative culture), its evolutionary model and archetypal topology forms of the EE (star form, web form).

Governance, through this case study, demonstrates its importance and impact on related EE. The strategic move to include private actors in the scope of the governance (and public) actor is a uncommon move. But the result, and its strength, is real. An inclusive strategy from the governance actor has a very positive impact on the creation of partnerships between EE actors and increases a more cooperative culture between EE actors.

The behavior of EE actors regarding the central actor is also very interesting, underlining an increasing magnetic effect, despite the fact that this actor does not have an active role within the EE.

Managerial Implications

This case study indicates the interest of an inclusive public-private approach between EE organizations for a better sustainability, and a less individual dependent EE. It leads to considering governance actors as accelerators of inter-organizational linkages, and limiters of any discontinuity effect across networks. Literature does not address this specific point, but managerial science suggests to raise stakeholders' objective alignment strategies previously to a comprehensive action plan for the benefit of all counterparts, and increase the outcomes in terms of productive entrepreneurship. Future research should address specifically this question, probably mobilizing the Resource Based View strategy perspective.

This early study after the covid-19 crisis demonstrates also a consistent resilience of Lyon's area EE Network attributes, indicating that existing EE attributes before that crisis allowed this EE to self re-dynamise after the crisis, particularly regarding the impressive growth of its inter-connectedness measures.

Limits

First and essential limit is due to its one case only scale, and also the lack of comparable metrics. Another limit is due to the additive model of data collection. Our data model can only detect the creation of inter-organizational ties, not their obsolescence or destruction.

Future Research

There are many other measures proposed by the Quantitative Graph Theory that could be investigated (role of various centrality measures for example) as well as other kinds of investigations under Network perspective (network archetypal forms, clusters, structural holes, etc.), and also looking forward to various causes of EE network evolution, and effects on its local spillovers. In order to increase validity of our results, and allow us to observe to which extent our actual observations can be generalized, comparative analysis between a large number

of territories shall be planned in the near future. Particularly, we shall especially observe in lower resources territories which between EE organizational attributes and local abundance of resources play more heavily on Entrepreneurial Dynamics levels and evolution.

The multiplication of cases will facilitate the capacity to generalize our findings, and observe - for example- various kinds of EE behaviors depending on place, development or other environmental factors.

We shall also observe in the future if the Governance effect trend is confirmed, and how important pivots in local governance can affect its EE, its structural configuration, attributes and dynamics. But even if limited, our observations confirm the importance of a comprehensive EE governance, preferably empowered by proper data and related analysis to orient their policy with effectiveness.

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