INTER-FACULTY MASTER PROGRAM on
COMPLEX SYSTEMS and NETWORKS
SCHOOL of MATHEMATICS
SCHOOL of BIOLOGY
SCHOOL of GEOLOGY
SCHOOL of ECONOMICS
ARISTOTLE UNIVERSITY of THESSALONIKI

MASTER THESIS

Exploration of trade structures of rice and wood sectors. Case study on agricultural - forest trade networks and intra industry trade.

Kalioropoulou N. Anna

Supervisor: Zikopoulos Christos

Thessaloniki, December 2016

ΔΙΑΤΜΗΜΑΤΙΚΟ ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ
ΣΠΟΥΔΩΝ στα
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ΜΕΤΑΠΤΥΧΙΑΚΗ ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

Διερεύνηση των δομών του εμπορίου στους τομείς ρυζιού και ξυλείας. Ενδοκλαδικό εμπόριο και συγκριτική ανάλυση σε αγροτικό και δασικό δίκτυο.

Καλιοροπούλου Ν. ‘Αννα

Επιβλέπων: Ζηκόπουλος Χρήστος

Θεσσαλονίκη, Δεκέμβριος 2016

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Approved by the Three-member Assessment Committee on 22nd December 2016

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ABSTRACT

The aim of the present thesis is the exploration of trade structures of rice and wood sectors. Social Network Analysis is used for investigation of agricultural and forest trade networks. Main goal of this study is to analyze international agricultural market, applying network theory. Particularly, centrality measures will be used. The countries will be ranked in hierarchies of import-export relations and these hierarchies will be visualized. Networks are dynamically described within and between 2011 and 2015 years. The benefit that is received from representing the inter country trade as a network of either trade partnerships or trade flows is the possibility to depict the interaction between trading countries and their hierarchies which otherwise remain indiscernible. Moreover, another advantage from network analysis is the detection of possible correlations between the hierarchical position of the countries inferred from network variables and their non-network characteristics resulting from conventional economic indicators. Each network is examined in weighted form, taking into consideration the economic value of trade flows and unweighted form that considers only the bilateral trade partnerships.

Keywords: *Social Network Analysis, Centralities, Valued Networks, Binary Networks*

ΠΕΡΙΛΗΨΗ

Ο στόχος της παρούσας μεταπτυχιακής διπλωματικής εργασίας είναι να διερευνήσει τις εμπορικές δομές των κλάδων του ρυζιού και της ξυλείας. Η κοινωνική ανάλυση δικτύου στην παρούσα εργασία χρησιμοποιείται για τη διερεύνηση εμπορικών δικτύων προϊόντων που ανήκουν στον πρωτογενή τομέα της οικονομίας. Πιο συγκεκριμένα, δείκτες κεντρικοτήτων θα χρησιμοποιηθούν και θα γίνει η κατάταξη των χωρών σε ιεραρχίες εισαγωγών - εξαγωγών και αυτές οι ιεραρχίες θα παρουσιαστούν απεικονιστικά. Τα δίκτυα που δημιουργήθηκαν θα περιγραφούν δυναμικά μεταξύ των ετών 2011 και 2015. Το όφελος που λαμβάνεται από την αναπαράσταση του εμπορίου μεταξύ των χωρών ως δίκτυο είτε των εμπορικών συνδέσεων – συνεργασιών, είτε των εμπορικών ροών που αναπαριστώνται με βάρη, είναι η δυνατότητα αποκάλυψης αλληλεπιδράσεων και ιεραρχιών που διαφορετικά δεν θα μπορούσαν να εντοπιστούν. Επιπλέον στόχος είναι ο εντοπισμός πιθανών συσχετίσεων μεταξύ των ιεραρχικών θέσεων των χωρών, μέσω της σύγκρισης των δικτυακών μεταβλητών και των συμβατικών οικονομικών δεικτών που φέρουν μη δικτυακά χαρακτηριστικά. Κάθε δίκτυο εξετάζεται στη μορφή με βάρη, όπου λαμβάνεται υπόψη η οικονομική αξία των εμπορικών ροών και στη μορφή χωρίς τα αντίστοιχα βάρη, όπου λαμβάνονται υπόψη μόνο οι διμερείς εμπορικές συνεργασίες.

Λέξεις – κλειδιά*: Ανάλυση Κοινωνικών δικτύων, Κεντρικότητες, Δίκτυα με βάρη, Δίκτυα χωρίς βάρη,*

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ΣΥΝΟΨΗ

Ο στόχος της παρούσας μεταπτυχιακής διπλωματικής εργασίας είναι να διερευνήσει τις εμπορικές δομές των τομέων του ρυζιού και της ξυλείας. Η κοινωνική ανάλυση δικτύου χρησιμοποιήθηκε για τη διερεύνηση εμπορικών δικτύων αγροτικού και δασικού κλάδου. Πιο συγκεκριμένα, δείκτες κεντρικότητων χρησιμοποιούνται και γίνεται η κατάταξη των χωρών σε ιεραρχίες εισαγωγών – εξαγωγών. Στη συνέχεια οι ιεραρχίες αυτές παρουσιάζονται απεικονιστικά. Τα δίκτυα που επιλέχθηκαν περιγράφονται δυναμικά μεταξύ των ετών 2011 και 2015. Το όφελος που λαμβάνεται από την αναπαράσταση του εμπορίου μεταξύ των χωρών ως δίκτυο είτε των εμπορικών συνδέσεων, είτε των εμπορικών ροών που αναπαριστώνται με βάρη, είναι η δυνατότητα αποκάλυψης αλληλεπιδράσεων και ιεραρχιών που διαφορετικά δεν θα μπορούσαν να εντοπιστούν. Επιπλέον στόχος είναι ο εντοπισμός πιθανών συσχετίσεων μεταξύ των ιεραρχικών θέσεων των χωρών, μέσω της σύγκρισης των δικτυακών μεταβλητών και των συμβατικών οικονομικών δεικτών που φέρουν μη δικτυακά χαρακτηριστικά. Κάθε δίκτυο εξετάζεται στη μορφή με βάρη, όπου λαμβάνεται υπόψη η οικονομική αξία των εμπορικών ροών και της μορφής χωρίς βάρη, όπου λαμβάνονται υπόψη μόνο οι διμερείς εμπορικές συνεργασίες.

Στην παρούσα ανάλυση που βασίζεται σε δεδομένα συγκεκριμένων κλάδων της οικονομίας, υπολογίζονται και συγκρίνονται μέτρα κεντρικοτήτων τοπικά (local) και ολικά (global). Μέσα από την ανάλυση επιβεβαιώνεται ότι η θέση ενός κόμβου αλλάζει, όταν λαμβάνονται υπόψη τα τοπικά μέτρα κεντρικοτήτων έναντι των ολικών. Οι διαφορές μεταξύ των τοπικών και των ολικών μέτρων κεντρικοτήτων είναι πιο εμφανείς για χώρες που είναι λιγότερο ενσωματωμένες στο παγκόσμιο εμπόριο και με κατάταξη σε χαμηλές θέσεις με βάση τους δείκτες κεντρικοτήτων. Από την άλλη, κυρίαρχοι κόμβοι με υψηλή κατάταξη στους παραπάνω δείκτες, παρουσιάζουν ομοιότητες στις δύο μορφές μέτρων κεντρικότητας. Σε μεγάλο βαθμό οι παρατηρήσεις αυτές επιβεβαιώνονται από την ανάλυση των δύο κλάδων υπό μελέτη. Τα δίκτυα που διαμορφώνονται είναι τέσσερα, δύο για τον κάθε κλάδο, που αντιστοιχούν σε δύο διαφορετικά έτη μελέτης και αναφέρονται ακολούθως: rice2011, rice2015, wood2011, wood2015.

Η επιλογή συγκεκριμένων εμπορικών κλάδων οφείλεται στο γεγονός ότι τα δημητριακά, ρυζιού συμπεριλαμβανομένου, συνιστούν ένα από τα πιο εμπορικά αγροτικά προϊόντα που δημιουργούν μεγάλη παγκόσμια οικονομική αξία, με το ρύζι να αποτελεί βασικό διατροφικό προϊόν σε ορισμένες πολυπληθείς χώρες, ενώ ο επιλεγμένος κωδικός ξυλείας παρουσιάζει ενδιαφέρον καθώς σχετίζεται άμεσα με τον τομέα της οικονομίας που αφορά την βιομηχανία.

Ο λόγος που εφαρμόζεται η ανάλυση δικτύου στα κοινωνικά και οικονομικά συστήματα είναι επειδή η δομική διάσταση του δικτύου αναλύεται λαμβάνοντας υπόψη την επίδραση παραπάνω από δύο μερών – κόμβων, με βασικό χαρακτηριστικό την αλληλεπίδραση που απορρέει από αυτή τη σχέση, που συμπεριλαμβάνει πάνω από δύο συμμετέχοντες.

Διάφορα χαρακτηριστικά των εμπορικών δικτύων μπορούν να ποσοτικοποιηθούν με την χρήση των δεικτών κεντρικότητας. Ορισμένα από αυτά τα χαρακτηριστικά είναι ο υψηλός βαθμός ανομοιογένειας και οι μεγάλες διαστάσεις του δικτύου. Η χρήση της δικτυακής ανάλυσης δεν είναι υποκατάστατο για τους συμβατικούς στατιστικούς και οικονομικούς δείκτες, αλλά μπορεί να χρησιμοποιηθεί συμπληρωματικά παρέχοντας πολύτιμες και διαφορετικές σε ορισμένες περιπτώσεις πληροφορίες.

Συνεπώς ο λόγος που η ανάλυση δικτύων συνίσταται στην ανάλυση εμπορικών δικτύων είναι επειδή είναι ένα χρήσιμο εργαλείο, ενίοτε συμπληρωματικό στις πιο συμβατικές ερευνητικές μεθόδους, αφορά μελέτη σχέσεων και αλληλεπιδράσεων, η μελέτη των σχέσεων γίνεται ταυτόχρονα και για το κόμβο *i* και για το κόμβο *j*, λαμβάνοντας υπόψη και την επίδραση και ενός τρίτου κόμβου *z* πάνω στη σχέση των *ij* και ούτε καθεξής. Επίσης η ανάλυση δικτύου λαμβάνει υπόψη όλη τη δομή του δικτύου και δίνει περισσότερη πληροφορία, ειδικά όταν το δίκτυο χαρακτηρίζεται από μεγάλες διαστάσεις και ανομοιογένεια. Επίσης μπορούν να λαμβάνονται ορισμένα κομμάτια του δικτύου και να προκύπτουν χρήσιμα συμπεράσματα, καθώς το μέγεθος του κόμβου μεταβάλλεται με βάση τη σχέση που θέλουμε να μετρήσουμε (π.χ. ο κόμβος να είναι ανάλογος του ΑΕΠ, του κατά κεφαλή ΑΕΠ, του λόγου εξαγωγές / ΑΕΠ). Σε σχέση με τους συμβατικούς δείκτες η ανάλυση δικτύου μπορεί να παρέχει τις ίδιες μετρήσεις. Για παράδειγμα η εσωτερική κεντρικότητα βαθμού με βάρη ή η εξωτερική κεντρικότητα βαθμού με βάρη δείχνει το

μερίδιο αγοράς μιας χώρας στο παγκόσμιο εμπόριο, σε όρους εισαγωγών ή εξαγωγών αντίστοιχα (De Benedictis et al., 2013)

Η δομή της παρούσας εργασίας είναι η ακόλουθη. Στο Κεφάλαιο 1 γίνεται η ανασκόπηση της βιβλιογραφίας και παρουσιάζονται οι ορισμοί των μέτρων κεντρικότητας, το Κεφάλαιο 2 αναφέρεται στην μεθοδολογία, το Κεφάλαιο 3 αναφέρεται στα αποτελέσματα, το Κεφάλαιο 4 περιέχει το σχολιασμό των βασικών ευρημάτων και το Κεφάλαιο 5 περιέχει τα συμπεράσματα. Στην παρούσα ενότητα παρατίθεται μια αναλυτική σύνοψη των αποτελεσμάτων και των συμπερασμάτων.

Από τα βασικά δικτυακά χαρακτηριστικά συνάγεται ότι ο κλάδος της ξυλείας έχει μεγαλύτερη πυκνότητα από τον κλάδο του ρυζιού. Η πυκνότητα έχει αυξηθεί μεταξύ των ετών μελέτης για τον κλάδο ξυλείας περίπου 6% και για τον κλάδου ρυζιού περίπου 7%, ενώ παράλληλα ο αριθμός των ακμών έχει αυξηθεί μεταξύ των ετών, 8% και 12% αντίστοιχα. Μια παρατήρηση που απορρέει από τις παραπάνω αλλαγές μεταξύ των ετών και μεταξύ κλάδων είναι ότι πιθανόν ο βιομηχανικός κλάδος της ξυλείας έχει περισσότερα εμπόδια εισόδου. Ως πυκνότητα ορίζεται ο αριθμός των υπαρκτών συνδέσεων προς τον αριθμό των πιθανών συνδέσεων και καθώς ο αριθμός των υπαρκτών συνδέσεων έχει αυξηθεί μεταξύ των ετών, αυτό αποτελεί μια ένδειξη μεγαλύτερης διασύνδεσης και ενοποίησης του παγκόσμιου εμπορίου στους προαναφερθέντες κλάδους. Μια γενική παρατήρηση, που βασίζεται στην παρούσα μελέτη και τη σχετική βιβλιογραφία είναι ότι τα εμπορικά δίκτυα τείνουν να γίνονται πιο πυκνά με την πάροδο του χρόνου. Επίσης παρατηρείται ότι προϊόντα από τον πρωτογενή τομέα παραγωγής δεν επηρεάζονται σε μεγάλο βαθμό από τις αρνητικές συνέπειες της οικονομικής κρίσης, καθώς αφορούν προϊόντα που ικανοποιούν βασικές ανάγκες. Τα παραπάνω δίκτυα χαρακτηρίζονται από μεγάλες διαστάσεις, καθώς σχεδόν 50 κόμβοι συμμετέχουν σε κάθε δίκτυο και είναι δίκτυα σχετικά ανομοιογενή σε ότι αφορά τα αποτελέσματα κεντρικοτήτων. Τα παραπάνω εμπορικά δίκτυα τείνουν να διαφοροποιούνται στα αποτελέσματά τους ανάλογα με το κύριο ερώτημα στο οποίο απαντούν. Για παράδειγμα η βαθμική κεντρικότητα απαντά στο ερώτημα πόσο καλά διασυνδεδεμένο είναι το δίκτυο, η κεντρικότητα εγγύτητας απαντά στο πόσο εύκολη είναι η πρόσβαση ενός κόμβου από τους άλλους κόμβους, η ενδιάμεση κεντρικότητα απαντά στο πόσο σημαντικός είναι ο κόμβος σε όρους σύνδεσης με άλλους

κόμβους και οι κεντρικότητες που βασίζονται στην ιδιοκεντρικότητα μετράνε πόσο σημαντικές είναι οι γειτονικές χώρες του κόμβου.

Σε ότι αφορά την εξωτερική βαθμική κεντρικότητα και τις απευθείας συνδέσεις που κατευθύνονται από τον έναν κόμβο προς τους άλλους κόμβους, παρατηρείται ότι υπάρχει ένας γεωγραφικός διαχωρισμός. Είναι φανερό από το δίκτυο του ρυζιού ότι οι δυναμικές οικονομίες της Ασίας (Ινδία, Ταϊλάνδη, Πακιστάν) που πιθανόν έχουν το συγκριτικό πλεονέκτημα του χαμηλού εργατικού κόστους, βρίσκονται στις πρώτες θέσεις, ενώ οι αναπτυγμένες οικονομίες της ΕΕ (Ιταλία, Ισπανία) και οι ΗΠΑ κυριαρχούν και στο δίκτυο με βάρη και στο δίκτυο χωρίς βάρη. Από τα παραπάνω αποτελέσματα προκύπτει το συμπέρασμα ότι χώρες με υψηλές κεντρικότητες συνεχίζουν με την πάροδο του χρόνου να είναι βασικοί παίκτες στο παγκόσμιο εμπόριο ρυζιού, είναι αρκετά συνδεδεμένες με τον υπόλοιπο κόσμο, παρουσιάζουν μεγαλύτερη ευρωστία και σταθερότητα στις δομές τους. Σε αυτό το σημείο θα πρέπει να ληφθεί υπόψη το γνωστό φαινόμενο της ‘’επίδρασης μεγέθους’’ που αναφέρει ότι οι μεγάλες χώρες εμπορεύονται περισσότερο σε απόλυτους όρους, σε σχέση με τις μικρότερες χώρες, καθώς επίσης και το φαινόμενο της ‘’επίδρασης εισοδήματος’’ που αναφέρει ότι οι πιο πλούσιες χώρες εμπορεύονται περισσότερο σε σχέση με τις χώρες που θεωρούνται πιο φτωχές (Helpman & Krugman, 1985; De Bendictis et al.,2013). Το πόσο φτωχή είναι μια χώρα δεν θα πρέπει να συσχετίζεται μόνο με το κατά κεφαλήν ΑΕΠ αυτής της χώρας, αλλά και με το συγκριτικό πλεονέκτημα που έχει μια χώρα που διαθέτει φυσικούς πόρους ή που κατέχει άλλους συντελεστές παραγωγής είτε αφορούν το έδαφος, είτε την εργασία, είτε το κεφάλαιο. Εδώ μπορεί να προστεθεί επίσης και η τεχνολογία και το άυλο κεφάλαιο της τεχνογνωσίας. Σε ότι αφορά την εξωτερική βαθμική κεντρικότητα του δικτύου ξυλείας με βάρη παρατηρείται αξιοσημείωτη διαφοροποίηση μεταξύ κόμβων με τις υψηλότερες τιμές. Η δομή παραμένει η ίδια με την πάροδο του χρόνου με την Γερμανία να ευθύνεται για το 25% των εμπορικών ροών, στη συνέχεια ακολουθεί η Κίνα με 12% και με μικρότερο μερίδιο η Πολωνία, το Βέλγιο και η Αυστρία. Ομοίως, στο δίκτυο ξυλείας χωρίς βάρη, οι ίδιες χώρες κατατάσσονται στις πρώτες θέσεις, με βασικό χαρακτηριστικό των δικτύων χωρίς βάρη να αποτελεί το γεγονός, ότι τα ποσοστά των κεντρικοτήτων παρουσιάζουν μικρή απόκλιση μεταξύ των χωρών, χωρίς να μπορούν ξεχωρίσουν ιδιαίτερα κάποιες χώρες. Είναι ενδιαφέρον να σημειωθεί ότι

σε ότι αφορά τους δείκτες εξωτερικής βαθμικής κεντρικότητας οι χώρες που κατατάσσονται με υψηλές τιμές είναι οι ίδιες και στο δίκτυο με βάρη και στο δίκτυο χωρίς βάρη, γεγονός που επιβεβαιώνεται τόσο από το δίκτυο του ρυζιού όσο και από το δίκτυο της ξυλείας.

Θεωρώντας τους δείκτες εσωτερικής βαθμικής κεντρικότητας του δικτύου του ρυζιού χωρίς βάρη για τα έτη μελέτης, οι πιο κεντρικές χώρες με απευθείας εξερχόμενες συνδέσεις που λαμβάνουν υπόψη μόνο τις συνδέσεις – εισαγωγές και όχι την αξία τους, είναι οι αναπτυγμένες χώρες όπως οι ΗΠΑ, οι χώρες της ΕΕ (Ηνωμένο Βασίλειο, Γερμανία, Ολλανδία, Ιταλία, Γαλλία, Ισπανία και Βέλγιο) και η Αυστραλία. Συνεπώς η δομή του συγκεκριμένου τομέα είναι σταθερή και οι βασικοί εισαγωγείς δεν έχουν μεταβληθεί σημαντικά. Όταν λαμβάνονται υπόψη και οι αξίες των εμπορικών ροών, το εμπόριο του ρυζιού κυριαρχείται από τις χώρες της δυτικής, ανατολικής και νοτιοανατολικής Ασίας, όπως είναι η Σαουδική Αραβία, Ιαπωνία, Μαλαισία, αλλά και οι ΗΠΑ, οι σημαντικές Ευρωπαϊκές οικονομίες (Ηνωμένο Βασίλειο, Γαλλία, Γερμανία) και η Νότια Αφρική. Η Κίνα που το 2011 δεν βρισκόταν στις πιο κεντρικές θέσεις, το 2015 κατατάσσεται δεύτερη σύμφωνα με την αξία των εισερχόμενων συνδέσεων. Αυτό αποτελεί ένδειξη ότι η πολυπληθής Κίνα εξελίσσεται τα τελευταία χρόνια σε αγορά στόχο για πολλές χώρες. Η παρουσία της Σενεγάλης, μια χώρας με χαμηλά επίπεδα εισοδήματος στην ομάδα των δέκα πιο κεντρικών χωρών στο δίκτυο του 2015 με βάρη αποτελεί κατά πάσα πιθανότητα ένδειξη ισχυρής αλληλεξάρτησης από πιο μεγάλους παίκτες, παρά κυρίαρχο ρόλο στο δίκτυο ρυζιού. Σε ότι αφορά τη θέση του Βελγίου και της Ολλανδίας θα πρέπει να ληφθεί υπόψη η λεγόμενη ‘’επίδραση Rotterdam’’ που σχετίζεται με την κοινή πρακτική τις μετεπιβίβασης στο λιμάνι του Ροτερνταμ στην Ολλανδία και του Αντβερπ στο Βέλγιο, που διαχειρίζονται σημαντικό όγκο του εισαγωγικού εμπορίου που εισέρχεται στην Ευρώπη. Στο δίκτυο της ξυλείας με βάρη η εμπορική αγορά διαχωρίζεται ανάλογα με τις ηπείρους. Από την μια κυριαρχούν οι ΗΠΑ και ο Καναδάς και από την άλλη ισχυρές οικονομίες της ΕΕ (Γαλλία, Ηνωμένο Βασίλειο, Γερμανία, Ολλανδία, Ιταλία, Βέλγιο) και η Ρωσία. Η Ρωσία από την $3^{η}$ θέση μεταξύ των ετών κατατάσσεται στην $9^{η}$ θέση, πιθανόν λόγω των κυρώσεων που είχαν επιβληθεί στην περίοδο μελέτης, με γενικότερη επιβράδυνση των εισαγωγών και ύφεση, που ακολούθησε μετά τα παρεμβατικά μέτρα στη λειτουργία της

ελεύθερης κυκλοφορίας προϊόντων. Η ίδια εικόνα επιβεβαιώνεται όταν θεωρούνται δίκτυα χωρίς βάρη. Οι ίδιες χώρες, είτε με βάση τον αριθμό των εμπορικών συνεργασιών είτε με βάση την αξία των εμπορικών ροών, κατατάσσονται στις υψηλότερες θέσεις, ίσως σε ορισμένες περιπτώσεις με ελάχιστη διαφοροποίηση στη σειρά κατάταξης.

Όπως έχει αναφερθεί παραπάνω, η κεντρικότητα εγγύτητας δείχνει πόσο εύκολα μια χώρα μπορεί να είναι προσβάσιμη από άλλες χώρες. Με βάση αυτήν την ερμηνεία, στο δίκτυο ρυζιού χωρίς βάρη, οι δυναμικές οικονομίες της Ασίας (Ινδία, Ταϊλάνδη, Πακιστάν), οι ΗΠΑ και οι αναπτυγμένες ευρωπαϊκές χώρες (Ιταλία, Ηνωμένο Βασίλειο, Ισπανία, Γερμανία) είναι οι πιο κεντρικές και πιο εύκολα προσβάσιμες από άλλες χώρες κόμβους. Όταν λαμβάνονται υπόψη και τα βάρη, μόνο η Γερμανία επιβιώνει στον ανταγωνισμό του πιο σύντομου μονοπατιού και συμπεριλαμβάνεται στη δεκάδα με τις υψηλότερες κεντρικότητες. Η κεντρικότητα εγγύτητας μπορεί επίσης εν δυνάμει να δείχνει προς πιο ευέλικτους κόμβους, που είναι στην προκειμένη περίπτωση η Τουρκία, η οποία βρίσκεται στο σταυροδρόμι μεταξύ ηπείρων, η Γερμανία, η Δανία και η Ολλανδία, η τελευταία πιθανόν ως κόμβος μετεπιβίβασης με τελικό προορισμό των εμπορικών προϊόντων προς άλλες χώρες της Ευρώπης. Γενικότερα, στην κεντρικότητα εγγύτητας δεν παρατηρούνται αξιοσημείωτες διαφορές μεταξύ κεντρικοτήτων ή κάποιων πολύ ξεχωριστών κόμβων με ιδιαίτερα υψηλές τιμές. Αντίστοιχα, στο δίκτυο ξυλείας, οι ίδιες χώρες με βασικό χαρακτηριστικό την εύκολη προσβασιμότητα τους από άλλες χώρες, παραμένουν στην κύρια δεκάδα μεταξύ των ετών μελέτης και είναι οι αναπτυγμένες ευρωπαϊκές χώρες, η Κίνα και οι ΗΠΑ. Συνεπώς η δομή του δικτύου ξυλείας δεν αλλάζει σημαντικά και οι ίδιοι εμπορικοί εταίροι παραμένουν. Η Νορβηγία έχοντας εκτεταμένα αποθέματα ξυλείας, κατατάσσεται στις πρώτες θέσεις στο δίκτυο με βάρη, ενώ οι ακόλουθοι κόμβοι που διατηρούν την κεντρική τους θέση μετά την πάροδο της πενταετίας είναι η Ινδία, το Ηνωμένο Βασίλειο και η Τουρκία.

Η ενδιάμεση κεντρικότητα στα εμπορικά δίκτυα, δείχνει πόσο σημαντική είναι η χώρα σε όρους σύνδεσης με άλλες χώρες και κατατάσσει σε υψηλή θέση χώρες που βρίσκονται σε μεγαλύτερη αναλογία του πιο σύντομου μονοπατιού που συνδέει ένας ζεύγος κόμβων. Στο δίκτυο ρυζιού χωρίς βάρη, οι πιο σημαντικοί διαμεσολαβητές είναι οι ΗΠΑ με μεγάλο ποσοστό, και ακολουθεί η Ιταλία, το Ηνωμένο Βασίλειο και το Πακιστάν. Μετά την

πάροδο των πέντε ετών, η Ινδία, που είναι ένας από τους μεγαλύτερους παραγωγούς ρυζιού στον κόσμο, έχει εισέλθει στην ομάδα των δέκα πιο κεντρικών χωρών και πιο συγκεκριμένα στην 3η θέση, μετά από τις ΗΠΑ και την Ιταλία. Από την δυναμική ανάλυση των δεικτών με βάρη, απορρέει ότι οι μεγάλες οικονομίες της ΕΕ (Γερμανία, Γαλλία) έχουν βελτιώσει τις κεντρικές τους θέσεις, ενώ η Ιαπωνία και το Ηνωμένο Βασίλειο πρώτες στην κατάταξη το 2011, έχουν πέσει σε λιγότερο κεντρικές θέσεις, πέντε χρόνια αργότερα. Στο δίκτυο ξυλείας, η ενδιάμεση κεντρικότητα του δικτύου χωρίς βάρη διατηρεί τα ίδια δομικά χαρακτηριστικά μεταξύ των ετών με μεγαλύτερους κόμβους την Κίνα, τις ΗΠΑ και τις σημαντικές οικονομίες της ΕΕ (Γαλλία, Ιταλία, Γερμανία) στις πρώτες θέσεις. Στο αντίστοιχο δίκτυο με βάρη, μια διαφορετική εικόνα των χωρών παρουσιάζεται με την Κορέα και το Ηνωμένο Βασίλειο, ενώ βρίσκονταν σε πιο κεντρικές θέσεις το 2011, να έχουν εκτοπιστεί το 2015 από την Ελβετία και την Νορβηγία. Η εμφάνιση της Ελβετίας ως πιο κεντρικής χώρας σε όρους του πιο ‘’σημαντικού κόμβου’’ με βάση την ενδιάμεση κεντρικότητα, είναι απόλυτα σύμφυτη με το γεγονός ότι η χώρα αυτή κατατάσσεται πρώτη σε πάρα πολλούς οικονομικούς δείκτες και είναι ένας από τους μεγαλύτερους εξαγωγείς στο κόσμο, παρά το μικρό της μέγεθος.

Σε ότι αφορά την κεντρικότητα status, αυτό που έχει σημασία είναι η κεντρικότητα των γειτονικών κόμβων, και όχι του ίδιου του κόμβου. Συνεπώς οι επόμενες χώρες είναι εμπορικοί εταίροι των περισσότερο ισχυρών, σημαντικών και κεντρικών κόμβων. Στο δίκτυο του ρυζιού χωρίς βάρη προτάσσονται οι οικονομίες της ΕΕ (Ηνωμένο Βασίλειο, Γερμανία, Ολλανδία, Ιταλία, Γαλλία, Βέλγιο, Ισπανία) και οι ΗΠΑ, ενώ στο δίκτυο με βάρη κυριαρχεί η Σαουδική Αραβία στο χρονικό διάστημα υπό μελέτη, η οποία ακολουθείται από την Ιαπωνία και τις ΗΠΑ. Είναι προφανές ότι αυτή η αναπτυγμένη χώρα της δυτικής Ασίας (Σαουδική Αραβία) που βασίζει την οικονομία της στην παραγωγή και εξαγωγή πετρελαίου, είναι εμπορικός εταίρος χωρών που έχουν προσδιοριστεί ως κεντρικές. Η Κίνα έχει ανέλθει το 2015 στην 2η θέση και αποτελεί εμπορικό εταίρο των πιο κεντρικών κόμβων, εκτοπίζοντας την Ιαπωνία και τις ΗΠΑ στις επόμενες θέσεις. Στο δίκτυο ξυλείας χωρίς βάρη οι κυρίαρχοι κόμβοι εντοπίζονται σε ΕΕ (Ολλανδία, Γερμανία, Ιταλία, Βέλγιο, Γαλλία, Ηνωμένο Βασίλειο), ΗΠΑ, Ρωσία, Κίνα και Αυστραλία, χώρες οι οποίες παραμένουν στην κεντρική δεκάδα το 2011 και το 2015, ενώ το δίκτυο με βάρη

χαρακτηρίζεται από την είσοδο του Καναδά, χώρα η οποία αποτελεί την ενδέκατη μεγαλύτερη οικονομία στον κόσμο σύμφωνα με στοιχεία του 2015, έχει αφθονία σε φυσικούς πόρους και ένα καλά αναπτυγμένο διεθνές εμπορικό δίκτυο. Ο μεγαλύτερος εμπορικός εταίρος του Καναδά, με κοντινούς γεωγραφικούς και εμπορικούς δεσμούς, είναι οι ΗΠΑ, ενώ γίνονται προσπάθειες διεύρυνσης του εμπορίου με τις ανερχόμενες οικονομίες της Ασίας.

Η κεντρικότητα pagerank, έχει συνάφεια με την ιδιοκεντρικότητα και συνεπώς και σε αυτήν την περίπτωση η κεντρικότητα των γειτονικών κόμβων είναι αυτή που συμβάλλει στην διαμόρφωση της τιμής της κεντρικότητας του κόμβου. Χώρες με υψηλές τιμές κεντρικότητας pagerank, έχουν συνδέσεις με πολλούς άλλους κόμβους, που με την σειρά τους και αυτοί συνδέονται με πολλούς άλλους. Από την ανάλυση συνάγεται ότι τόσο το δίκτυο ρυζιού χωρίς βάρη, όσο και αυτό με βάρη κυριαρχείται από ευρωπαϊκές οικονομίες (Γερμανία, Ηνωμένο Βασίλειο, Γαλλία) και από τη Σιγκαπούρη, η οποία αποτελεί βασικό οικονομικού κόμβο παγκοσμίως σε πολλούς τομείς. Η κεντρική θέση της Σιγκαπούρης δεν επιβεβαιώνεται με την πάροδο του χρόνου, καθώς απουσιάζει από τα αντίστοιχα δίκτυα πέντε χρόνια αργότερα. Οι ΗΠΑ βρίσκονται σε υψηλή κατάταξη στο δίκτυο χωρίς βάρη, χωρίς όμως να καταλαμβάνουν τις πρώτες κεντρικές θέσεις στο δίκτυο με βάρη. Αντίστοιχα στο δίκτυο ξυλείας, χώρες της ΕΕ, οι ΗΠΑ και η Κίνα παραμένουν σε κεντρικές θέσεις με την πάροδο του χρόνου στο δίκτυο χωρίς βάρη, ενώ στο δίκτυο με βάρη ηγετικές θέσεις διατηρούν οι ΗΠΑ και ο Καναδάς, με την Ρωσία να υποχωρεί από την $3^{η}$ στην $10^{η}$ θέση, που αποτελεί εν δυνάμει ένδειξη μεγαλύτερης απομάκρυνσης από κόμβους με επιρροή πιθανόν λόγω πολιτικών ανακατατάξεων που επηρέασαν την οικονομική δραστηριότητα και την ελεύθερη κυκλοφορία των αγαθών στη διεθνή εμπορική σκηνή.

Σύμφωνα με την αρχική τους σύλληψη οι δείκτες που αποκαλούνται κεντρικότητες ομφαλού και αυθεντίας (hubs & authorities) ήταν αλληλένδετοι. Συνεπώς σε ότι αφορά την κεντρικότητα authority του δικτύου ρυζιού χωρίς βάρη, παρατηρήθηκε υπεροχή των κόμβων της ΕΕ (Ηνωμένο Βασίλειο, Γερμανία, Ολλανδία) και ΗΠΑ, ενώ στο δίκτυο με βάρη είναι προφανής η υπεροχή της Σαουδικής Αραβίας, η οποία διατηρήθηκε μεταξύ των ετών μελέτης. Ενώ η Νότια Αφρική αποτελούσε στο δίκτυο με βάρη του 2011 το τρίτο

κόμβο (μετά την Σαουδική Αραβία και τις ΗΠΑ) με τη μεγαλύτερη επιρροή, έχει εκτοπιστεί το 2015 από την Σενεγάλη, γεγονός που κατά πάσα πιθανότητα είναι αποτέλεσμα της ισχυρής αλληλεξάρτησης της χώρας αυτής από τους κεντρικούς κόμβους. Ομοίως, στον τομέα της ξυλείας, τα πιο σημαντικά αποτελέσματα μπορούν να συνοψιστούν στην ηγετική θέση και στις δύο μορφές δικτύων των ισχυρών οικονομιών της ΕΕ (Ολλανδία, Γερμανία, Ιταλία, Βέλγιο, Ηνωμένο Βασίλειο, Γαλλία), της Ρωσίας και των ΗΠΑ. Από το δίκτυο με βάρη, μπορεί να συναχθεί το συμπέρασμα ότι οι ΗΠΑ έχουν ισχυροποιήσει τη θέση τους, εκτοπίζοντας τη Γαλλία σε χαμηλότερη θέση, ο Καναδάς έχει ανέλθει σε ότι αφορά τις τιμές της κεντρικότητας authority, ενώ η Ρωσία παρουσίασε πτώση, με πιθανή ερμηνεία την οικονομική ύφεση λόγω κυρώσεων και διακοπής εμπορικών σχέσεων, που την αποσυνέδεσαν από πολλούς κόμβους με υψηλές τιμές hub.

Η τελευταία κεντρικότητα, η λεγόμενη hub παρουσιάζει αξιοσημείωτα ποσοτικά αποτελέσματα. Στο δίκτυο ρυζιού με βάρη ενώ το 2011, υψηλότερες τιμές hubs παρουσίαζαν η Ινδία (36%), η Ταϊλάνδη (36%), οι ΗΠΑ (8,5%) και το Πακιστάν (7,5%), το 2015 η αναλογία έχει σχεδόν διπλασιαστεί υπέρ της Ινδίας (63,5%) με αντίστοιχη πτώση της Ταϊλάνδης (15,9%) και με Πακιστάν (7,9%) και ΗΠΑ (5,7%) να ακολουθούν. Η κυριαρχία αυτή δεν είναι προφανής από τα δίκτυα χωρίς βάρη, αν και σε αυτήν την περίπτωση οι προαναφερθείσες κεντρικές χώρες παραμένουν σε υψηλές θέσεις, χωρίς όμως να υπάρχει τόσο έντονος διαχωρισμός τους. Στο δίκτυο ξυλείας χωρίς βάρη, το Βέλγιο και η Γερμανία παραμένουν δυναμικά στις πρώτες θέσεις. Ενώ στο δίκτυο ξυλείας 2011 με βάρη η Γερμανία βρίσκεται στην πρώτη θέση με την Κίνα να ακολουθεί, πέντε χρόνια αργότερα η Γερμανία παραχωρεί τη θέση της στην Κίνα. Ο τρίτος πιο κεντρικός κόμβος το 2011 είναι το Βέλγιο, που υποχωρεί πέντε χρόνια αργότερα σε χαμηλότερες θέσεις, μετά τον Καναδά και την Χιλή, που ανήλθαν σε πιο κεντρικές θέσεις με βάση το δείκτη hub.

Από την ανάλυση στα πλαίσια της παρούσας εργασίας συνάγεται το συμπέρασμα ότι οι αναπτυγμένες οικονομίες βρίσκονται στις πρώτες θέσεις με βάση τους δείκτες που προτάθηκαν, ενώ χώρες από πιο εσωστρεφείς και λιγότερο αναπτυγμένες οικονομίες δεν καταλαμβάνουν τις πιο κεντρικές θέσεις και δεν κάνουν εύκολα συνδέσεις. Οι αναπτυγμένες οικονομίες της ΕΕ τείνουν να είναι πιο κεντρικές και να κάνουν

περισσότερους δεσμούς, σε αντίθεση με τις λιγότερο ανοιχτές οικονομίες ή απομονωμένες γεωγραφικά, που έχουν λιγότερες συνδέσεις. Το εμπόριο στους συγκεκριμένους κλάδους έχει δομές γεωγραφικού διαχωρισμού με σημαντικό ρόλο να διαδραματίζεται από τις οικονομικά αναπτυγμένες οικονομίες της ΕΕ, Αμερικής και Ασίας από τη μια και Αυστραλίας, Αφρικής και Λατινικής Αμερικής από την άλλη σε λιγότερο κεντρικές θέσεις.

Στα πλαίσια της παρούσας μελέτης έγιναν προσπάθειες για εντοπισμό πιθανόν συσχετίσεων των ιεραρχικών θέσεων των χωρών, όπως εκφράζονται από τις δικτυακές μεταβλητές και από τα μη δικτυακά χαρακτηριστικά, ως αποτέλεσμα συμβατικών οικονομικών δεικτών. Ως δικτυακές μεταβλητές χρησιμοποιήθηκαν τα μέτρα κεντρικότητας (indegree, outdegree, betweenness, closeness, status, pagerank, authority, hub) για τα έτη μελέτης 2011 και 2015 των δικτύων με βάρη και χωρίς βάρη. Ως μη δικτυακές μεταβλητές χρησιμοποιήθηκαν ο δείκτης ενδοκλαδικού εμπορίου Grubel – Lloyed για τα έτη 2011 και 2015, η αξία εξαγωγών του 2011, η αξία εξαγωγών του 2015, η αξία εισαγωγών του 2011, η αξία εισαγωγών του 2015, το κατά κεφαλήν ΑΕΠ του 2015 και κατά κεφαλή ΑΕΠ του 2015 με βάση την αγοραστική δύναμη.

Ο δείκτης indegree έχει θετική συσχέτιση με τις εισαγωγές, καθώς στην πραγματικότητα ο δείκτης αυτός αντιπροσωπεύει τις ροές εισαγωγών. Ο δείκτης outdegree είναι θετικά συσχετισμένος με τις εξαγωγές, γεγονός που δείχνει ότι όσο υψηλότερη είναι η αξία των εξαγωγών τόσο περισσότερες συνδέσεις ο κάθε κόμβος τείνει να κάνει.

Σε ότι αφορά τους υπόλοιπους μη δικτυακούς δείκτες, όπως το κατά κεφαλήν ΑΕΠ και το κατά κεφαλήν ΑΕΠ που βασίζεται στην αγοραστική δύναμη, αυτοί οι δείκτες τείνουν να παρουσιάζουν σημαντική θετική συσχέτιση με τους δείκτες indegree και outdegree. Γεγονός που οδηγεί στο συμπέρασμα ότι οι ροές εισαγωγών και εξαγωγών, έχουν άμεση σχέση με το κατά κεφαλήν επίπεδο εισοδήματος.

Μια πιθανή ερμηνεία για την θετική συσχέτιση των δεικτών status, authority και pagerank με τις εισαγωγές και το ΑΕΠ, είναι ότι η υψηλότερη κεντρική θέση ενός κόμβου με βάση την κεντρικότητα των γειτονικών κόμβων, συσχετίζεται με υψηλότερη αξία εισαγωγών και υψηλότερο επίπεδο εισοδήματος.

Οι εισαγωγές και οι εξαγωγές έχουν σημαντική θετική συσχέτιση με τον δείκτη betweenness, που αποτελεί ένδειξη ότι όσο πιο σημαντική είναι μια χώρα ως συνδετικός κρίκος μεταξύ κόμβων, τόσο υψηλότερη είναι η αξία των εισαγωγών και εξαγωγών.

Σχετικά με τη μη δικτυακή μεταβλητή του ενδοκλαδικού εμπορίου, όπως είναι ο δείκτης Grubel – Lloyed, η περίπτωση ισχυρής συσχέτισης με τους δείκτες indegree και outdegree θα μπορούσε να αποτελέσει ένδειξη ύπαρξης προτιμήσεων ενδοκλαδικού εμπορίου. Δυστυχώς, δεν παρατηρήθηκε συσχέτιση μεταξύ του δείκτη Grubel – Lloyed και των δεικτών indegree και outdegree. Συνεπώς δομές ενδοκλαδικού εμπορίου δεν μπόρεσαν να προσδιοριστούν από τις δικτυακές μεταβλητές και από τη σχέση τους με τις μη δικτυακές μεταβλητές στα πλαίσια αυτής της μελέτης.

Γενικότερα, από την δυναμική ανάλυση του δικτύου ρυζιού και ξυλείας μεταξύ των ετών 2011-2015 προέκυψε ισχυρή συσχέτιση των ίδιων δικτυακών μεταβλητών μεταξύ των ετών, που θα μπορούσε να αποτελέσει ένδειξη ότι παρά τις παγκόσμιες μεταβολές, οι ηγέτιδες χώρες στις εξαγωγές των συγκεκριμένων προϊόντων δεν επηρεάστηκαν σημαντικά. Ένα επιπρόσθετο συμπέρασμα είναι ότι οι κυρίαρχες εξαγωγικές χώρες των συγκεκριμένων προϊόντων που σχετίζονται άμεσα με τον πρωτογενή τομέα της οικονομίας είναι σταθερές στην εμπορική τους συμπεριφορά και μπορούν να είναι αρκετά ευέλικτες ώστε να αναπροσαρμόσουν τους εμπορικούς τους εταίρους, σε περίπτωση ανάγκης.

Επίσης το γεγονός ότι η συσχέτιση των δικτυακών μεταβλητών μεταξύ των ετών είναι θετική, ενισχύει την αντίληψη ότι οι μεγαλύτεροι εξαγωγείς στους κλάδους του ρυζιού και της ξυλείας, δεν βίωσαν μεγάλες δομικές μεταπτώσεις στους ασταθείς καιρούς της οικονομικής κρίσης, διατηρώντας στις περισσότερες περιπτώσεις την κεντρική τους θέση. Πολύ πιθανόν αυτές οι χώρες διέθεταν την ικανότητα να απορροφήσουν αυτές τις εξωτερικότητες μέσω προσαρμογής της συμπεριφοράς των μονάδων λήψης αποφάσεων και εύρεσης νέων συνεργασιών, ενδεχομένως αντικαθιστώντας τις παραδοσιακές αγορές εξαγωγής από νέες ή αυξάνοντας τις εμπορικές ροές. Επιπλέον μπορεί να προβλεφθεί ότι οι χώρες που έχουν επηρεαστεί από την οικονομική αστάθεια, τείνουν να γίνουν πιο εξωστρεφείς και προσπαθούν να κάνουν νέες συνδέσεις, που οφείλεται στους μηχανισμούς αυτοσυντήρησης και επιβίωσης στον ανταγωνιστικό κόσμο της ροής των αγαθών και των υπηρεσιών.

Επιπλέον στα παραπάνω συμπεράσματα, που έχουν σχέση με τις δομές του εμπορίου μεταξύ των χωρών, επιπρόσθετες αλληλεπιδράσεις των οικονομικών συνδέσεων μπορούν να διερευνηθούν. Η εξάρτηση του εμπορίου μεταξύ των χωρών και μεταξύ κλάδων της οικονομίας από τον βαθμό της οικονομικής ανάπτυξης ή της γεωγραφικής θέσης και του συγκριτικού πλεονεκτήματος λόγω κλιματολογικών συνθηκών ή εποχικότητας στην παραγωγή προϊόντων του πρωτογενή τομέα, θα μπορούσαν να αναλυθούν. Επίσης, η ιδέα ότι οι μεγαλύτερες χώρες διέπονται από εμπορικές δομές, με την τάση να εμπορεύονται περισσότερο από ότι οι μικρότερες και πιθανές προτιμήσεις σε λίγες συνδέσεις με υψηλή αξία παρά σε πολλές συνδέσεις χαμηλής αξία, θα μπορούσε να αποτελέσει αντικείμενο μελλοντικής έρευνας. Επίσης δομές μικρών οικονομιών, και η τάση τους να είναι πιο ανοιχτές και εξωστρεφείς μπορούν να μελετηθούν. Ιδιαιτέρως στην περίπτωση διευρυμένων δικτύων ανά κλάδο οικονομίας, που χαρακτηρίζονται από μεγάλες διαστάσεις και ισχυρή ανομοιογένεια, λόγω του μεγέθους τους, η δομή ολόκληρου του δικτύου με όλους τους υπαρκτούς κόμβους μπορεί να αναλυθεί, συνεισφέροντας επιπρόσθετη και συμπληρωματική πληροφορία σε σχέση με συμβατικούς οικονομικούς δείκτες. Η ανάλυση δικτύων μπορεί να γίνει φορέας σημαντικής προστιθέμενης αξίας στην μελλοντική έρευνα που θα αφορά το εμπόριο αγροτικών προϊόντων και τον πρωτογενή τομέα της οικονομίας γενικότερα.

INTRODUCTION

Aim of this paper is to analyze international trade of agricultural and forest products, applying network theory. Particularly, centrality measures will be used. The countries will be ranked in hierarchies of import-export relations and these hierarchies will be visualized.

The networks are dynamically described within and between 2011 and 2015 years. The benefit that is received from representing the inter-country trade as a network of either trade partnerships or trade flows is the possibility to depict the interactions between trading countries and their hierarchies which otherwise remain indiscernible. Moreover, effort will be made in detecting possible correlation between the hierarchical position of the countries expressed by network variables and their non-network characteristics resulting from conventional economic indicators. Each network is examined in both unweighted or binary form and in weighted or valued form. Unweighted or binary networks include links based on partnerships, where occurrence of the interaction equals one and no occurrence equals zero. On the other side, in weighted or valued networks the occurrence of trade link is accompanied by specification of the economic value of export flows. The centrality measures, weighted and unweighted, that will be used are indegree, outdegree, closeness, betweenness, status, pagerank, hubs and authority. Degree centrality measures how a country is connected to other countries, closeness centrality measures how easily a country can be reached by other countries, betweenness centrality measures how important is a country in terms of connecting other countries and finally eigenvector related centralities measures how important are neighboring countries.

In order to justify also the use of binary measures, rather than only of weighted networks we have to note that both measures are useful as they point to different aspects. Weighted measures put emphasis on volumes while binary measures give prominence also on the number of trade interactions of a country. Both weighted and unweighted centrality measures are useful and can provide complementary information.

The organization of the structure of international trade for a given product can provide valuable information about trade patterns and might differ according the type of goods traded. When the product is homogeneous and the trade based on the lowest price offered, one or few partners tend to monopolize the market, thus creating market structure with few

vertices, few links and few interactions. When on the other side the product is differentiated and is subjected to monopolistic competition terms, many trading partners can possibly claim their part in the world market share, so many vertices will appear and consequently many links will be sent from one partner to another.

Before proceeding to network analysis some definitions related to market characteristics are mentioned. It is important to explain perfect competition principles in order to understand the market structure of monopolistic competition. Theoretically, the term of perfect competition has some distinctive characteristics. These characteristics are large number of buyers and sellers, perfect information about prices and product utilities, perfect substitutability of the products, no barriers to entry and exit, no party involved with market power to set prices, the factors of production are flexible to adjustments in the long run thus allowing changes in the market conditions, with main goal of trading parties being profit maximization, buyers are rational and try to increase their economic utility, there are no externalities affecting any private or public third party, no transaction cost and no economies of scale exist. In the real world of trade, markets are not subjected to perfect competition terms, but instead they are imperfect. One type of imperfect competition is monopolistic competition, when the principle of substitutability is no valid and the product is produced in many varieties and qualities. Structures similar to monopolistic competition exist in the industry of cereals and wood that is object of study in the present work.

So market structure and the existence of many or few links is defined by product differentiation. There are also other factors that define market structure. One of them can be transport costs, that might depend on weight, on vulnerability of the product, on selling price – freight ratio etc. Another considerable determinant of structure patterns is geographic proximity. Both geographic proximity and transport costs are interconnected in generation of links in international trade terms. In case of countries with high workload, the transport costs are minimized per item, so the final price is not affected and vital role is played by on time planning, when low transport costs are provided on the prerequisite of the use of inexpensive transport modes, such as transportation by sea. When the product traded is sensitive or has to be delivered in a short length of time, the barriers based on geographic proximity continue to exist, since the final product price is extremely increased.

In case of present sectoral analysis, the two sectors examined (rice and wood sectors) are not sensitive to transportation and inexpensive means of transport can be used in order for the costs related to transportation to be minimized. Other factors that define the creation of links between countries are religion, tradition or former colonial relationships. Also, additional reason for link occurrence is the possibility of profit due to price difference between countries or the possibility of exploiting economies of scales in production and the preference for variety and differentiated products. In this differentiated goods context very dense trade networks are expected. On the other side the search and the access costs to foreign markets will tend to reduce the number of arcs between each country pair (Helpman et al, 2008).

Influence on the structure and formation of the arcs in trade network is exercised also by the conditions of production, supply and demand. The production of a product is affected on the supply side by comparative advantage, weather conditions, possession of raw materials, technological expertise etc. On the demand side the trade links are formed by preferences of trade partners. Generally, it is important from microeconomic point of view to define the trade patterns, with the help of network analysis and its tools, since valuable information can be deduced concerning the economic model of supply and demand, which is fundamental in price determination in international trade networks.

In the present thesis, the main goal is to explore and compare the diverse structural characteristics of two distinctive agricultural sectors, the sector of rice and the sector of wood. Taking into consideration specific hypotheses that shape a network model of international trade, an effort is made to investigate the structural differences in networks formed, according the characteristics related to the product type and to node features. The structure of these two sectors is compared, to assess the extent the world market attributes vary between different sectors. The hypothesis of more dense networks for differentiated products and less dense networks for homogeneous products will also be considered.

The structure of the present thesis is the following. In Chapter 1 literature review and definitions of basic centrality measures used are presented, Chapter 2 refers to methodology, Chapter 3 to results, Chapter 4 to discussion and Chapter 5 concludes.

CHAPTER 1: LITERATURE REVIEW AND NETWORK BASICS

1.1 Literature review

Network analysis has been used in the past to analyze international networks by Fagiolo et al. (2009), Garlaschelli & Loffredo (2005), Serrano & Boguna (2003). Also network analysis has been applied to networks of single commodities by De Benedictis et al., (2010; 2013). An application of network analysis in agriculture was the potato trade network by Kleinwechter & Suarez (2012). Moreover, investigation of the time evolution of world trade in terms of hub-authority is shown in Deguchi et al. (2014). The correlation of economic hubs and authorities will be examined in the present agricultural and forest networks for a wide sample of 50 countries. Network analysis has been used also by Raskovic et al. (2015) to study inter-country export patterns of EU member states and showed that small states do not necessarily focus their exports more on neighbouring markets compared to large states.

1.2 Network basics

The main characteristics of two networks under examination are summarized by indices computed and reported in Appendices. These attributes used to characterize the network structure are centrality measure of indegree, outdegree, betweenness, closeness, status, authority, pagerank and hub. Each of them provide different type of information, capturing different aspect of country's position. Indegree and outdegree centrality measures are considered local, whereas all the other centrality measures in consideration in the present thesis are global measures. Degree centralities are local measures because only direct connections of a vertex are considered, while the remaining centrality indexes are global, with their central position depending on the central position of their neighbors.

A brief review and a few definitions of main centrality measures are presented below, for a given graph $G = (V, E)$ with V vertices and E edges. In unweighted graph, the degree centrality equals degree:

$C_D(u) = deg(u)$, $C_{iD} = indeg(u)$, $C_{oD} = outdeg(u)$

In weighted graphs, the indegree and outdegree centrality of a node is defined as the sum of the strengths of incoming and outgoing links respectively. For standardization purposes the degree centralities are divided by $(n-1)^{-1}$, because (n-1) is the maximum possible degree in an unweighted simple graph.

The normalized closeness is defined as the average length of the shortest path between the vertex and all other vertices:

$$C_C^{©}(u) = (C_C(u))/(N-1)$$

where $C_c(u) = \left[\sum_{u=v}^{N} d(u,v)\right]^{-1}$ and *d(u,v)* is the distance between *u* and *v*.

For directed graph, beetweenness centrality is defined as following:

$$C_B(u) = \sum_{j<k} g_{jk}(u) / g_{jk}$$

The common normalized definition of the formula for betweenness centrality is:

$$C_B^{©}(u) = C_B(u)/[(n-1)(n-2)]$$

For the purpose of this study, instead of the above standardization, the scaling to percentage values is suggested, which is used by Visone software.

Considering the following centralities the ranking of a node depends on the ranking of its neighbors, which means that node is more central, the more central its neighbors are. One of these centralities, Katz status, is considered as a generalization of degree centrality and it was introduced by Katz (1953). The status centrality of directed and weighted graph with edge ω is defined as following:

$$C_{KS}(u) = a\sum_{(u,v)} \omega((u,v)(1+c_{KS}(u)))$$

where

$1/\alpha = min\ \{\ max\ indeg_{\omega}(u),\ max\ outdeg_{\omega}(u)\}\ ,\ u \in V$

Hubs and Authorities are centralities introduced by Kleinberg (1999). Authorities C_A and Hubs C_H centralities with edge strength ω are defined as the normalized values of:

$$C_A(v) = \frac{1}{\lambda} \cdot \sum_{(u,v) \in E_{(u)}} \omega\big((u,v)\big) \cdot \Big(\sum_{(u,\omega) \in E_{(u)}} \omega\big((u,\omega)\big)\ C_E(\omega)\ \Big)$$

where λ is the largest eigenvalue of the matrix $A^T A$.

$$C_H(v) = \frac{1}{\lambda} \cdot \sum_{(u,v) \in E_{(u)}} \omega\big((v,\omega)\big) \cdot \Big(\sum_{(u,\omega) \in E_{(u)}} \omega\big((u,\omega)\big)\ C_E(u)\Big)$$

where λ is the largest eigenvalue of the matrix AA^T

And PageRank centrality is the combination of eigenvector centrality with a uniform initial score assigned to each node and was developed by Larry Page and Sergey Brin (1998). For directed graph $G = (V, E)$ with edge strength ω, PageRank is defined as the normalized values of:

$$C_{PR}(v) = \alpha\ \frac{1}{n} + (1 - a) \sum_{(u,v) \in E_{(u)}} \omega\big((u,v)\big) \cdot C_{PR}(u),$$

where $0 < \alpha < 1$ is a free parameter.

Moreover in order to examine whether the network is dense and widespread or centralized around a dominating hub, more attributes will be calculated to analyze those network properties and characteristics

The density *D* of a network is defined as a ratio of the number of edges *E* to the number of possible edges:

$$D = \frac{2E}{N(N-1)}$$

Average degree <*k*> of a network is defined as following:

$$< k > = \frac{2E}{N}$$

Clustering coefficient was introduced by Watts and Strogatz (1998), as a local density measure for the neighborhood of a node and it represents the likeliness that two neighbors of a vertex v ∈ V are connected. A definition of clustering coefficient in terms of triangles and triples of a node is presented below. Triangle $\lambda(v)$ is a complete subgraph of three nodes and Triple $\tau(v)$ is a subgraph of three nodes and two edges. The clustering coefficient of a node v ∈ V is defined below:

$$\mathrm{cc(v)} = \frac{\lambda(v)}{\tau(v)}$$

CHAPTER 2: METHODOLOGY

The market networks of rice and wood sectors, selected as a case study, follow International Trade Centre classification. Product code 1006, namely "Cereals – Rice" and product code 4411, namely "Wood and articles of wood; wood charcoal – fibreboard of wood or other ligneous materials, whether or not agglomerated with resins or other organic bonding agents" refer to rice and wood sectors respectively. The reason these specific product codes were selected for analysis, is because cereals, rice included, are among the most traded agricultural products, generating high world economic value, with rice being the basic food product in many highly populated countries and on the other side the selected wood product code is of great interest because it is closely related to economy sector that concerns wood industry. Generally, it is useful the structures of agricultural trade networks to be explored, because products belonging to primary sector of the economy, are used by many countries as policy tool which often results in differentiated interactions between countries that tend to change their traditional export markets, according to policy restrictions rather than free market rules. Also the sectors selected, do not require high specialization and concerns products that can be produced by most countries, both developed and developing. Thus, we can expect the structure of inter - country trade on these agricultural and forest products to be similar in several countries.

We start out with constructing bilateral trade matrices (Appendix Table 1-4) from trade data provided by International Trade Centre and UN COMTRADE database. Total exports and imports of 50 most important exporters according the trade volumes are used for the years 2011 and 2015. Our aim is to identify trade structures of export countries, trade preferences of importing and exporting the same product and discover possible interactions between network and not network variables.

Due to disadvantage of missing values for some countries, the countries in rice sector are reduced to 45 and in wood sector to 47. Countries with no available data for the years of study, even though included in the 50 greatest rice exporters are Viet Nam, United Arab Emirates, Myanmar, Suriname, Lebanon and Bangladesh. Countries omitted from wood sector, even though also included in the 50 greatest exporters in the selected wood product are Viet Nam, United Arab Emirates and Bolivarian Republic of Venezuela.

Both weighted and unweighted version of networks will be analyzed. The unweighted matrices are based on trade partnerships, while the weighted matrices are based on the value of trade flows between each pair of countries.

The software used was Visone 2.16, because it uses interactive graphical user interface, tailored to social networks and assist us to get the trade patterns through analysis of different types of centralities. Also the statistical package SPSS was used and the conventional statistical tests (Spearman rho) implemented in order to realize the dynamic network analysis from 2011 to 2015 and to explore relation between structures and between non-network and network variables.

Visone software suggests the percentage method for computation of centralities instead of traditional standardization or computation of pure values. The normalization proposed, suggest division by the sum of all scores and achieve to overcome the limitation related to graph size and is applicable to all types of graphs. The resulting indices can be perceived as percentage values and represent the share of the significance of a vertex in its graph (Baur, 2008).

CHAPTER 3: RESULTS

In this chapter the main findings of the analysis, are presented. Results of every centrality measure, for two sectors, between the years of study, will be analyzed and compared.

3.1 Density and basic network characteristic

In the following section four networks based on sectoral data and related to primary sector of economy are analyzed and compared. These networks are called from now on: rice2011, rice2015, wood2011, wood2015.

The *V* dimension of the graph is *V = (1,…45)* for rice network and *V = (1,..,47*) for wood network, according to the available data for 50 leading exporters of commodities under examination. The number of links and some basic network statistics are mentioned in the Table 3.1. The link dimension of rice2011 network is *L= (1,…607),* of rice2015 network is *L= (1,…688),* of wood2011 network is *L= (1,…1049)* and of wood2011 network is *L= (1,…1141)*. The links are directed from the exporting country towards the importing country. The information included in the link dimension is either binary or valued. In case of binary network, existence of a trade link equals one and non existence equals zero, while in case of valued network the strength of the link is introduced into the link and represents the export volumes.

In wood network, the existence of 1049 links for 2011 and of 1141 links for 2015 corresponds to network density of 0,641 and 0,675 respectively. Concerning the more sparse rice network the existence of 607 links for 2011 and 688 links for 2015 corresponds to network density of 0,465 and 0,5 respectively. Density has increased between years, for wood and rice networks, around 6% and 7% respectively, while links are increased between years 8% and 12% respectively. One observation, from the aforementioned changes between years and between sectors is that probably wood industry is more difficult to entry compared to rice sector, because connections between countries are increased at a slower pace. Density of a network is defined as the number of existing connections to the number of possible ones, thus the fact that the existing links are increased between the last years, imply greater world integration on sectors under consideration. A general remark based on present research and preceding studies is that networks tend to become more dense throughout the years. Another note is that

commodities from the primary sector are not influenced strongly by the effects of economic crisis, since they address to products directed to satisfaction of basic needs. These networks can be characterized by high dimensionality given the fact that almost 50 nodes participate in each network and also they are heterogeneous in centrality scores, that differ on the basic question posed. For example degree centrality index answers on how well connected is a network, closeness centrality answers on how easily reachable are the nodes, betweenness centrality answers on how important are the nodes by measuring the fraction of paths connecting all pairs of countries and eigenvector related centralities, like hub and authorities, measure how important are other countries, when the score of a vertex depends on the score of its neighbors.

Table 3.1: Network statistics (Rice/ Wood sectors)

Network statistics	Rice sector 2011	Rice sector 2015	Wood sector 2011	Wood sector 2015
Density	0,465	0,5	0,641	0,675
Average degree	26,978	30,578	44,638	48,553
Average in / out degree	13,489	15,289	22,319	24,277
Nodes	45	45	47	47
Links	607	688	1049	1141

Note: Software used was Visone 2.16.

3.2 Centralities

3.2.1 Indegree index

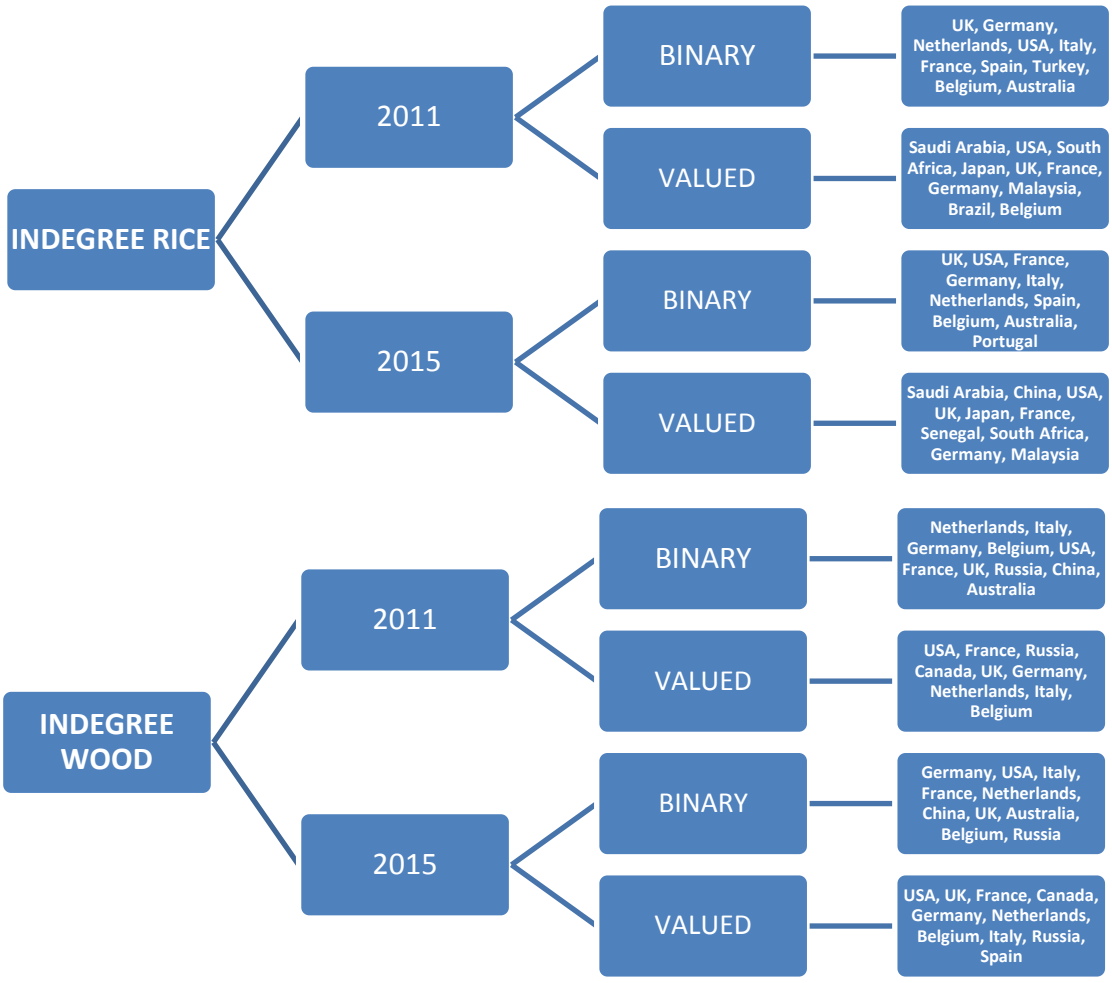
Degree centrality is the number of connection a node has. Indegree centrality reperesents the imports whereas outdegree centrality the exports. That is why the prevalence of outdegree over indeegree in weighted networks indicates an overall trade surplus, which is a conventional trade indicator (de Benedictis et al, 2013).

From weighted indegree centrality for 2011 rice network, it is observed that leading Asian economies (Saudi Arabia, Japan), USA and South Africa are in the first places, followed by leading EU economies (UK, France, Germany) and Malaysia. From 2015 data the leading Asian economies (Saudi Arabia, Japan), USA, UK, France and Germany remain in the first places, while China went up from 14^{th} place to 2^{nd}. In case of unweighted indegree centrality for 2011, the leading EU economies, USA, Turkey and Australia are in the ten first ranking places. The same structure of centralities is observed for 2015.

In weighted 2011 wood netework, the countries with the highest indegree centrality in descending order are USA, France, Russia, Canada, UK, Germany, Netherlands, Italy and Belgium. There are considerable differentiation in centrality indexes between two first highly centralized nodes and the remainder vertices. In binary 2011 version, the countries with the highest indegree centrality are Netherlands, Italy, Germany, Belgium, USA, France, UK, Russia, China and Australia. The indegree centrality is almost the same for these countries, with very small deviation. In weighted 2015 version, the countries with the highest indegree centrality are USA, UK, France, Canada, Germany, Netherlands, Belgium and Italy. There are considerable differentiation in centrality indexes between the first highly centralized vertex and the next ones. Very small differences in ranking between 2011 - 2015 are observed, with the same countries dominating in the first ten places. In binary 2015 version, the countries with the highest indegree centrality in descending order of centralization are Germany, USA, Italy, France, Netherlands, China, UK, Australia, Belgium and Russia. The indegree centrality is again almost similar for these countries with very small deviation. Between 2011 - 2015, almost the same countries keep their positions as highly centralized.

Below, in Figure 1, indegree centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 1: Indegree index



Note: Rice and wood networks, valued and binary, 2011/2015.

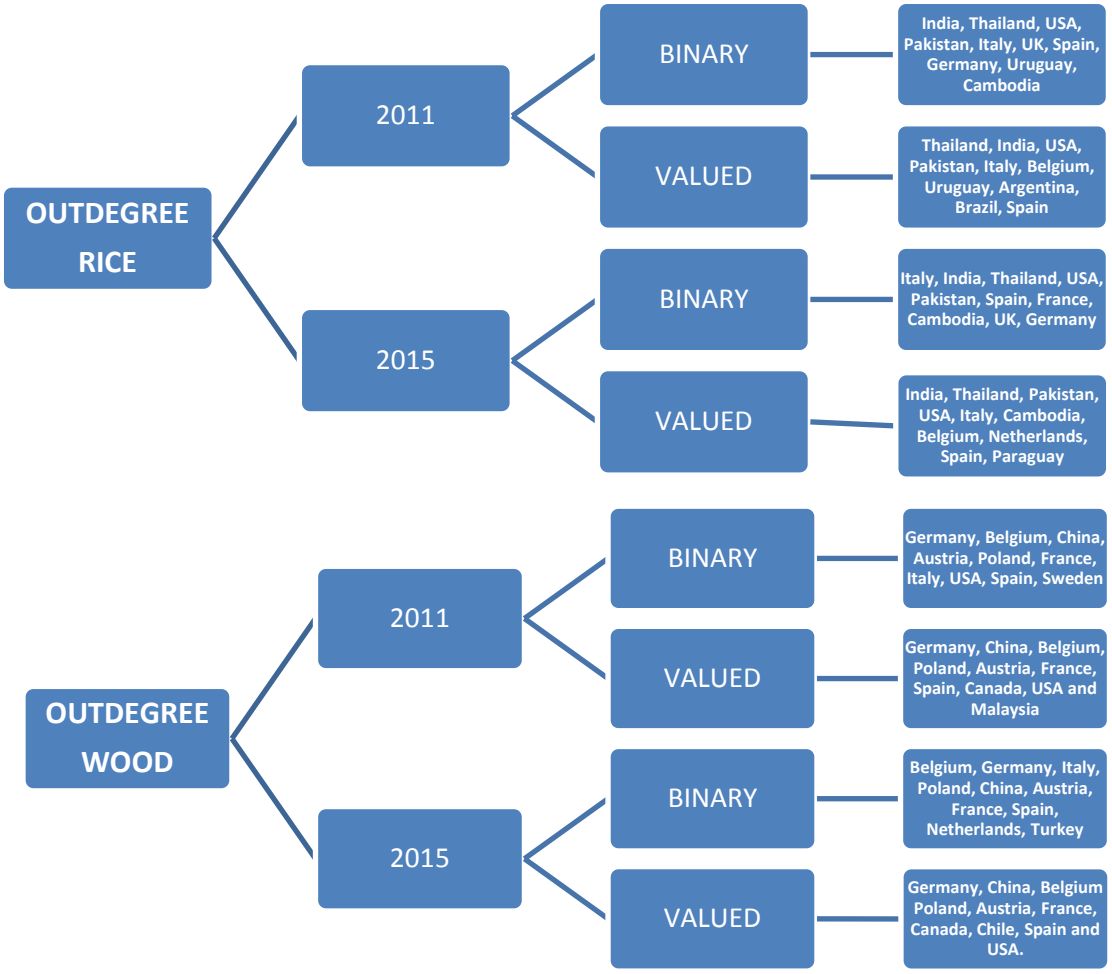
3.2.2 Outdegree index

In weighted 2011 rice network, more central nodes according outdegree measure are Thailand, India, Pakistan, USA and developed EU countries (Italy, Belgium). The same countries remain as highly scored (India, Thailand, Pakistan, USA, Italy, Belgium) while Cambodia goes up from 12^{th} place to 6^{th}. In the unweighted version both for 2011 and 2015, the rankings of the above countries follow similar structure. It should be noted that for these EU countries that present high indegree and outdegree centrality scores at the same time, there might be an indication of presence of intra-industry trade. These countries that coincide in highly ranked group of ten in both indegree and outdegree indices are USA, Belgium and Brazil in weighted version and UK, Germany, USA, Italy and Spain in unweighted version. Generally when we look at unweighted centrality measures the network tend to show only the interconnection between countries and does not discriminate according the bilateral trade volumes.

In weighted 2011 wood network, the countries with the highest outdegree centrality in descending order are Germany, China, Belgium, Poland, Austria, France, Spain, Canada, USA and Malaysia. There are considerable differentiation in centrality index of Germany and China, compared with the countries that follow. In binary 2011 wood version, the countries with the highest outdegree centrality in descending order are Germany, Belgium, China, Austria, Poland, France, Italy, USA, Spain, Sweden. In weighted 2015 version, the countries with the highest outdegree centrality in descending order are Germany, China, Belgium, Poland, Austria, France, Canada, Chile, Spain and USA. There are considerable differentiation in centrality index of Germany and even China to a lesser extent with countries that follow. In binary 2015 version, the countries with the highest outdegree centrality are Belgium, Germany, Italy, Poland, China, Austria, France, Spain, Netherlands, Turkey. The binary outdegree classify almost all countries with similar values of centrality index, with no remarkable differentiation observed.

Below, in Figure 2, outdegree centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 2: Outdegree index



Note: Rice and wood networks, valued and binary, 2011/2015.

The weakness of degree centrality, considered local measure, is that it counts your neighbors but not whether or not they count. So the following global measures are also introduced. Global indicators (closeness, betweenness, status, pagerank, authority and hub) are suitable for the analysis of countries with an intermediate degree of integration (de Benedictis, 2013). In more dense network local and global indicators provide more similar results.

3.2.3 Closeness index

Concerning closeness centrality, it is known that the lesser one country is directly linked to other countries, the lower will be its closeness centrality. Also, It is observed that countries with long geodesic distances and lower weighted closeness centrality are less developed and geographically more isolated (Raskovic et al., 2015).

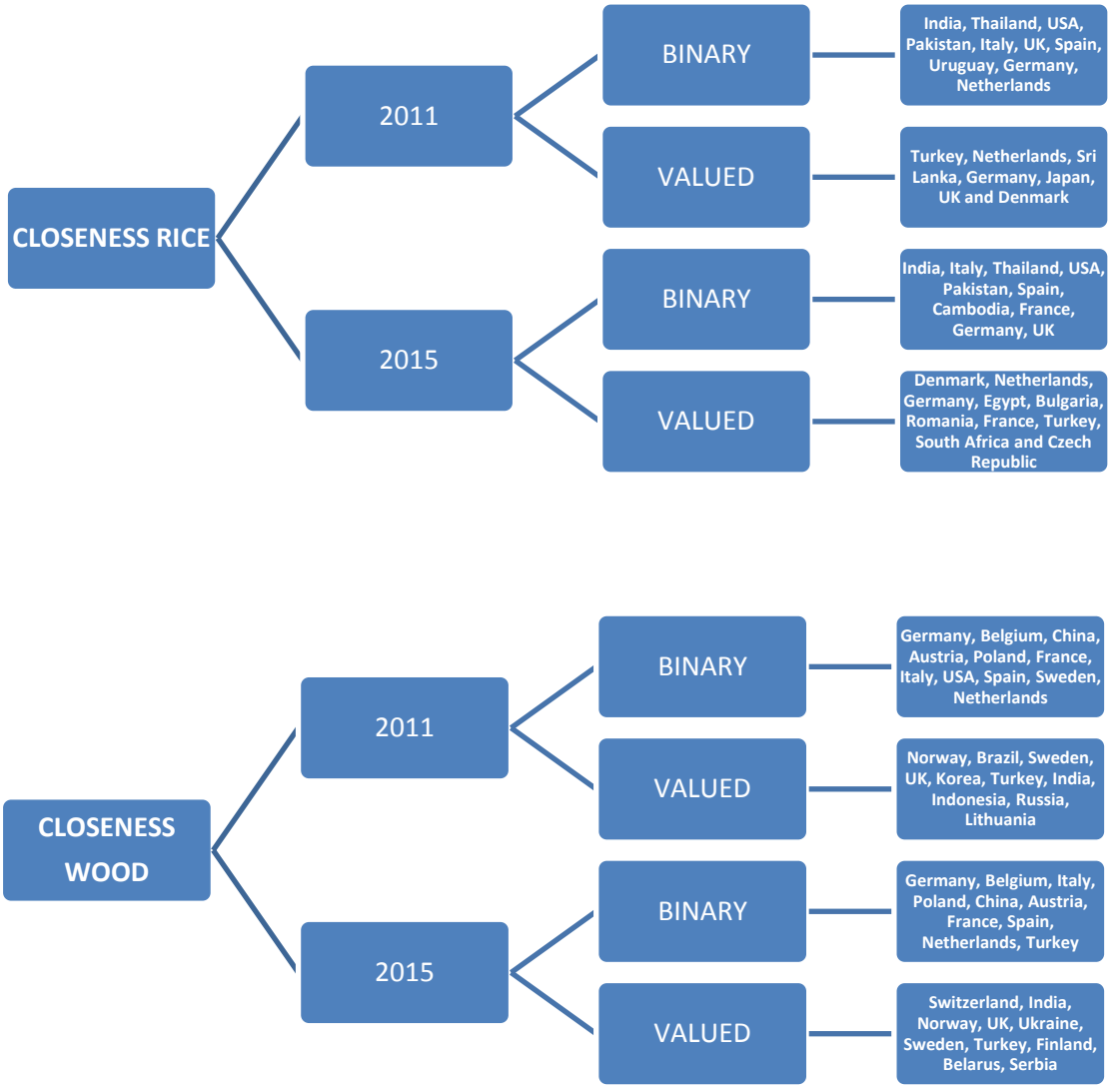
Concerning weighted closeness centrality of rice sector for 2011, it highlights the importance of two groups of countries, on one side there are Turkey, Netherlands, Sri Lanka, Germany, Japan, UK and Denmark with closeness percent centrality around 4% for each node and on the other side there are Czech, Poland, Russia, Bulgaria, Spain, Belgium, Singapore, China, Hong Kong and South Africa with closeness percent centrality around 3% for each node. As for weighted closeness rice centrality for the year 2015 the countries occupying the first ten places are Denmark, Netherlands, Germany, Egypt, Bulgaria, Romania, France, Turkey, South Africa and Czech Republic. In unweighted version for rice sector for 2011 and 2015, closeness measure for almost the same countries (India, Thailand, USA, Pakistan, Italy, UK, Spain, Uruguay, Germany, Netherlands for 2011 and India, Italy, Thailand, USA, Pakistan, Spain, Cambodia, France, Germany, UK respectively for 2015) classify them in the first ten places. This fact, highlights the importance and stability of India, Thailand, USA and Italy in the world rice trade in the mentioned time period and the fact that they are directly linked to many other countries in the network.

In weighted 2011 wood network, the countries with the highest closeness index in descending order are Norway, Brazil, Sweden, UK, Korea, Turkey, India, Indonesia, Russia and Lithuania. There is no distinctively differentiated node with the very high closeness index. In binary 2011 wood version, the countries with the highest closeness centrality in descending order are Germany, Belgium, China, Austria, Poland, France, Italy, USA, Spain, Sweden and Netherlands. Again we can observe that in closeness centrality there is no vertex that stands out due to its relative high value. In weighted 2015 wood version, the countries with the highest closeness index in descending order are Switzerland, India, Norway, UK, Ukraine, Sweden, Turkey, Finland, Belarus and Serbia. In binary 2015 wood version, the countries with the highest closeness centrality in descending order are Germany, Belgium, Italy, Poland, China, Austria, France, Spain,

Netherlands, Turkey. The nodes that form the network change significantly, probably due to the fact that binary centrality takes into account only the trade links, and conducts its analysis irrespectively of trade volumes.

Below, in Figure 3, closenesss centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 3: Closenesss index



Note: Rice and wood networks, valued and binary, 2011/2015.

3.2.4 Betweenness index

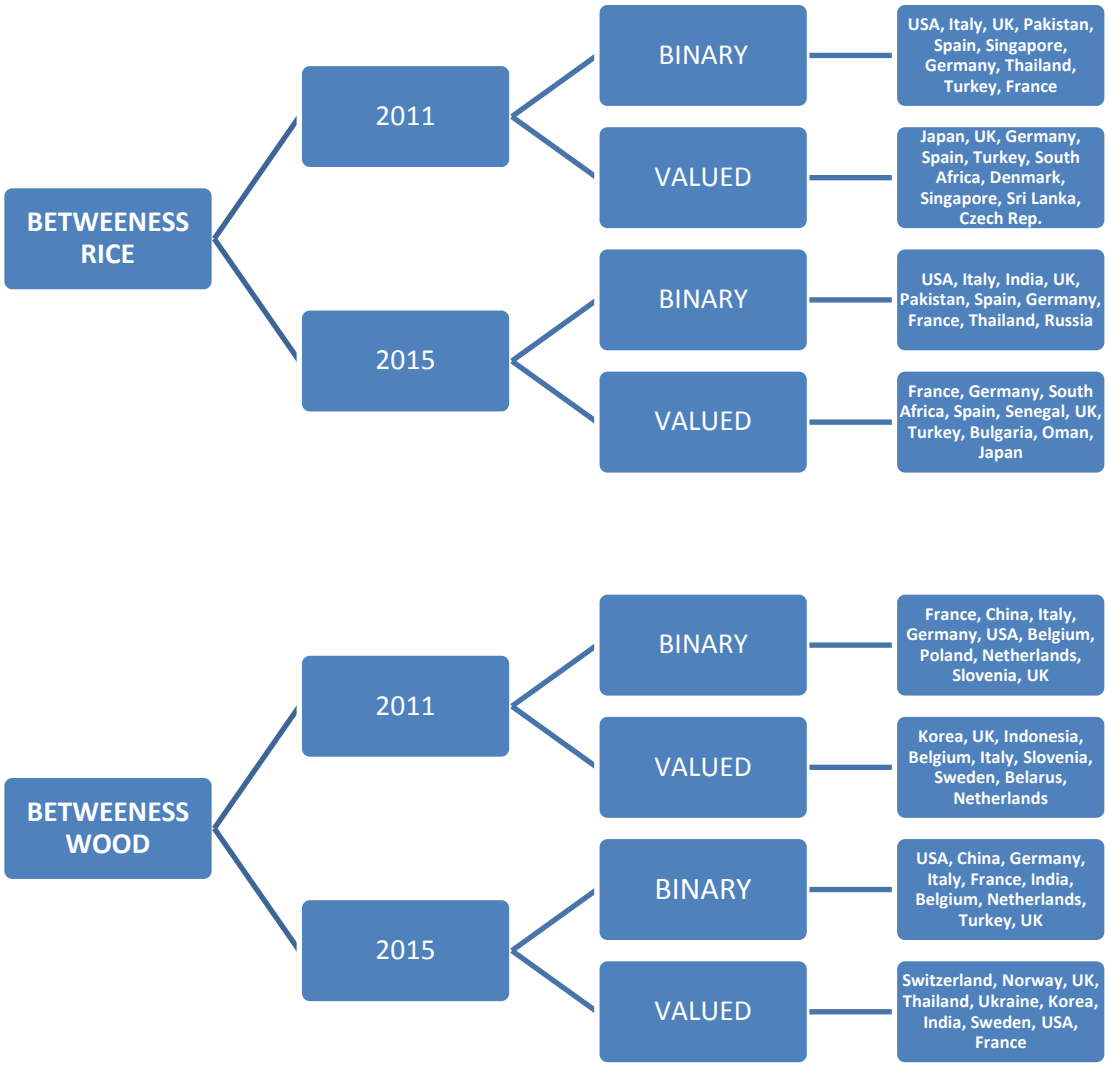
Usually nodes with high betweenness centrality are interesting because they control information flow in a network.

Regarding weighted betweenness indicators of 2011 rice network, the country of Japan, strong EU economies (UK, Germany, Spain), Turkey, South Africa, Denmark, Singapore, Sri Lanka, Czech Republic present the highest centrality scores. In 2015 the countries that are highly ranked are France, Germany, South Africa, Spain, Senegal, UK, Turkey, Bulgaria, Oman, Japan. Looking at the unweighted betweenness index for 2011, only Sri Lanka, UK, Spain and Singapore are found in the first group of ten. Japan the former highest scored is removed to a completely different centrality position.

In weighted 2011 wood network, the countries with the highest betweenness index in descending order of centrality ranking are Korea, UK, Indonesia, Belgium, Italy, Slovenia, Sweden, Belarus and Netherlands. The centrality indexes of Korea and UK has almost the double value compared with the countries that follow. In binary 2011 wood version, the countries with the highest betweenness centrality are France, China, Italy, Germany, USA, Belgium, Poland, Netherlands, Slovenia and UK. The centrality of the first five countries are distinctively higher. In weighted 2015 wood version, the countries with the highest betweenness index in descending order are Switzerland, Norway, UK, Thailand, Ukraine, Korea, India, Sweden, USA and France. The centrality of Switzerland is very high, with Norway presenting high index value as well. In binary 2015 wood version, the countries with the highest betweenness centrality are USA, China, Germany, Italy, France, India, Belgium, Netherlands, Turkey and UK. The two most highly ranked nodes, have almost equivalent centrality scores.

Below, in Figure 4, betweenness centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 4: Betweenness index



Note: Rice and wood networks, valued and binary, 2011/2015.

As suggested by Ladias et al. (2011) nodes with high betweenness are important in the field of agricultural production and international trade because the determination of macroregions or macrostructures assist, industries or producers, to rational decision making and to achieve optimal accessibility to markets within economic macro-regions, that are defined based on some common characteristics rather than arbitrarily.

3.2.5 Status index

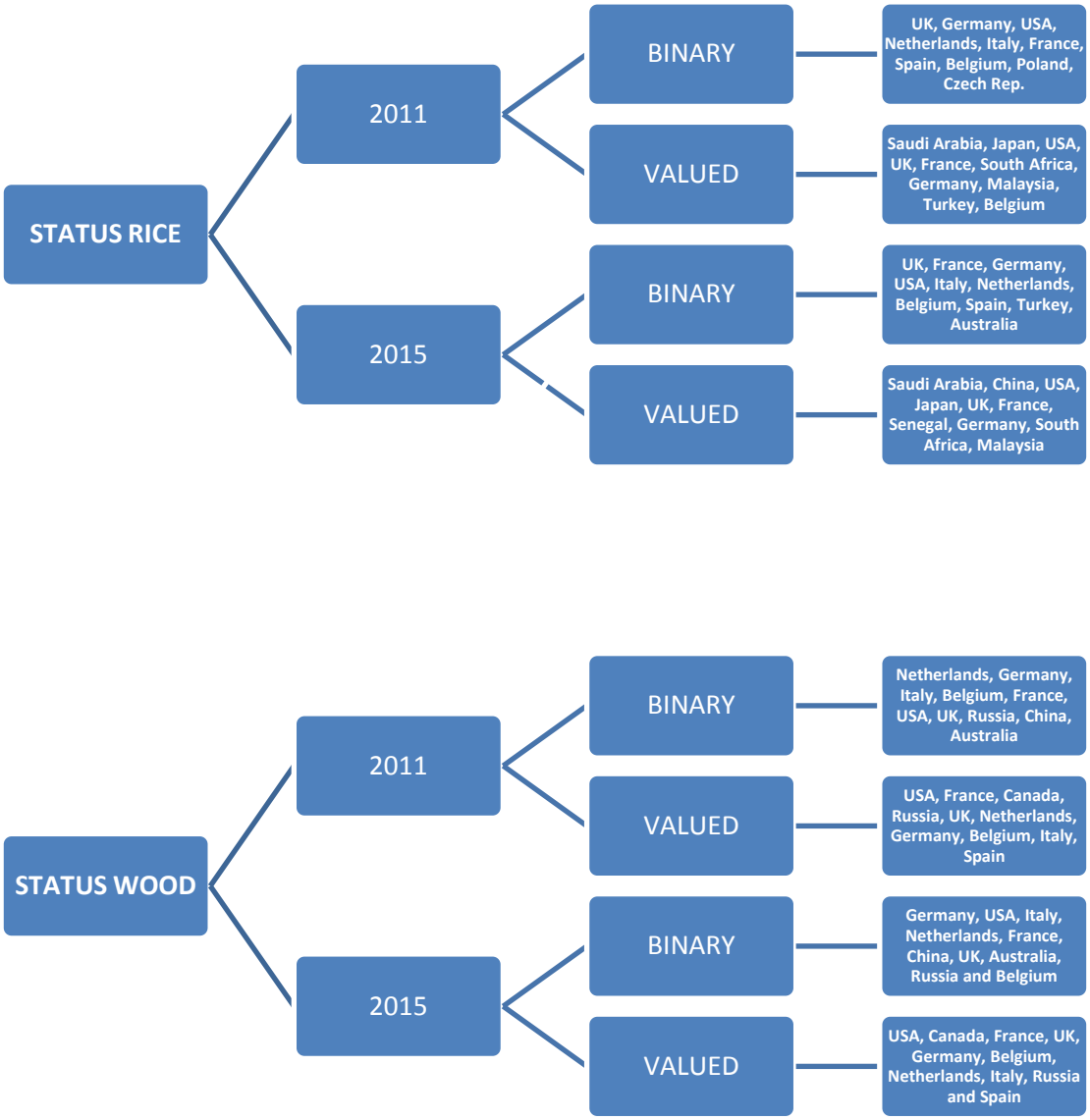
Considering status and pagerank centralities, what actually matters is the centrality of the neighboring countries. High value of these centralities indicates countries that are linked to many other countries, which are in turn connected to many other countries.

From weighted status centrality for 2011 rice network it is observed that leading Asian economies (Saudi Arabia, Japan) are in the first places, followed by USA, UK, France, South Africa, Germany. In case of unweighted status centrality for 2011, the main EU economies and USA are in the highly scored group of ten. In 2015, the structure of trade changes and another leading country occupies the second place in weighted status centrality (China instead of Japan), while Saudi Arabia remains in the first place. US, Japan and important EU economies remain among those highly scored, while Senegal a developing country is making its way to seventh place. In the binary version of status centrality, important EU economies, are mostly found in the first places, while Turkey and Australia are also included.

In weighted 2011 wood network, the countries with the highest status index are USA, France, Canada, Russia, UK, Netherlands, Germany, Belgium, Italy and Spain. The highest centrality indexes are divided between continents. USA and Canada on the one side and European countries on the other. In binary 2011 version, the countries with the highest status in descending order are Netherlands, Germany, Italy, Belgium, France, USA, UK, Russia, China and Australia. There is no distinctively differentiated nodes with very high status index. In weighted 2015 wood version, the countries with the highest status index are USA, Canada, France, UK, Germany, Belgium, Netherlands, Italy, Russia and Spain. USA has very high status in the weighted 2015 form. In binary 2015 version, the countries with the highest status in descending order are Germany, USA, Italy, Netherlands, France, China, UK, Australia, Russia and Belgium. No extremely dominant nodes are observed in latter version of status index.

Below, in Figure 5, status centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 5: Status index



Note: Rice and wood networks, valued and binary, 2011/2015.

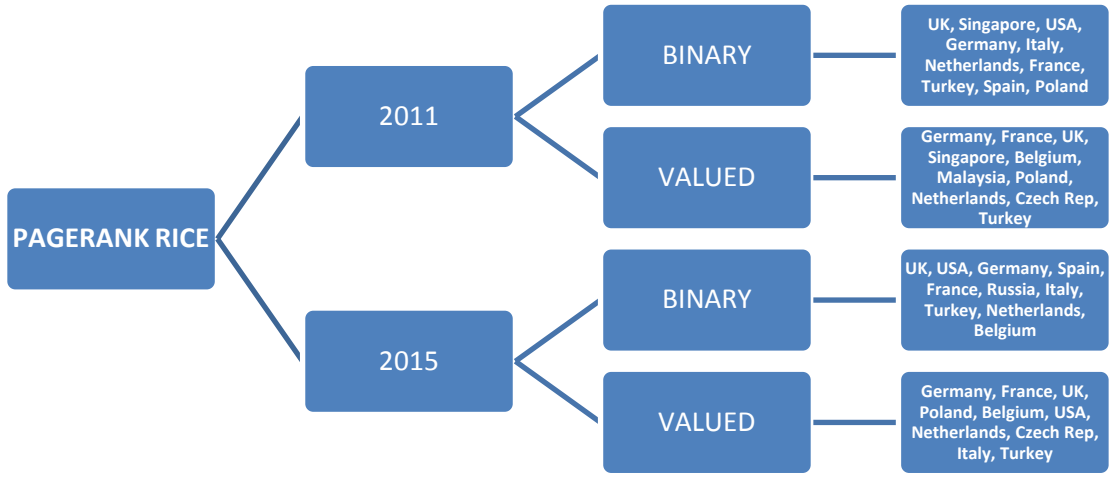
3.2.6 PageRank index

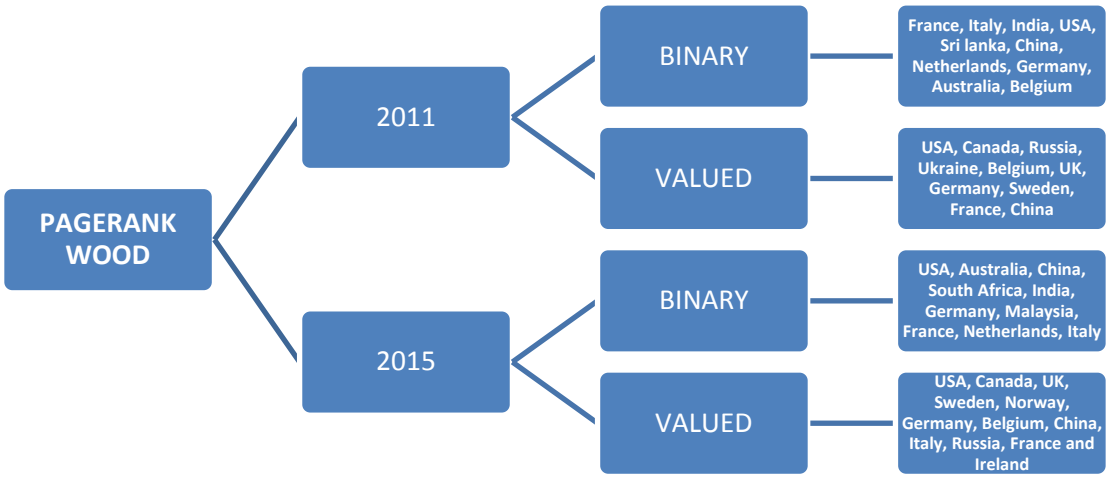
The weighted pagerank centrality for 2011 rice network, position developed EU countries (Germany, France, UK) and developed Asian countries (Singapore, Malaysia) as highly ranked. In the unweighted version, the rankings of the above countries slightly differ. The weighted pagerank centrality for 2015, position EU countries (Germany, France, UK) in the first places of ranking, with no change observed after 5 years. In the unweighted version, the rankings of the above countries slightly differ, while USA and Russia climb up to 2nd and 6th places respectively.

In weighted 2011 wood network, the countries with the highest pagerank index in descending order are USA, Canada, Russia, Ukraine, Belgium, UK, Germany, Sweden, France and China. USA is again the more central node, with Canada and Russia following in the classification. In binary 2011 wood network, no considerable differences between centralities are noticed and the countries with the highest pagerank in descending order are France, Italy, India, USA, Sri lanka, China, Netherlands, Germany, Australia, Belgium. In weighted 2015 version, the countries with the highest pagerank index are USA, Canada, UK, Sweden, Norway, Germany, Belgium, China, Italy, Russia, France and Ireland. USA and Canada has the highest distinctive centrality. In binary 2015 wood network, other than USA no country is extremely centered. Thus, the countries with the highest pagerank are USA, Australia, China, South Africa, India, Germany, Malaysia, France, Netherlands and Italy.

Below, in Figure 6, pagerank centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 6: PageRank index





Note: Rice and wood networks, valued and binary, 2011/2015.

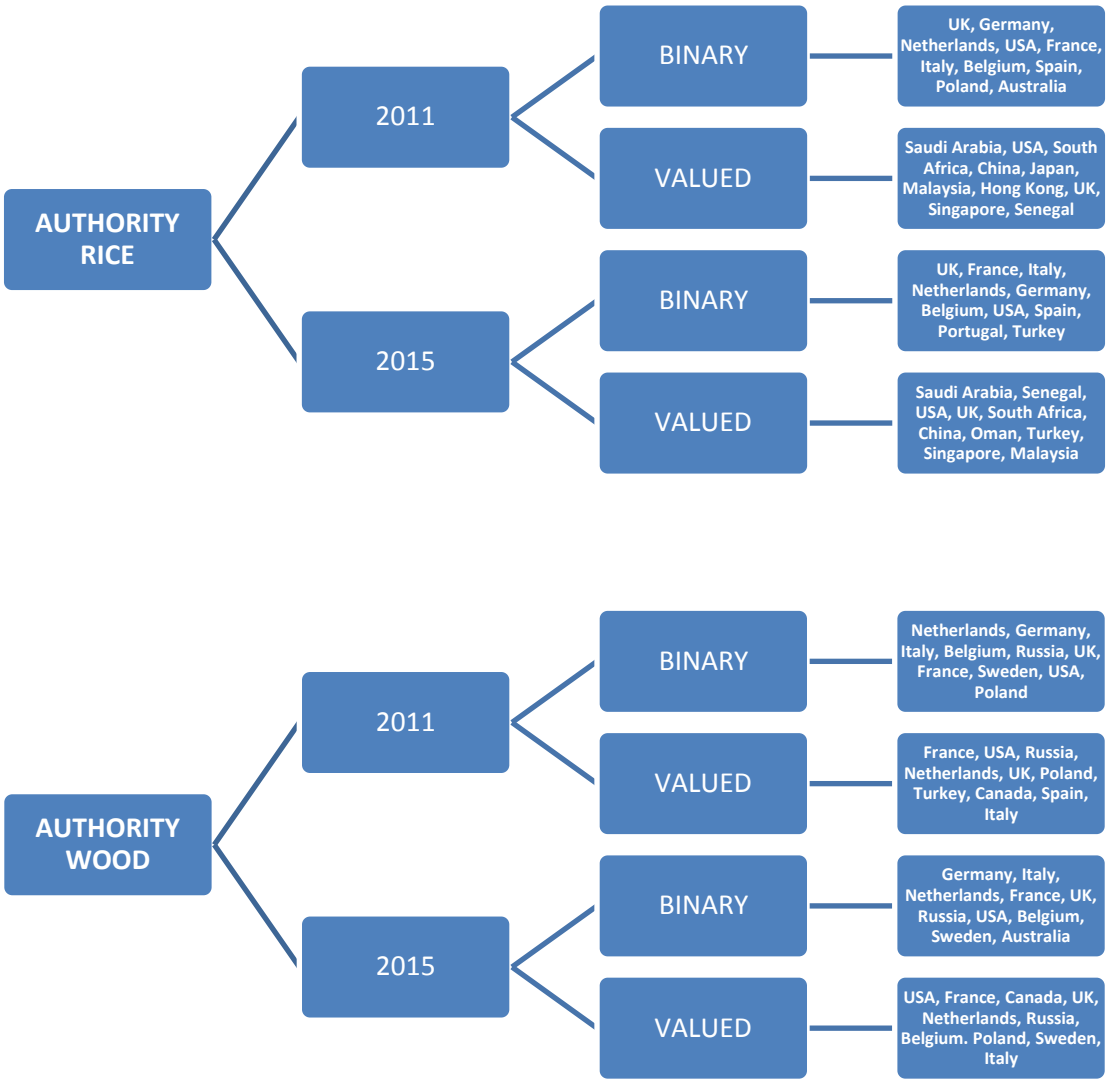
3.2.7 Authority index

Regarding weighted rice indicator of authority for 2011, Saudi Arabia presents the highest centrality ranking, followed by USA and South Africa, while China, Japan, Malaysia, Hong Kong and UK consist the second group with approximate centrality scores values. In 2015, Saudi Arabia keep holding the reins, while Senegal has risen from 10^{th} place to 2^{nd}. USA remains highly ranked, while South Africa has dropped in classification from 3^{rd} to 5^{th} place. In weighted indices for 2011, the authority measure classifies UK, Germany, Netherlands, USA, France, Italy, Belgium, Spain in the first places. For weighted 2015 rice authority, Saudi Arabia has extremely high centrality score, followed by Senegal and USA.

In weighted 2011 wood network, the countries with the highest authority index in descending order are France, USA, Russia, Netherlands, UK, Poland, Turkey, Canada, Spain and Italy. France has the highest authority. In binary 2011 wood network, the countries with the highest authority index in descending order are Netherlands, Germany, Italy, Belgium, Russia, UK, France, Sweden, USA and Poland. Trade volumes are again not evident in the binary version, that represents trade partnerships. In weighted 2015 version, the countries with the highest authority index are USA, France, Canada, UK, Netherlands, Russia, Belgium. Poland, Sweden and Italy. The more central vertex is USA, with very high centrality index. In binary 2015 version, the countries with the highest authority index are Germany, Italy, Netherlands, France, UK, Russia, USA, Belgium, Sweden, Australia and China. The binary authority figures stress trade partnership rather than trade volumes.

Below, in Figure 7, authority centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 7: Authority index



Note: Rice and wood networks, valued and binary, 2011/2015.

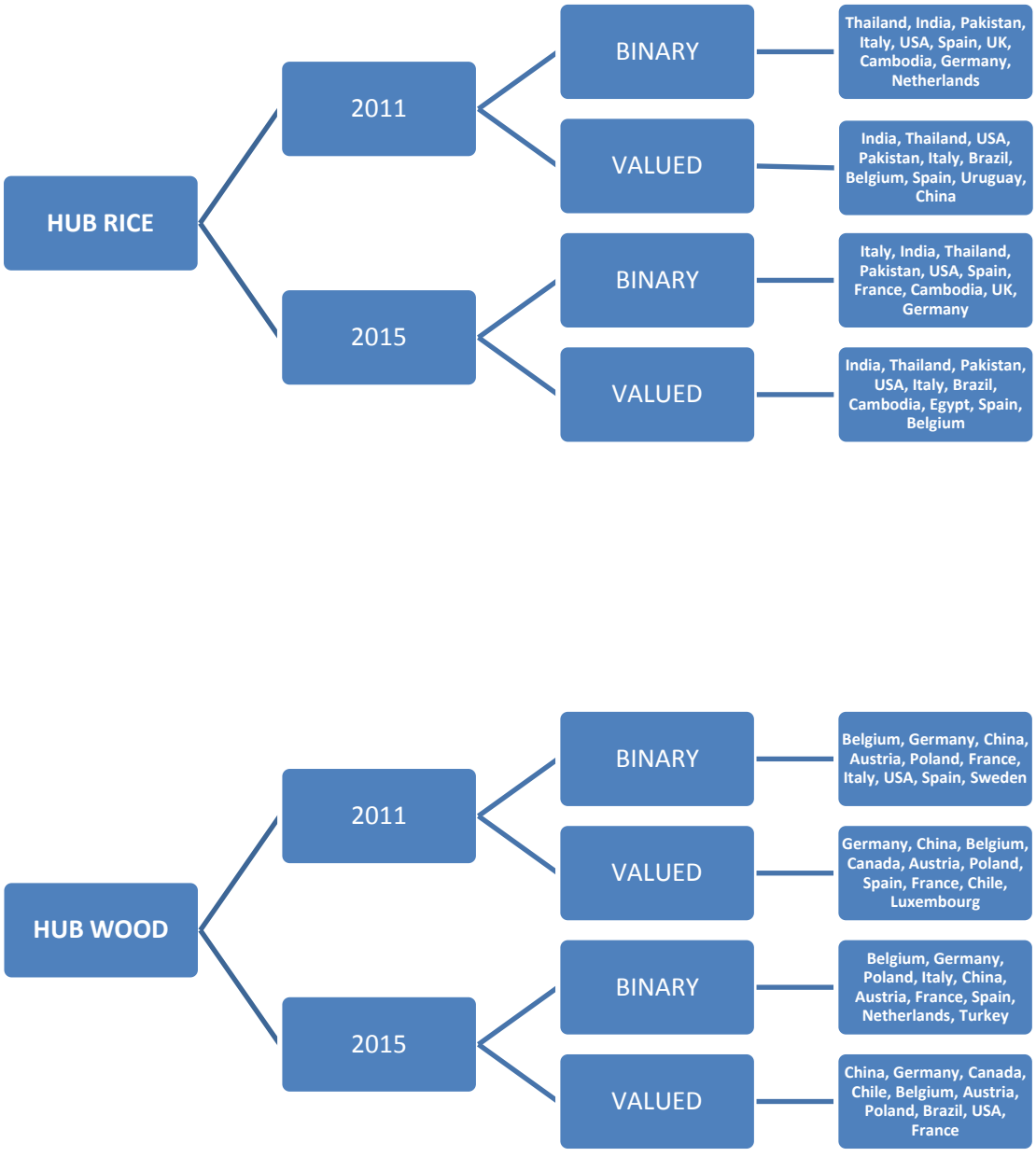
3.2.8 Hub index

According to weighted hub measure for 2011 rice network, India and Thailand have the highest scores, followed by USA and Pakistan. The same is the case also for 2015, with importance of India compared to Thailand stressed by its higher ranking. In unweighted hub measure for 2015 the importance of Thailand and India is less stressed and Italy acquires a leading position. Lower centrality indexes for leading countries of India and Thailand are evident also from the centrality results for 2011.

In weighted 2011 wood network, the countries with the highest hub index in descending order are Germany, China, Belgium, Canada, Austria, Poland, Spain, France, Chile and Luxembourg. Highly centralized is Germany, with China and Belgium following. In binary 2011 version, the countries with the highest hub index in descending order are Belgium, Germany, China, Austria, Poland, France, Italy, USA, Spain and Sweden. The centralization scores are very low, featuring the main characteristic of networks based on unweighted measures, that tend to present similar and not very differentiated scores between nodes. In weighted 2015 version, the countries with the highest hub index in descending order are China, Germany, Canada, Chile, Belgium, Austria, Poland, Brazil, USA and France. The network is characterized by high centralization especially for the first three nodes of China, Germany and Canada. In binary 2015 version, the countries with the highest hub index in descending order are Belgium, Germany, Poland, Italy, China, Austria, France, Spain, Netherlands and Turkey. The main characteristic of the last network is the low centralization.

Below, in Figure 8, hub centrality scores of ten highly ranked countries are presented, for both binary and valued versions of rice2011, rice2015, wood2011, wood2015 networks.

Figure 8: Hub index



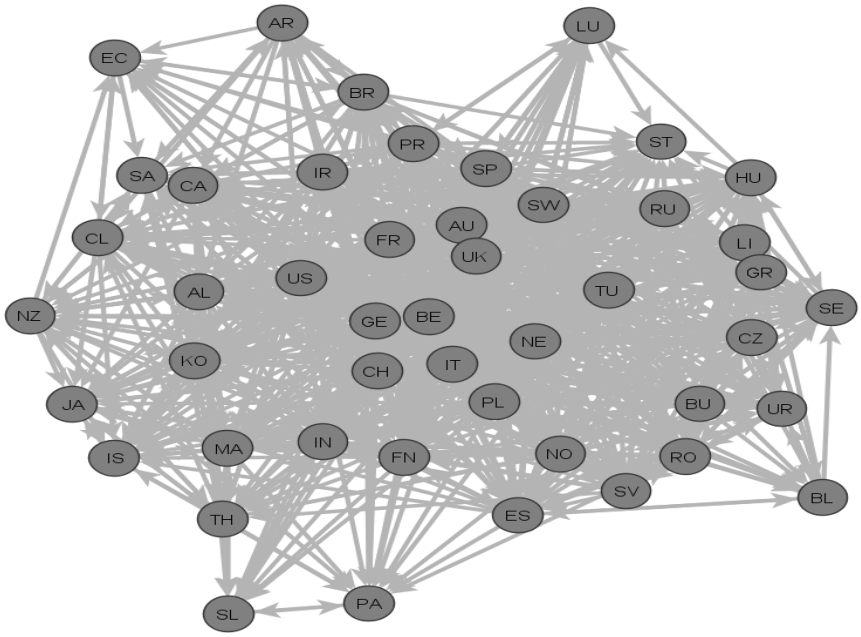
Note: Rice and wood networks, valued and binary, 2011/2015.

3.3 Visualization of Networks

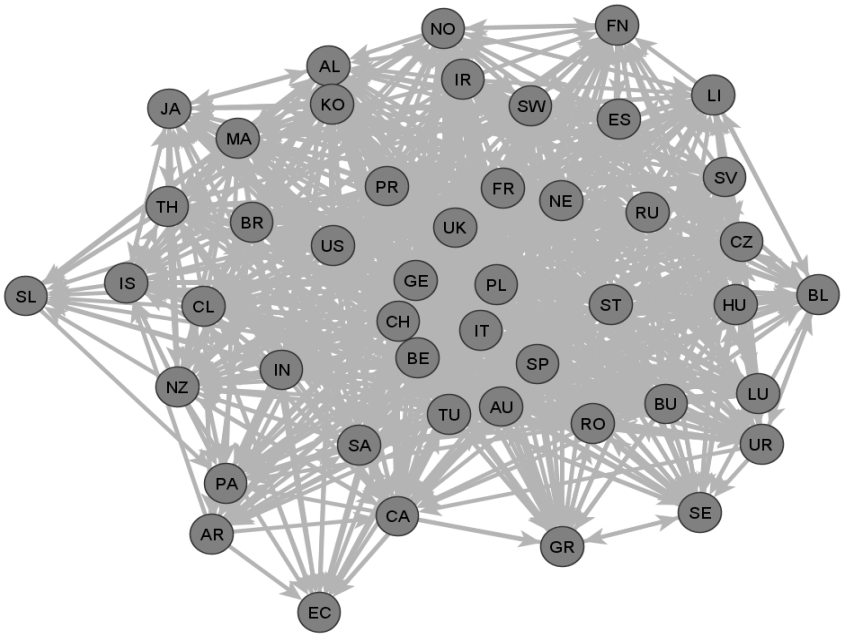
The difference of the two distinctive sectors between years can be appreciated also visually in Figures 9-10. So in the following figures the visual interdependence result is presented. The overall visualization of rice and wood networks is depicted also in the subsequent Appendix Figures 1, where structural dimension of trade connections, the interdependence between countries and the higher rankings of more central nodes are more easily observable. High dimensionality of the network with almost 50 countries included in each sector, make in some cases the network complex in observation. In visualizations mentioned in the Appendix Figures 1, nodes with the same attribute value are arranged on horizontal lines, where nodes with higher value are closer to the top, and nodes with lower value are closer to the bottom of the drawing.

Figure 9: Wood Trade Networks

2011



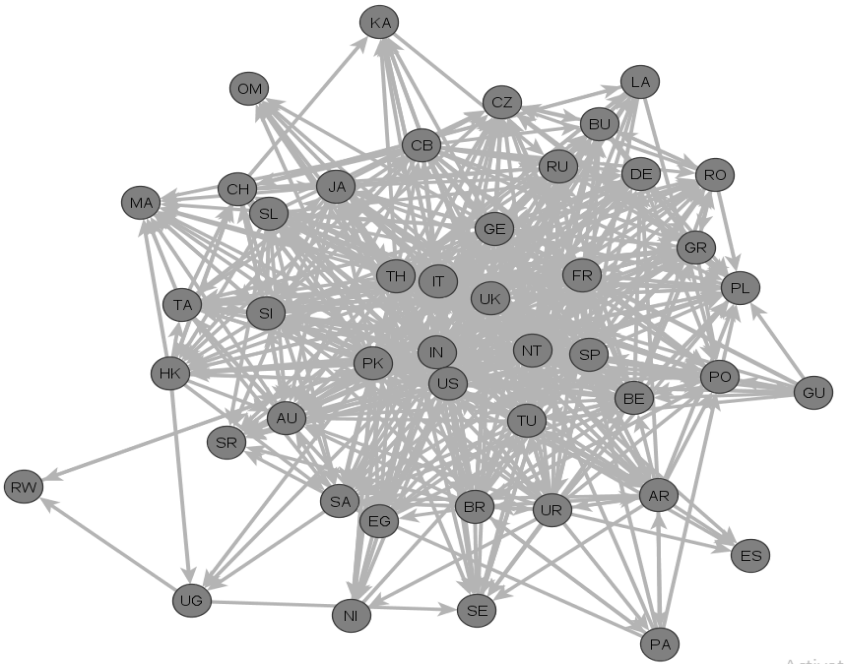
2015



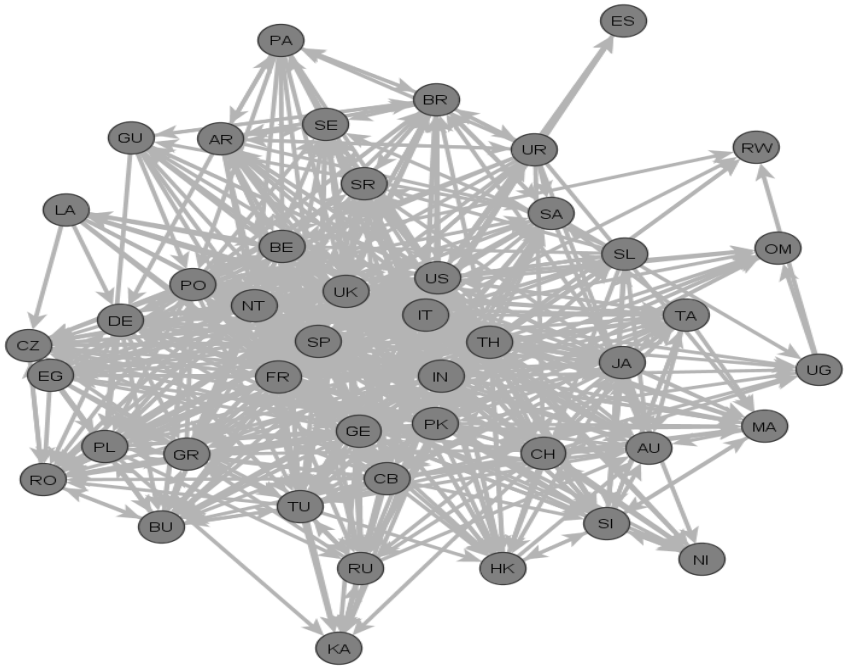
Note: Visualization of 47 countries – leading exporters. Product classification code 4411: Wood and articles of wood; wood charcoal – fibreboard of wood or other ligneous materials, whether or not agglomerated with resins or other organic bonding agents. Trade data come from UN Comtrade database and International Trade Statistics. The network is drawn using Visone 2.16.

Figure 10: Rice Trade Networks

2011



2015



Note: Visualization of 45 countries – leading exporters. Product classification code 1006: Rice. Trade data come from UN Comtrade database and International Trade Statistics. The network is drawn using Visone 2.16.

3.4 Relation between network and non network variables

In Tables 3.2 – 3.3, we have an insight into the relation between non-network and network variables.

Network variables are the centrality measures of indegree, outdegree, betweenness, closeness, status, pagerank, authority and hub of valued and binary networks for the years 2011 and 2015.

Non network variables are Grubel - Lloyed index, Exports value for 2011, Exports value for 2015, Imports value for 2011, Imports value for 2015, GDP 2015 per capita and GDP 2015 per capita based on purchasing power parity (PPP). The Grubel–Lloyd index measures intra-industry trade of a particular product (Grubel & Lloyd, 1971;1975)

Below are presented some definitions of non network variables of GDP and PPP GDP, according to data from World Bank. "GDP per capita is gross domestic product divided by midyear population, being the sum of gross value added by all resident producers plus any product taxes and minus any subsidies not included in the value of the products. GDP is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars." (World Bank data, 2016). "GDP per capita based on purchasing power parity (PPP GDP), is gross domestic product converted to international dollars using purchasing power parity rates. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current international dollars based on the 2011 ICP round." (World Bank data, 2016)

In both rice and wood networks, indegree index valued and binary for both years of study has positive and significant correlation at 0.01 level with non network variables of Imports for 2011 and Imports for 2015. The correlation of indegree index with imports results from the fact that indegree measure represents the import flows from each partner country and which might be an evidence that countries that import more tend to make links with more nodes-countries. Indegree measure has also positive and significant correlation with GDP 2015 per capita and GDP 2015 per capita based on purchasing power parity.

Outdegree measure has positive and statistically significant correlation with Exports for 2011 and Exports for 2015, which also can be explained by the fact that outdegree represents the number of export flows. So the higher is the value of exports, the more connections each node tends to make.

Status, Pagerank and Authority are positively and significantly correlated with Imports 2011& 2015, GDP 2015 and GDP PPP 2015.

Betweenness is mostly correlated with Exports 2011&2015 and Imports 2011& 2015. Also is observed sparse and not very strong positive correlation of betweenness with GDP 2015 and GDP PPP 2015.

Gruble –Lloyed index presents almost no correlation with any centrality measure. Only in 2011 rice network, some correlation was observed. Higher values of Gruble – Lloyed index are indication of intra – industry trade. For example when $GL_i = 1$, means that a country in consideration exports the same quantity of good *i* as much as it imports. Conversely, if $GL_i = 0$, there is no intra-industry trade, but only inter-industry trade exists. This would mean that the country in consideration either only exports or only imports good *i*.

So in this case more centralized countries according to centrality indexes could possibly correlate with countries with high share of intra – industry trade. Intra-industry trade as a term is applied to international trade and refers to the exchange of similar products belonging to the same industry, when the same types of goods or services are both imported and exported. From Gruble – Lloyd indexes, only rice GL 2011 index, appeared to correlate with few centrality measures in 0.01 level. The remaining non network variables, rice GL 2015 and wood GL 2011 & 2015 have no correlation with centrality measures. So intra – industry trade cannot be adequately explained by centrality measures, within this study. On the other side, patterns of inter - country trade can be studied and defined.

Table 3.2: Relation between non-network and network variables – Rice Network

Spearman's rho **Correlation is significant at the 0.01 level / *Correlation is significant at the 0.05 level	Exports 2011	Exports 2015	Imports 2011	Imports 2015	Grubel-Lloyd 2011	Grubel-Lloyd 2015	GDP 2015	GDP PPP 2015
indegree valued (2011)	,056	,015	**,960****	**,904****	,227	,050	**,559****	**,599****
	,717	,920	,000	,000	,134	,745	,000	,000
indegree valued (2015)	-,018	-,042	**,937****	**,959****	,248	,027	**,514****	**,562****
	,907	,787	,000	,000	,100	,861	,000	,000
indegree binary (2011)	**,310***	,169	**,638****	**,536****	**,413****	,279	**,738****	**,717****
	,039	,267	,000	,000	,005	,064	,000	,000
indegree binary (2015)	**,338***	,173	**,639****	**,550****	**,421****	,264	**,716****	**,699****
	,023	,255	,000	,000	,004	,080	,000	,000
outdegree valued (2011)	**,849****	**,781****	-,157	-,210	,040	-,182	,043	-,028
	,000	,000	,303	,167	,796	,233	,778	,855
outdegree valued (2015)	**,736****	**,749****	-,228	-,248	,003	-,177	,012	-,044
	,000	,000	,132	,100	,985	,244	,939	,773
outdegree binary (2011)	**,706****	**,691****	-,045	-,071	-,011	-,203	,239	,159
	,000	,000	,768	,643	,942	,181	,113	,297
outdegree binary (2015)	**,610****	**,585****	,035	,017	,008	-,212	,252	,187
	,000	,000	,818	,913	,958	,162	,095	,218
status valued (2011)	,042	,002	**,956****	**,905****	,213	,047	**,570****	**,605****
	,784	,990	,000	,000	,161	,757	,000	,000
status valued (2015)	-,024	-,045	**,939****	**,960****	,236	,025	**,515****	**,561****
	,874	,768	,000	,000	,119	,873	,000	,000
status binary (2011)	**,308***	,169	**,620****	**,514****	**,397****	,274	**,751****	**,730****
	,039	,266	,000	,000	,007	,069	,000	,000
status binary (2015)	**,324***	,151	**,618****	**,525****	**,423****	,265	**,709****	**,696****
	,030	,323	,000	,000	,004	,078	,000	,000
pagerank valued (2011)	,099	,054	**,714****	**,616****	,255	,181	**,620****	**,641****
	,517	,724	,000	,000	,091	,235	,000	,000
pagerank valued (2015)	,179	,088	**,709****	**,656****	,254	,158	**,639****	**,654****
	,238	,564	,000	,000	,092	,301	,000	,000
pagerank binary (2011)	,291	,180	**,602****	**,494****	**,363***	,264	**,673****	**,660****
	,052	,236	,000	,001	,014	,079	,000	,000
pagerank binary (2015)	**,423****	,245	**,512****	**,412****	**,405****	,249	**,615****	**,602****
	,004	,105	,000	,005	,006	,099	,000	,000
authority valued (2011)	-,044	-,003	**,916****	**,920****	,173	-,005	**,487****	**,542****
	,774	,983	,000	,000	,255	,976	,001	,000
authority valued (2015)	-,137	-,130	**,836****	**,897****	,244	,034	**,415****	**,477****
	,369	,395	,000	,000	,106	,826	,005	,001
authority binary (2011)	,266	,129	**,645****	**,550****	**,396****	,276	**,768****	**,748****
	,077	,399	,000	,000	,007	,067	,000	,000
authority binary (2015)	,245	,085	**,641****	**,557****	**,406****	,276	**,733****	**,725****
	,105	,579	,000	,000	,006	,066	,000	,000
beetwen valued (2011)	**,299***	,224	**,354***	**,322***	,242	,010	**,455***	**,360***
	,046	,140	,017	,031	,110	,949	,002	,015
beetwen valued (2015)	,136	,082	**,524****	**,470****	**,298***	,132	**,298***	**,295***
	,371	,592	,000	,001	,047	,389	,046	,049
beetwen binary (2011)	**,616****	**,558****	**,325***	,275	,116	,013	**,319***	,238
	,000	,000	,029	,067	,447	,934	,033	,115
beetwen binary (2015)	**,647****	**,550****	**,332***	,274	,095	-,093	**,376***	**,349***
	,000	,000	,026	,069	,536	,541	,011	,019
closeness valued (2011)	,125	,014	,167	,167	**,382****	,146	**,336***	**,303***
	,413	,926	,272	,273	,010	,340	,024	,043
closeness valued (2015)	-,018	-,136	**,318***	,245	**,445****	**,298***	**,307***	**,296***
	,907	,373	,033	,105	,002	,047	,040	,048
closeness binary (2011)	**,672****	**,658****	-,016	-,036	-,052	-,207	,262	,181
	,000	,000	,916	,813	,733	,172	,082	,233
closeness binary (2015)	**,603****	**,573****	,018	,001	-,006	-,227	,233	,167
	,000	,000	,906	,997	,967	,133	,123	,273
hub valued (2011)	**,819****	**,801****	-,049	-,097	,012	-,200	,142	,077
	,000	,000	,749	,524	,937	,188	,354	,617
hub valued (2015)	**,700****	**,746****	-,161	-,193	,036	-,129	,054	-,007
	,000	,000	,290	,204	,812	,398	,723	,965
hub binary (2011)	**,691****	**,672****	-,065	-,102	-,020	-,189	,223	,148
	,000	,000	,671	,506	,898	,212	,141	,333
hub binary (2015)	**,585****	**,562****	,001	-,022	-,003	-,204	,233	,165
	,000	,000	,995	,886	,984	,179	,124	,279

Table 3.3: Relation between non-network and network variables – Wood Network

Spearman's rho **Correlation is significant at the 0.01 level / *Correlation is significant at the 0.05 level	Exports 2011	Exports 2015	Imports 2011	Imports 2015	Grubel-Lloyd 2011	Grubel-Lloyd 2015	GDP 2015	GDP PPP 2015
indegree valued (2011)	,284	**,293***	**,926****	**,947****	,038	,023	**,343***	**,374****
	,053	,046	,000	,000	,801	,877	,018	,010
indegree valued (2015)	**,324***	**,309***	**,879****	**,990****	-,025	,040	**,434****	**,469****
	,026	,034	,000	,000	,868	,788	,002	,001
indegree binary (2011)	**,233**	,224	**,712****	**,803****	-,007	-,032	,277	**,298***
	,115	,131	,000	,000	,961	,829	,060	,042
indegree binary (2015)	**,354***	**,347***	**,677****	**,760****	-,044	-,001	**,324***	**,359***
	,015	,017	,000	,000	,767	,995	,026	,013
outdegree valued (2011)	**,918****	**,866****	**,366***	**,324***	-,058	-,090	**,375****	**,407****
	,000	,000	,011	,027	,699	,547	,009	,005
outdegree valued (2015)	**,921****	**,926****	**,407****	**,370***	-,064	-,069	**,344***	**,393****
	,000	,000	,004	,011	,667	,643	,018	,006
outdegree binary (2011)	**,666****	**,639****	**,590****	**,548****	,075	-,035	**,349***	**,385****
	,000	,000	,000	,000	,618	,816	,016	,008
outdegree binary (2015)	**,605****	**,579****	**,556****	**,607****	,047	-,079	**,344***	**,394****
	,000	,000	,000	,000	,753	,598	,018	,006
status valued (2011)	**,299***	**,302***	**,917****	**,944****	,041	,028	**,391****	**,422****
	,041	,039	,000	,000	,786	,853	,007	,003
status valued (2015)	**,355***	**,336***	**,873****	**,985****	-,034	,035	**,458****	**,495****
	,014	,021	,000	,000	,818	,814	,001	,000
status binary (2011)	,246	,229	**,711****	**,806****	-,002	-,018	**,309***	**,335***
	,096	,122	,000	,000	,988	,904	,035	,021
status binary (2015)	**,349***	**,339***	**,676****	**,754****	-,051	-,010	**,337***	**,371***
	,016	,020	,000	,000	,734	,947	,021	,010
pagerank valued (2011)	,264	,262	**,778****	**,763****	,040	,055	,167	,196
	,073	,075	,000	,000	,790	,712	,261	,186
pagerank valued (2015)	**,320***	**,305***	**,764****	**,823****	-,013	-,034	**,372***	**,394****
	,028	,037	,000	,000	,930	,821	,010	,006
pagerank binary (2011)	,202	,200	**,537****	**,617****	-,033	,043	-,016	,015
	,174	,178	,000	,000	,827	,773	,916	,921
pagerank binary (2015)	**,366***	**,384****	**,428****	**,510****	-,232	-,214	,116	,135
	,011	,008	,003	,000	,116	,149	,439	,364
authority valued (2011)	**,309***	**,291***	**,822****	**,877****	,033	,093	**,425****	**,454****
	,035	,047	,000	,000	,824	,533	,003	,001
authority valued (2015)	**,346***	**,331***	**,793****	**,927****	-,097	,009	**,439****	**,464****
	,017	,023	,000	,000	,517	,953	,002	,001
authority binary (2011)	,215	,199	**,705****	**,804****	,010	-,019	**,374****	**,394****
	,147	,180	,000	,000	,948	,897	,010	,006
authority binary (2015)	**,317***	**,304***	**,694****	**,775****	,017	,057	**,374****	**,406****
	,030	,038	,000	,000	,909	,705	,010	,005
beetwen valued (2011)	-,142	-,106	,205	,108	**,404****	,255	-,044	-,028
	,343	,479	,166	,472	,005	,084	,771	,854
beetwen valued (2015)	-,173	-,173	-,011	,089	-,168	-,249	,116	,136
	,244	,244	,944	,550	,260	,092	,437	,361
beetwen binary (2011)	**,549****	**,538****	**,586****	**,555****	,021	,008	,138	,162
	,000	,000	,000	,000	,887	,959	,353	,277
beetwen binary (2015)	**,572****	**,574****	**,563****	**,673****	-,082	-,144	**,296***	**,323***
	,000	,000	,000	,000	,585	,335	,043	,027
closeness valued (2011)	-,207	-,139	,263	,114	**,355***	,180	-,144	-,154
	,163	,351	,074	,447	,014	,225	,335	,303
closeness valued (2015)	**-,383****	**-,398****	-,035	,047	,076	-,102	,074	,080
	,008	,006	,815	,753	,611	,495	,623	,592
closeness binary (2011)	**,666****	**,638****	**,590****	**,548****	,076	-,030	**,349***	**,385****
	,000	,000	,000	,000	,610	,839	,016	,008
closeness binary (2015)	**,602****	**,578****	**,560****	**,611****	,051	-,079	**,343***	**,392****
	,000	,000	,000	,000	,732	,599	,018	,006
hub valued (2011)	**,871****	**,833****	**,442****	**,373****	,011	-,055	**,383****	**,417****
	,000	,000	,002	,010	,940	,715	,008	,004
hub valued (2015)	**,891****	**,903****	**,345***	,272	-,078	-,146	**,319***	**,353***
	,000	,000	,018	,064	,604	,326	,029	,015
hub binary (2011)	**,643****	**,615****	**,604****	**,561****	,088	-,010	**,360***	**,396****
	,000	,000	,000	,000	,556	,947	,013	,006
hub binary (2015)	**,595****	**,570****	**,572****	**,615****	,074	-,055	**,361***	**,409****
	,000	,000	,000	,000	,620	,714	,013	,004

3.5 Dynamic Network Analysis

Dynamic network analysis and the relation between structures, within and between 2011 - 2015, are presented in the following Tables 3.4 – 3.5.

In transition to dynamic network analysis from 2011 to 2015, generally it is found from the analysis of both rice and wood networks that there is positive and statistically important correlation of the same centralities between 2011 and 2015, that can be an evidence that despite worldwide changes, the 50 leading exporters have not been significantly affected. Also it can be inferred that leading countries are stable in their trading attitude and can be flexible enough to readjust their trading partners.

From current dynamic network analysis, it has not been found significant correlation that proves that ‘’authority values are large for countries with significant imports from large hub countries and that hub values are large for countries with significant exports to high authority countries’’ as observed for 1992-2012 by Deguchi et al (2014). The correlation in present research endeavor is actually negative and not statistically important for both hub and authority measures.

Also positive and strong correlation appear between 2011- 2015 for indegree, outdegree, status, pagerank, authority, betweenness, closeness and hub centralities. The trade structures in terms of imports from 50 main exporters of these two agricultural and forest related sectors, are not changed significantly throughout the years, even though it is known that between the years of study significant changes came up due to crisis that affected all sectors of the economy, primary production sector in consideration included.

The main observation and interesting finding is that weighted measures of betweenness and closeness in wood sector have no correlation with any centrality between years.

The fact the binary measures are correlated, whereas valued measures are not, might be a proving ground that trade partnerships developed in the previous years continue to exist, whereas trade volumes or volumes of export, in the present case, between trading partners, tend to change.

Moreover, from Tables 3.4 – 3.5, positive and statistically significant correlation in rice network is noticed, between outdegree 2011 with outdegree, betweenness, closeness and hub measures of 2015. Closeness centrality implies short geodesic distance to other countries, so the positive relation of outdegree with closeness is an indication that the

higher the closeness centrality scores and thus shorter geodesic distance to other countries, the higher the flows of exports. In wood network, outdegree 2011 is correlated in 0.01 or in 0.05 levels with most indexes.

Status, pagerank and authority of wood 2011 network, have strong positive correlation with all 2015 centrality measures. The same relations are observed for rice network. The main differentiation of two sectors is that betweenness valued and closeness valued in wood products are not correlated with any other variables. Possibly, betweenness is not so explanatory centrality measure to explain the differences in trade network structures. De Benedictis et al. (2013) prefer not to use betweenness centrality in their world trade network of 178 countries, since they consider it less appropriate for the specific trade network analysis.

Betweenness and closeness (binary 2011) and hub (both valued and binary 2011) present strong and positive correlation with all the remaining centrality measures.

The same network measure of 2011 has positive and significant correlation with the same network measure of 2015, so the central position of each of about 50 leading exporters is dynamically confirmed throughout five years time during the unstable time of economic crisis. Most probably these countries have found new markets replacing their traditional export markets by others or have absorbed the negative consequences internally. Trade links can either be redirected to new trade partners or the volumes can be increased to new or existent ones. Moreover, it could be anticipated that countries affected by economically unstable times, tend to become more extrovert and try to make new links in order to survive in a competitive world of goods and services flow.

Table 3.4: Dynamic network analysis from 2011 to 2015 and relation between structures – Rice sector (**Correlation is significant at the 0.01 level /*Correlation is significant at the 0.05 level)

Spearman's rho	indegree valued (2015)	indegree binary (2015)	outdegree valued (2015)	outdegree binary (2015)	status valued (2015)	status binary (2015)	pagerank valued (2015)	pagerank binary (2015)	authority valued (2015)	authority binary (2015)	between valued (2015)	between binary (2015)	closen valued (2015)	closen binary (2015)	hub valued (2015)	hub binary (2015)
indegree valued (2011)	**,942****	**,682****	-,128	,165	**,946****	**,665****	**,734****	**,565****	**,814****	**,682****	**,584****	**,415****	**,412****	,158	-,034	,142
	,000	,000	,403	,279	,000	,000	,000	,000	,000	,000	,000	,005	,005	,300	,822	,353
indegree binary (2011)	**,616****	**,970****	,160	**,430****	**,610****	**,970****	**,816****	**,912****	**,514****	**,967****	**,564****	**,638****	**,538****	**,420****	,191	**,423****
	,000	,000	,293	,003	,000	,000	,000	,000	,000	,000	,000	,000	,000	,004	,209	,004
outdegree valued (2011)	-,099	,261	**,923****	**,777****	-,109	,262	,177	**,357***	-,246	,209	,215	**,671****	,128	**,762****	**,875****	**,773****
	,516	,083	,000	,000	,477	,082	,245	,016	,104	,169	,156	,000	,403	,000	,000	,000
outdegree binary (2011)	,045	**,359***	**,820****	**,931****	,045	**,364***	**,317***	**,427****	-,092	**,315***	**,311***	**,761****	,176	**,925****	**,880****	**,916****
	,768	,015	,000	,000	,771	,014	,034	,003	,550	,035	,038	,000	,249	,000	,000	,000
status valued (2011)	**,940****	**,680****	-,139	,166	**,949****	**,663****	**,754****	**,567****	**,815****	**,682****	**,580****	**,416****	**,401****	,159	-,049	,144
	,000	,000	,361	,275	,000	,000	,000	,000	,000	,000	,000	,005	,006	,298	,748	,346
status binary (2011)	**,599****	**,967****	,177	**,445****	**,594****	**,970****	**,821****	**,914****	**,489****	**,966****	**,553****	**,638****	**,544****	**,435****	,205	**,442****
	,000	,000	,246	,002	,000	,000	,000	,000	,001	,000	,000	,000	,000	,003	,177	,002
pagerank valued (2011)	**,648****	**,787****	,062	**,344***	**,651****	**,781****	**,867****	**,725****	**,540****	**,787****	**,427****	**,492****	**,476****	**,325***	,106	**,333***
	,000	,000	,685	,021	,000	,000	,000	,000	,000	,000	,003	,001	,001	,029	,488	,025
pagerank binary (2011)	**,555****	**,929****	,137	**,425****	**,555****	**,926****	**,828****	**,903****	**,480****	**,905****	**,520****	**,633****	**,421****	**,412****	,175	**,409****
	,000	,000	,370	,004	,000	,000	,000	,000	,001	,000	,000	,000	,004	,005	,250	,005
authority valued (2011)	**,917****	**,541****	-,182	,081	**,923****	**,513****	**,623****	**,433****	**,923****	**,535****	**,435****	**,302***	,220	,069	-,100	,053
	,000	,000	,231	,597	,000	,000	,000	,003	,000	,000	,003	,044	,146	,652	,514	,727
authority binary (2011)	**,623****	**,958****	,143	**,407****	**,616****	**,958****	**,805****	**,883****	**,512****	**,968****	**,537****	**,610****	**,560****	**,398****	,168	**,406****
	,000	,000	,349	,005	,000	,000	,000	,000	,000	,000	,000	,000	,000	,007	,271	,006
between valued (2011)	**,382****	**,495****	,122	**,467****	**,392****	**,481****	**,471****	**,451****	,269	**,482****	**,527****	**,505****	**,376***	**,458****	,204	**,430****
	,010	,001	,423	,001	,008	,001	,001	,002	,074	,001	,000	,000	,011	,002	,178	,003
between binary (2011)	**,333***	**,566****	**,450****	**,690****	**,336***	**,546****	**,560****	**,600****	,214	**,499****	**,430****	**,782****	,179	**,677****	**,543****	**,651****
	,025	,000	,002	,000	,024	,000	,000	,000	,159	,000	,003	,000	,239	,000	,000	,000
closen valued (2011)	,233	**,422****	,192	**,432****	,235	**,441****	**,445****	**,459****	,186	**,435****	**,460****	**,405****	**,537****	**,434****	,226	**,423****
	,124	,004	,206	,003	,121	,002	,002	,002	,220	,003	,001	,006	,000	,003	,135	,004
closen binary (2011)	,074	**,362***	**,775****	**,913****	,073	**,363***	**,345***	**,432****	-,069	**,323***	**,299***	**,786****	,152	**,912****	**,842****	**,899****
	,630	,015	,000	,000	,632	,014	,020	,003	,652	,031	,046	,000	,320	,000	,000	,000
hub valued (2011)	,018	,281	**,895****	**,826****	,010	,273	,240	**,367***	-,135	,226	,232	**,717****	,093	**,810****	**,928****	**,816****
	,908	,062	,000	,000	,950	,069	,113	,013	,376	,136	,125	,000	,544	,000	,000	,000
hub binary (2011)	,022	**,363***	**,818****	**,923****	,020	**,372***	**,312***	**,439****	-,114	**,328***	**,324***	**,754****	,203	**,920****	**,882****	**,919****
	,888	,014	,000	,000	,896	,012	,037	,003	,457	,028	,030	,000	,180	,000	,000	,000

Table 3.5: Dynamic network analysis from 2011 to 2015 and relation between structures – Wood sector (**Correlation is significant at the 0.01 level /*Correlation is significant at the 0.05 level)

Spearman's rho	indegree valued (2015)	indegree binary (2015)	outdegree valued (2015)	outdegree binary (2015)	status valued (2015)	status binary (2015)	pagerank valued (2015)	pagerank binary (2015)	authority valued (2015)	authority binary (2015)	between valued (2015)	between binary (2015)	closen valued (2015)	closen binary (2015)	hub valued (2015)	hub binary (2015)
indegree valued (2011)	**,946****	**,701****	**,345***	**,611****	**,945****	**,698****	**,768****	**,431****	**,889****	**,737****	,076	**,620****	,049	**,615****	,273	**,620****
	,000	,000	,018	,000	,000	,000	,000	,003	,000	,000	,610	,000	,744	,000	,063	,000
indegree binary (2011)	**,799****	**,894****	,262	**,592****	**,787****	**,893****	**,693****	**,668****	**,782****	**,905****	,096	**,762****	,076	**,595****	,154	**,587****
	,000	,000	,075	,000	,000	,000	,000	,000	,000	,000	,522	,000	,613	,000	,301	,000
outdegree valued (2011)	**,333***	**,348***	**,952****	**,626****	**,371***	**,349***	**,342***	,252	**,339***	**,336***	-,111	**,520****	**-,308***	**,620****	**,939****	**,625****
	,022	,017	,000	,000	,010	,016	,019	,088	,020	,021	,457	,000	,035	,000	,000	,000
outdegree binary (2011)	**,558****	**,619****	**,718****	**,891****	**,581****	**,620****	**,496****	**,352***	**,535****	**,648****	,018	**,751****	,023	**,891****	**,687****	**,890****
	,000	,000	,000	,000	,000	,000	,000	,015	,000	,000	,903	,000	,878	,000	,000	,000
status valued (2011)	**,948****	**,699****	**,376****	**,640****	**,952****	**,698****	**,760****	**,392****	**,892****	**,747****	,070	**,618****	,073	**,644****	**,308***	**,652****
	,000	,000	,009	,000	,000	,000	,000	,006	,000	,000	,639	,000	,625	,000	,035	,000
status binary (2011)	**,801****	**,889****	,286	**,624****	**,796****	**,890****	**,710****	**,617****	**,771****	**,916****	,093	**,751****	,115	**,627****	,173	**,622****
	,000	,000	,051	,000	,000	,000	,000	,000	,000	,000	,536	,000	,441	,000	,245	,000
pagerank valued (2011)	**,741****	**,592****	**,308***	**,454****	**,748****	**,599****	**,870****	**,415****	**,641****	**,631****	,132	**,517****	,115	**,453****	,230	**,450****
	,000	,000	,035	,001	,000	,000	,000	,004	,000	,000	,377	,000	,440	,001	,120	,002
pagerank binary (2011)	**,603****	**,734****	,148	,347*	**,568****	**,725****	**,525****	**,742****	**,598****	**,672****	,179	**,649****	-,059	**,343***	,040	**,328***
	,000	,000	,321	,017	,000	,000	,000	,000	,000	,000	,230	,000	,693	,018	,789	,024
authority valued (2011)	**,895****	**,700****	**,388****	**,669****	**,903****	**,697****	**,648****	,331*	**,908****	**,757****	,181	**,638****	,163	**,671****	**,318***	**,684****
	,000	,000	,007	,000	,000	,000	,000	,023	,000	,000	,224	,000	,274	,000	,029	,000
authority binary (2011)	**,803****	**,871****	,277	**,635****	**,802****	**,873****	**,718****	**,553****	**,773****	**,919****	,081	**,727****	,137	**,637****	,163	**,635****
	,000	,000	,060	,000	,000	,000	,000	,000	,000	,000	,589	,000	,357	,000	,274	,000
between valued (2011)	,098	,133	-,065	,184	,077	,132	,109	,009	,076	,181	,225	,118	,275	,182	-,107	,201
	,513	,375	,663	,215	,609	,377	,465	,950	,611	,222	,128	,428	,061	,221	,473	,176
between binary (2011)	**,562****	**,724****	**,555****	**,663****	**,551****	**,721****	**,493****	**,637****	**,586****	**,680****	,153	**,813****	-,118	**,656****	**,507****	**,644****
	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,306	,000	,428	,000	,000	,000
closen valued (2011)	,096	,076	-,211	,098	,075	,082	,112	-,030	,079	,127	,179	,071	**,347***	,102	-,213	,102
	,521	,609	,155	,511	,614	,586	,452	,839	,600	,396	,228	,634	,017	,494	,150	,496
closen binary (2011)	**,558****	**,617****	**,717****	**,891****	**,581****	**,618****	**,495****	**,348***	**,534****	**,646****	,022	**,749****	,025	**,891****	**,687****	**,890****
	,000	,000	,000	,000	,000	,000	,000	,017	,000	,000	,884	,000	,865	,000	,000	,000
hub valued (2011)	**,381****	**,338***	**,936****	**,693****	**,425****	**,338***	**,367***	,161	**,376****	,355*	-,117	**,510****	-,211	**,690****	**,941****	**,703****
	,008	,020	,000	,000	,003	,020	,011	,279	,009	,014	,433	,000	,154	,000	,000	,000
hub binary (2011)	**,570****	**,612****	**,702****	**,893****	**,594****	**,612****	**,494****	**,313***	**,541****	**,649****	,006	**,730****	,039	**,894****	**,670****	**,897****
	,000	,000	,000	,000	,000	,000	,000	,032	,000	,000	,968	,000	,793	,000	,000	,000

CHAPTER 4: DISCUSSION

In the present analysis of sectoral data, local and global centrality measures were calculated and compared. It is verified that relative position of a node in the network changes, when we take into consideration global rather than local centrality measures. Differences between local and global measures are evident for countries less integrated in the world trade and holding a low position in centrality rankings. On the other side key players with high ranking in centrality indices, have similarity in local and global centrality measures. This is evident from the analysis of sectoral data that is compared and verified in a sample of four networks: rice2011, rice2015, wood2011, wood2015.

Specific commodities codes were selected because cereals, rice included, are among the most traded agricultural commodity generating great economic value and the selected wood product code is directly related to wood industry and plays a dominating role in today's wood economy.

The reason network analysis is applied in social and economic systems is because the structural dimension of a network is analyzed taking into account the effect of more than two parties, with main characteristic the interdependence that stems from this relation of more than two participants. Various characteristics of trade networks are quantifiable by the use of centrality indices. Some of these features are high degree of heterogeneity and high dimensionality of trade networks (De Benedictis, 2013). Network analysis is not a substitute for conventional financial indicators, but can be used complementary, providing valuable information.

From basic network characteristics it can be inferred that wood network is more dense than rice sector. Density has increased between years for both wood and rice networks. One observation, from the above changes between years and between sectors is that probably wood industry is more difficult to entry. Density of a network is defined as the number of existing connections to the number of possible ones, so the existing links are increased between the last years, which is an indication of more world integration on the mentioned sectors. Density results, based on the present study provide another proof that networks tend to become more dense throughout the years. Also commodities from the primary sector are not influenced largely by the effects of economic crisis, being directed mainly to

satisfaction of basic needs. The above networks are characterized by high dimensionality since almost 50 nodes participate in each network and also they are heterogeneous in centrality scores, that are differentiated in their results depending on the basic question they have to answer. For example degree centrality answers on how well connected is a network, closeness how easily reachable are the nodes, betweenness centrality how important are the nodes measuring the amount of traffic flowing through that node to the other nodes and eigenvector related centralities measure how important are neighboring nodes.

Concerning outdegree centrality and the direct out-going links the scores are geographically segmented. It is evident from rice network data that dynamic Asian economies (India, Thailand, Pakistan) that probably have the comparative advantage of low labor cost are ranked first, while developed EU (Italy, Spain) economies and USA dominate in both binary and value version. From the above results in can be concluded that countries with high centrality scores continue to be key players in the rice world trade over time, are highly integrated, more robust and stable. At this point, it should be considered also the well known phenomenon of ‘’size effect’’ of larger countries trading more, in absolute terms, than the smaller ones and the ‘’income effect’’ that richer countries trade more that the poorer ones (Helpman & Krugman, 1985; De Bendictis et al.,2013). The richness of a country should not be directly associated only with GDP per capita, but also the comparative advantage related to natural resources or main factors of production or technology or the intangible asset of know how. On the other side in wood sector, outdegree centrality, based on trade volumes, has remarkable distinction between the highly ranked. The structure remain the same in time with Germany to account for large percent of export flows, followed by China, Poland, Belgium and Austria. Likewise, in binary form of the network, the same countries are in the first places, with main characteristic feature of binary networks, being the low deviation between centrality scores. So these countries have more direct outgoing links to all other pair nodes according both numerosity of links and value of export flows. It is interesting to notice that outdegree indices suggest as highly ranked the same countries in binary and valued form. The same goes for both rice and wood networks.

Considering indegree indices of binary version of rice network within and between years of study, the more central countries with ingoing direct links that take into account only incident import connections, and not the import value, are the developed and highly integrated countries of USA, EU (UK, Germany, Netherlands, Italy, France, Spain, Belgium) and Australia. So the structure of this trade sector is stable and key importers have not changed significantly. When values of export flows are also considered, the rice import trade is dominated by West, East and Southeast Asian countries like Saudi Arabia, Japan, Malaysia, also by USA, important European economies (UK, France, Germany) and South Africa. China that in 2011 was not present in the most central positions, in 2015 is ranked second according to value of received links. It is an indication that the most populated country in the world is evolving in the last years to target market for many countries. The position of Senegal, a low income level country in the highly ranked group of ten in 2015 weighted network denounces probably strong dependence on major players rather than a key role in the rice network. Concerning Belgium and Netherlands we have to consider the ‘’Rotterdam effect’’ associated with the common practice of transshipment ports of Rotterdam in Netherlands and Antwerp in Belgium that handle substantial imports trade. In wood valued indegree measure the trade market is intercontinentally segmented. On one side it is dominated by USA and Canada and on the other side by strong EU economies (France, UK, Germany, Netherlands, Italy, Belgium) and Russia. Russia from 3rd ranking position has dropped to 9th probably due to the fact of sanctions imposed during the period of study with a general slowdown of imports and recession, followed market intervention measures. The same picture is verified, when binary network is considered. Almost the same countries that are receiving the maximum links, are more central, based on both trade partnerships and trade volumes.

As above underlined, closeness centrality infers how easily a country can be reached by other countries. Based on this fact, in rice network, dynamic Asian economies (India, Thailand, Pakistan), USA and important economies of Europe (Italy, UK, Spain, Germany) are more central and more easily reached by other countries. When trade volumes are considered only Germany survives in the competition of shortest path and is included in the highly ranked group of ten first nodes. Closeness centrality might also point to more

flexible nodes, and as such nodes are detected for both years, export flows considered, the vertex of Turkey that is on the crossroad between continents, of Germany, of Denmark and of Netherlands, probably as a transit station with final destination of trading commodities towards other EU countries. It is plain to detect that concerning closeness centrality indexes in wood network, the same countries remain easily reachable between five years time (developed EU economies, China and USA). So the structure of wood sector is not changed substantially and same trading partners and patterns are maintained. Norway having extensive reserves of lumber is ranked in first positions in volume based link comparison and subsequent nodes that maintain their central position from year 2011 to 2015, are India, UK and Turkey. Probably closeness centrality index is not so firm indicator to discern countries occupying the first places, because the value of this index presents uniformity from node to node. So it is suggested the exploration of trade patterns by taking into consideration the index of at least ten countries ranked most central. Moreover, it should be taken into account that centrality indices are only accurate for identifying the most central nodes (Lawyer, 2015; Sikic et al., 2013). A centrality measure that might be optimal in classifying the most influential nodes, but might be sub – optimal for the remainder vertices (Lawyer, 2015; da Silva et al, 2012; Bauer & Lizier, 2012; Sikic, 2013)

Betweenness centrality in the present networks, shows how important is a country in terms of connecting other countries and it assigns highest score to countries that lie on a larger part of shortest paths linking pairs of other vertices. In rice binary network the important intermediaries are USA with large proportion, following by Italy, UK and Pakistan. In five years time, India, that is responsible for great proportion of rice world production, has emerged as highly ranked after USA and Italy. From the dynamic analysis of valued indices it stems that great EU economies (Germany, France) have improved their central position, while Japan and UK has fallen after five years to less central places. In wood sector the binary network between the years maintain the same structural characteristics with the greatest hubs of China, USA and important EU economies (France, Italy, Germany) in first position. In valued wood network a different illustration of countries is depicted with Korea and UK, while more central in 2011, being displaced in 2015 by Switzerland and Norway. The emergence of Switzerland as highly centralized country in terms of connecting other

countries, matches naturally with the fact that it is ranked first in various financial indicators and being one of the largest exporters in the world, despite of its small size.

Concerning, status centrality what actually matters is the centrality of neighboring nodes. So the following countries are trade partners of most important, influential and central vertices. In rice binary network, EU countries (UK, Germany, Netherlands, Italy, France, Belgium, Spain) and USA dominates, while in valued form, Saudi Arabia has the highest centrality score for the time period under study, followed by Japan and USA. It is evident that this oil-based developed Western Asian economy (Saudi Arabia) is a trade partner of countries that were identified as more centralized according to weighted inflow and outflow indices mentioned above. China is ranked 2nd in 2015 and has emerged in five years as a vertex with influential trade partners, displacing Japan and USA in the subsequent positions. For wood network, it follows that the dominating nodes in binary version are from EU countries (Netherlands, Germany, Italy, Belgium,, France, UK), USA, Russia, China and Australia, that remain in the central group of ten for both 2011 and 2015. Weighted wood network is marked by emergence of Canada to second position, after USA in five years time. Canada is the eleventh largest economy in the world according to 2015 data, abundant in natural resources and with well-developed international trade networks. Canada's major counterpart, with close geographical and trade ties, is the most influential node of USA, while efforts are made to expand trade with emerging Asian economies.

In pagerank the main concept is to combine eigenvector centrality with a uniform initial score assigned to each node, and as such the centralities of neighboring countries are those contributing to final centrality score of a node. Countries with high value of pagerank centrality are linked to many other nodes, that are in turn also linked to many others. So rice 2011 binary and valued networks are dominated by EU economies (Germany, UK, France) and also by Singapore that is considered a major hub in many world economic sectors. Singapore's central position is not confirmed over time period of five years, because it is not present in 2015 rice networks binary or valued. USA is highly ranked in binary networks, but not very central in valued ones. In wood sector, main EU economies, USA and China remain central over time in binary version, while in valued version USA and Canada are keeping the leading positions, with Russia retreating from 3rd place to 10th,

implying further alienation from influential nodes, possibly due to political disturbances that affected the economic activity and free circulation of goods in international trade scene.

As it was originally introduced a good authority represented a page that was linked by many good hubs, while a good hub represented a page that pointed to many good authorities. This notion was applied to the current trade network. So in authority results for rice sector, no strong deviation in binary version were observed in all rice networks, with supremacy of EU nodes (UK, Germany, Netherlands) and USA. In valued rice version is evident that Saudi Arabia presented a remarkably high scores, a position that was maintained dynamically through the years of study. The authority structure consists also by USA in both years, while South Africa being the third more influential authority or in other words was linked by many good hubs in 2011, is displaced by Senegal in 2015, probably as a result of high dependence of the latter on most influential hub nodes. Likewise, in wood network, the most important results can be summarized in leading position of EU economies (Netherlands, Germany, Italy, Belgium, UK, France), Russia and USA in weighted and unweighted versions of network. Also, it can be inferred from wood valued network between 2011 – 2015, that USA has strengthened its position becoming the best authority linked by many good hubs and displacing France to a lower position. At the same time Canada emerged in authority scores, while Russia have fallen, with possible interpretation being the financial decline of the latter, due to penalties imposed related to political problems, that isolated and resulted in disconnection from many good hubs.

Finally, good hubs that link to many good authorities were identified. The most remarkable result in 2011 valued rice network is related to proportion of India (36%) and Thailand (36%), followed by USA (8,5%) and Pakistan (7,5%). In 2015, the percentage share in overall centrality has increased in favor of India (63,5%) and dropped against Thailand (15,9%), followed also by lower share for Pakistan (7,9%) and USA (5,7%). This predominance of India and Thailand is not evident from binary networks and despite the fact that these nodes are highly ranked in the binary networks as well, the differentiation from other nodes that greatly stands out in valued network, is not so distinct when trade volumes are not considered. In binary wood network, Belgium and Germany are

dynamically present as highly ranked. In valued 2011 network Germany ranks first and China second with very high difference in proportion, while five years later Germany allows its position to China. In valued 2011 network, the third more central node is Belgium, possessing one of the biggest transshipment ports in the world, while five years later it retreats to lower position, after Canada and Chile that emerged in higher hub status.

It is noticed that developed countries are in the first ranking positions, while countries from more introvert and less developed economies are ranked last and do not tend to make links. Developed EU countries tend to be more central and to make many links, in contrast less open economies or geographically distant are in less central places. Inter - country trade preferences in this analysis are proved geographically segmented with important role played by financially developed countries of EU, America and Asia on one side and Australia, Latin America and Africa on the other, with less central position.

Efforts of detection of possible correlation between the hierarchical position of the countries expressed by network and non network variables was made. Network variables are the centrality measures of indegree, outdegree, betweenness, closeness, status, pagerank, authority and hub for 2011 and 2015, both valued and binary, while non network variables are Grubel - Lloyed index, Exports value for 2011, Exports value for 2015, Imports value for 2011, Imports value for 2015, GDP per capita and GDP per capita based on purchasing power parity.

Indegree indices are positively correlated with imports. This derives from the fact that indegree measures represent import flows from each partner country and which might be an evidence that countries that import more tend to make links with more nodes-countries. Outdegree indices are positively correlated with exports. From the strong positive correlation of outdegree with exports, it is proved that the higher is the value of exports, the more connections each node tends to make. Concerning the remaining non network indicators, indegree and outdegree have positive strong correlation with GDP 2015 per capita and GDP 2015 per capita based on purchasing power parity. Thus it can be inferred that import and export flows are closely related with per capita level of income. The positive correlation of status, authority and pagerank with imports and GDP is possible indication that the higher is the value of commodities imported and the greater is GDP per

capita and GDP per capita based on purchasing power, the more centralized is a node in terms of its neighbor's centrality. Betweenness centrality is strongly and positively correlated with variables of Exports and Imports, which is an indication that the more important is a country in terms of connecting other countries, the higher is its import and export share. Correlation of Grubel - Lloyed index with centrality measures is a way to connect network and non-network variables. Strong positive correlation with indegree and outdegree indices might be an indication of existence of intra-industry trade preferences. Unfortunately no strong correlation was indentified between network variables and indegree and outdegree measures. So intra – industry trade patterns cannot be adequately identified by centrality measures, within this study.

The findings from dynamic network analysis within and between 2011 - 2015, from the analysis of both rice and wood networks, is the strong positive correlation of the same centralities between years of study. This might be an evidence that despite the worldwide changes, the leading importers have not been significantly affected. Also it can be stated that leading countries are stable in their trading attitude and can be flexible enough to readjust their trading partners. The positive correlation through dynamic analysis between years, gives considerable notion that 50 leading exporters in rice and wood sectors have not encountered great falls during unstable time of financial crisis, maintaining in most of the cases their central position. Most probably these countries have absorbed these external shocks through adaptive behavior of decision making units by finding new partnerships and replacing their traditional export markets by new ones or increasing the volumes. Moreover, it could be anticipated that countries affected by economically unstable times, tend to become more extrovert and try to make new links due to mechanisms of self-preservation and survival in a competitive world of flow of goods.

CHAPTER 5: CONCLUSION

The relative position of countries in the world rice and wood networks differ depending on type of bilateral relationship, binary or valued, and the centrality of neighbors. Local (indegree, outdegree) and global indicators (closeness, betweenness, status, pagerank, authority and hub) are used.

From local centrality measures of rice network, taking into consideration the type of bilateral relationship and indegree index, in its valued and binary versions, some useful findings are inferred. Binary measures provide more uniform results, assigning similar values to each node. From binary measures the increased importance of EU economies and USA is stressed. On the other side from valued indegree centrality measure, a framework that emphasizes the importance of Saudi Arabia, USA and the emergence of China in the last five years as important player in incoming links, is received. This might be an indication of strong dependence of oil based Arab world on imports related to other sectors of the economy, (e.g. rice sector or sectors related to food industry or primary sector of the economy). In transition to outdegree index, the next local centrality measure, rice network is dominated by India and Thailand that are two leading exporters in rice sector. This strength of two distinctive nodes is not so evident from binary networks that do not emphasize the volumes rather than only the trade partnerships. In valued version of rice network, outdegree index, that is equivalent to exports trade shares, give prominence to leading exporting Asian economies, followed by strong economies of USA and EU. The structure of network does not change, and the same nodes remain highly ranked with some variation in out - going links. Uniform results are characteristic mostly of local centrality measures (degree indices), that take into consideration only the direct links to neighboring countries.

Closeness, being global measure, provide also uniform results, without stressing some remarkably differentiated node in both valued and binary version of the network. Another featured differentiation of global closeness measure from local degree measures is, that it provides completely different nodes as highly ranked between binary and valued version. While local measures, valued or binary, classify almost the same countries as highly scored, on the contrary, global closeness index, valued or binary, promotes different nodes as most

centered. From the remaining global indicators, betweenness unlike closeness, has distinctive power, both in binary and valued version, promoting some highly rated nodes in both versions. The importance of USA as most significant intermediary is stressed from binary indices. From valued measures the importance of Japan, UK, France and Germany is emphasized. From katz status global indicator and weighted indices, Saudi Arabia is identified as a node with very important neighbors. So this major Asian advanced country is emerged not only as the most important importer (as shown from indegree indices), but also as being partner of most influential nodes. This importance of Saudi Arabia is also verified by authority indices. Hub and authorities global measures, are seen simultaneously in their valued version. Good authorities are Saudi Arabia and USA and they are pointed by good hubs i.e. India and Thailand. Finally from valued pagerank, Germany and other EU countries have more influential partners.

In wood world network and local measure of indegree the dominance of USA is highlighted from valued measures on import side, while from binary measures both EU and USA are considered central when only trade partnerships, and not volumes, are considered. When volumes are considered, the intensity of leading position of USA is evident as main importer. From local valued and binary outdegree indices, the leading position of Germany as main exporter is stressed. Valued indices seems to be more firm indicators of more central nodes, promoting some discrete nodes that yield higher scores. Thus considering outdegree valued indices, wood network is dominated by Germany with more intensity, followed by China and other EU countries.

From global measures of wood world network, closeness provides uniform results with no high discriminating results between nodes. Betweenness, has distinctive power both in binary and valued version, promoting some highly scored nodes. The importance of France, China and USA, as most significant intermediaries is stressed from binary betweenness indices. Valued betweenness measures emphasize the importance of South Korea, UK, Switzerland and Norway. From katz status, valued indices, the importance of USA, France and Canada is stressed. The importance of USA and Canada and the fall of Russia, due to disconnection from influential neighbors, is confirmed also by pagerank valued measures.

Good authorities are France and USA and they are pointed by good hubs i.e. Germany and China. Good hubs, to a lesser extent, are considered also Belgium, Canada and Chile.

From dynamic network analysis from 2011 to 2015 and considering the relation of network and non network variables, valuable information about structural network characteristics, financial interactions and trade interdependence are inferred.

A comprehensive and overall representation of network's structure received through network measures, complements conventional financial indicators. For example indegree measures are positively correlated with imports and outdegree measures have positive correlation with exports. Especially, in valued version, this is a natural consequence of a network variable, indegree and outedgree measure, being similar or identical to imports trade share and to export trade shares respectively. From correlation of local network measures with non network variables of Gross Domestic Product, it can be inferred that import and export flows are closely related with per capita level of income. From betweenness centrality correlation with imports and exports is inferred that the more important is a country in terms of connecting other countries, the higher is its import and export share.

From dynamic network analysis between years, the same network indices of one year have strong positive correlation with same network indices of the next year of study, implying that world rice and wood sectors are not so prone to transmission of international shocks and despite the worldwide changes due to financial crisis, leading exporters have not been affected significantly. The agricultural and forest trade networks are stable, adaptive and resistant to external shocks. The overall rice and wood world networks follow the notion of evolution to more dense networks over time, higher integration into world trade and have relatively stable structure with main players holding key positions.

In addition to the above conclusions, relating to inter - country trade patterns, further interactions of financial interconnections can be explored. The dependence of inter - country trade on the degree of economic development or geographical location and comparative advantage due to weather conditions or seasonality, can be investigated. Moreover, the notion that larger countries use to have trade patterns with trend to trade more than the smaller ones and possible preference to few high valued links rather than

many of low value might become the object of coming research. Also patterns of small economies to be more open and more extrovert can be studied. Especially, in case of extended sectoral networks, characterized by high dimensionality and strong heterogeneity due to their size, the structure of entire network can be analyzed, contributing additional information to conventional economic indicators. Network analysis could be a promising ground for future work, being a carrier of considerable added value in the field of agricultural trade and primary sector in general.

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APPENDICES

Appendix Table 1: Adjacency matrix (Exports 2011 – Rice Network)

	IN	TH	US	PK	IT	UR	BR	AU	CB	CH	BE	GU	NT	SP	AR	PA	RU	GE	EG	UK	SA	FR	SI	GR	TA	SE	JA	PO	MA	KA	LA	PL	TU	UG	ES	BU	NI	OM	RW	CZ	HK	DE	RO	SL	SR
IN		706	104.845	584	20.350	0	62	20.176	0	0	18.464	1	31.799	6.479	33	0	3.096	18.141	20.849	133.454	67.930	18.420	36.877	1.432	64	33.662	40	1.770	8.488	11		437	21.050	358	18	334	41	36.358	0	34	1.086	585	71	5.639	736.552
TH	267	0	494.727	9.899	16.125	0	399	92.950	2.824	235.352	47.565	0	41.182	21.940	15	0	24.112	22.337	3.594	47.197	332.473	84.809	161.097	1.057	20.881	104.863	155.975	1.784	200.294	90	9.284	5.459	5.643	0	0	255	9.068	7.297	0	7.715	218.031	4.177	123	197	82.473
US	811	1.688	0	18.004	164	17	483	11.050	843	309	3.891	11	7.205	973	158	0	2.975	8.207	30	30.377	1.378	3.402	8.031	45	16.479	5.927	302.841	0	1.161	0	1.453	257	44.955	0	34.642	0	6.754	172	0	514	1.422	525	0	292	112.690
PK	0	541	15.622		14.832	0	55	17.527	0	9.732	34.707	0	11.364	7.569	35	0	19.025	13.496	9.996	65.824	29.521	8.693	2.218	2.252	19	20.786	461	936	77.125	0	0	759	46.683	233	0	435	229	104.978	63	242	2.324	1.777	835	10.830	95.188
IT	178	131	13.821	0	0	22	3.882	3.637	21	153	39.782		38.818	8.692	150	0	2.622	117.179	66	56.098	490	137.760	250	9.598	88	0	219	4.002	31	6	0	23.048	17.921	0	5	2.142	0	13	0	35.777	357	6.516	6.680	0	57
UR	0	0	18.657	431	1.053	0	79.152	34	0	1.973	15.431	0	3.647	7.363	2.039	241	4.884	9.162	0	8.655	2.130	266	17	0	0	22.632	0	14.049	0	0	0	2.477	8.419	0	42		221	0	0	0	0	0	0	0	0
BR			10.998		6.236	646		1			3.598	0	12.147	16.674	2.142	400	1.814	1.696	30	3.427	44.818	158	1.485			45.424		7.124					4.718				0				0			1.158
AU		0		0										41									43						4															
CB			1.714	0	2.659			960		170	3.099		6.443	729			12.503	2.714		2.358	0	29.034	499	144	0	0	0	2.464	12.285			14.347	0			2.225				504	604	24	2.263		0
CH	0	0	0	16.664	0			0	0		0		0	0			4.262	0		0	9.700		2		0		26.055	0	0	1.372	19		1.034	0			0			23.479				0
BE	272	11	101		2.533			883					20.334	736			2.596	61.362		27.066	1	111.293		4.668		642		315				4.762	16			0	0		0	1.448		2.540	192		
GU			3.184		0		0				1.433		3.259	2.874				2.445		2.082		615						8.866				115	18												
NT	0	219	4		4.994		0	1	0	0	13.923			1.321			0	70.953	0	22.435	4	30.236	4	1.887	0		0	52		0		4.168	3			2				368	27	5.725	272		23
SP	194	0	7.386		2.640	2	0	1.023	0	0	50.658		13.099		26		27	10.654	0	43.468	3	15.757	22	115	0	0	9	6.660	0	0		49	2.409			3.789				118	16	131	445		2
AR			1.882		2.802	829	120.508				922		9.920	10.902		225		1.673		1.277	92	0				25.015		4.356				2.796	3.951									340	0		
PA			0		0	0	67.192				0		151	148	819		0			0	1.863	0				0		245				0													0
RU			46					0			0		510	0				7	0	434					1					0			59.232			0				0					
GE	0	0	122	0	1.887		12			0	2.843		8.642	803	0		67		0	6.020	4	5.197	0	1.099	7		1	198	10	2		19.982	2.466			104	0	1		2.454	0	18.906	175	0	0
EG	0	0	0		25			0			9.713		46	352			0	35		6.065	0	0		0	118			0				0				71	0	0			0	0	0		20
UK	465	216	317	61	4.748			37		2	2.632		5.674	1.825			69	8.547				11.432	36	108		0	2	245				220	0			1		2		360	76	616	14		13
SA	0		18	0	0		0	40		0		0	0					0		9		0	0	0									12							0				
FR	260	0	323		11.040		65	0	0	0	12.140		4.170	7.600			0	5.829		15.826		0	0	164	0	61	0	2.018				840	0			299	0			233	0	1.191	506		34
SI	0	700	109		0			110	52	35			0					7		17	0	61			11		0		5.911											152	114			0	0
GR		27	9		1.510			52			1.478		5.140	1.551			0	2.566		2.840		1.188				0		219				19.240	2.693							1.761		737	15.890		0
TA	0	0	114			0		459	1	7			38					12		25	130	9	34				301	0	373															0
SE					0									0						347		20										10.526													
JA	0	72	301	0	0	0	6	472	0	0	10		35	3			168	186	0	215	0	167	2.296		830			0	72		0						0			3	3.218	3			25
PO		0	20		457		4			0	71		264	5.293				64	0	2.403	0	4.419				0						33	0			0				0	0	0	0		0
MA	0	0		0				0	0	0											0		339																				0	
KA					203					0							3.587	0															374												
LA		21	0		71					2.147	0		230	144				159		71		1.071	0					8			0									0	0	0			
PL			150		50				0		1		1.299	0			0	70		245		130		1				0		0						0				5.401					
TU	0		287	39	0			13	0	0	401		18		0		104	594	9.681	1.028	1	20	2	244		0				62				0		63	0				0		0	1	0
UG				0																						25							0				0	926					
ES			0																																									
BU			0		133						0		156	0				0		4		0		182				0				113	3.961							159			13.944		
NI	0	3.235	0	1.318	141	0	0			0												0	0						0			60								0				
OM	0			0	0													0				0										0												
RW				45																																								
CZ					46						0		0	0			0	887		2		0										717				43							0		
HK	0	0	1.356					70		652				0						419	23	0	0		1				12					1										
DE	0		219	24	6	0	0	0			0		0	0	0		0	227		3		0	0	0				1				0	0			0				0	0		0	0	
RO					1.394						0		0	0				0		20		0		302								28	20.023			2.609				57					
SL	16		192	0	167			483		0	0		44					58	0	801	1	161	69			0			0				0				0				1	10	27			185
SR	0			0																																								

Appendix Table 2: Adjacency matrix (Exports 2015 – Rice Network)

	IN	TH	US	PK	IT	UR	BR	AU	CB	CH	BE	GU	NT	SP	AR	PA	RU	GE	EG	UK	SA	FR	SI	GR	TA	SE	JA	PO	MA	KA	LA	PL	TU	UG	ES	BU	NI	OM	RW	CZ	HK	DE	RO	SL	SR
IN	0	1.517	159.830	1.049	30.280	0	70	39.050	37	1.044	39.394	3	44.230	4.112	67	0	26.280	16.424	17.853	160.047	107.868	27.898	74.729	1.586	157	250.434	459	5.595	31.199	381		4.052	101.219	749	0	873	15.496	118.766	264	371	1.649	1.695	716	81.944	1.072.002
TH	376	0	406.221	101	11.930	0	406	61.675	1.970	472.009	34.116	0	29.949	17.922	67	0	13.721	12.968	2.820	33.049	221.969	55.709	106.294	469	14.752	82.005	114.763	2.222	177.919	0	69.099	3.007	6.185	141	0	26	32.411	2.072	47	6.300	174.516	4.023	0	187	50.071
US	1.143	1.441	0	286	509	53	520	12.002	2.285	19	860	80	4.657	2.733	15	0	896	6.599	34	17.528	975	3.573	6.500	296	44.403	98	277.948	115	742	0	356	387	68.527	0	15.728	0	0	6	0	780	1.316	402	0	501	87.860
PK	0	483	30.568		15.565	0	59	17.256	0	167.050	42.222	0	16.135	18.100	52	0	20.370	9.383	514	54.052	5.061	8.365	1.740	1.284	46	25.771	723	2.293	68.617	6.990	0	1.001	6.881	0	0	339	0	104.898	0	249	2.170	3.416	334	9.684	87.937
IT	216	110	13.739	33	3	111	4.753	3.421	7	189	40.284		20.848	8.506	52	14	1.096	113.767	101	61.060	327	106.423	288	5.953	273	0	200	2.809	82	15	0	16.980	22.853	2	19	1.617	0	10	4	16.936	698	6.311	2.642	5	390
UR	0	0	3.589	0	373	0	19.398	18	0	25	8.572	0	825	1.914	1.762	1	0	4.408	0	4.213	663	918	0	0	0	0	0	0	21	0	0	0	0	0	253		0	0	0	0	0	115	0	0	0
BR			13.682		274	206		0			1.319	3	3.821	141	451	378	0	0	0	469	4.013	5	0			31.450		88					0				0						0			5.398
AU		0		0										0									0						0															
CB			1.699	0	12.450			1.490		41.698	11.517		21.064	5.060			1.767	9.644		9.932	43	51.135	4.856	4.483	175	44	0	5.430	37.086			23.477	120			3.522				9.911	3.050	1.980	3.132		107
CH	0	0	1.346	19.527	0			318	0		17		39	21			2.117	56		50	0		144		163		32.652	0	18	320	0		77	19			0				18.364				41
BE	0	0	0		4.825			570					18.356	1.059			161	55.589		30.283	0	73.545		3.187		0		240				5.664	1			26	0		4	3.259		3.961	153		
GU			7.638		17.746		8.902				1.061		4.012	14.205				0		1.894		5.540						15.333				288	0												
NT	11	0	0		2.146		0	0	0	0	15.055			2.411			0	81.930	1	27.595	4	32.160	13	700	0		0	457		1		5.500	5			180				1.317	0	2.250	466		19
SP	253	0	6.387		3.169	1	26	909	0	6	36.672		15.849		44		30	7.334	0	30.918	21	13.796	36	803	15	7	5	16.880	3	0		1.458	3.008			2.218				68	68	212	2.029		1.961
AR			4.613		329	146	32.548				1.237		46	15		642		588		90	18	21				6.561		0				0	0									366	0		
PA			375		0	0	95.926				3.686		3.502	6	1.852		0			106	0	0				0		29				0													60
RU			104					1			0		0	0				39	0	1					1					14.752			19.775			0				0					
GE	0	0	252	0	3.342		0			1	2.821		5.963	692	0		11		0	2.566	3	3.671	1	537	0		2	109	13	15		39.680	233			60	1	5		2.166	0	6.046	116	1	0
EG	0	0	188		1.266			0			18.864		2.254	2.238			0	1		8.034	0	600		4	0			0				2.407			158	0	0			0	80	1.647		10.024
UK	29	10	6.193	0	4.351			700		2	3.433		5.993	1.886			3	7.301				12.189	6	121		7	0	285				426	12			17		3		849	102	864	248		60
SA	0		132	4	0		33	9		0		1	0					0		8		1	0	0									15								0				
FR	0	1	4		9.548		91	0	132	0	12.224		5.694	6.243			2	7.657		11.387		37	3	9	1	29	0	686				850	436			2	6			247	5	569	47		92
SI	40	58	602		0			37	0	76			51					25		21	0	0			8		127		1.784										0	8			106	0
GR		0	18		2.813			63			24		2.165	18			0	561		3.002		883				1		42				6.516	8.621							1.100		0	7.466		1.107
TA	0	0	247			0		701	1	904			70					18		84	75	35	382				23	6	367																0
SE					0									4						1		0											0												
JA	0	306	852	0	102	0	5	694	66	2.401	7		118	7			80	236	0	495	0	119	3.829		2.216			2	335		0						467			0	5.446	0			96
PO		0	20		3.132		11			2	569		1.767	4.881				834	0	2.027	153	3.727				5						752	4.534			2.102				72	2	0	1.179		1.088
MA	2	0		0				2	0	127											0		782																				0	
KA					0					0							5.110	0															0												
LA		3.869	92		137					22.993	45		233	50				501		104		929	0					0				0								22	0	195			
PL			122		15				0		28		1.999	8			102	579		2.189		6		29				0		1					0				5.922					
TU	0		474	0	346			26	18	0	1.106		32		0		173	48	0	118	4	20	0	1		0				51				1		10	0				3		3	0	227
UG				14																						0												72	2.169					
ES			5																																									
BU			3		5						0		0	33				4		78		1		137				149				239	8.054							305			10.317		
NI	9.770	8.709	249	140	0	0	0			26												0	40						0				0								0				
OM	22			277	0													6				0											0												
RW				0																																								
CZ					65						5		6	0			0	2.543		7		39										471				58							36		
HK	0	48	1.106					25		498				66						281	0	0	2		0				0					0											
DE	1		2	0	772	0	0	0			78		22	55	0		5	684		197		2.863	0	7				61				126	1			16				18	0		35	0	
RO					4.607						2		0	1				229		104		4		333								38	0			387				1.125					
SL	84		206	8	256			736		0	24		15					131	0	555	0	114	6			2.581			0				0				0				0	6	31			166
SR	255			44																													398												

Appendix Table 3: Adjacency matrix (Exports 2011 – Wood Network)

	GE	CH	PL	BE	TH	AU	CL	FR	SP	CA	MA	TU	US	NZ	BR	IR	RU	RO	IT	PR	IS	HU	BL	NE	SW	LU	SV	AR	PA	UK	AL	NO	CZ	SA	LI	KO	FN	BU	SL	ES	UR	IN	SE	GR	EC	ST	JA
GE		7.779	125.165	87.721	1.164	89.347	20.009	210.920	77.560	37.250	224	116.126	19.619	180	1.606	6.054	100.053	38.173	79.943	16.344	689	26.243	10.374	154.708	94.415	6.885	16.041	4.467	277	98.020	9.181	25.035	36.606	9.654	17.122	1.251	40.192	12.170	21	8.268	35.342	5.492	19.306	3.488	2.658	79.270	656
CH	434		296	1.410	8.280	2	15.116	3.184	5.214	110.399	11.979	3.080	295.123	930	13.519	3.637	140.960	25.277	2.830	2.057	6.640	38	846	1.242	239		104	11.256	4.430	11.509	26.013	180	87	16.138	769	40.731	1.283	2.969	1.487	112	17.593	31.510	504	2.363	7.057	62	31.793
PL	81.914	146		4.228	148	2.260	440	14.548	5.261	2.263	7	11.452	3.927	0	745	141	25.775	19.606	17.840	1.131	10	5.567	15.618	12.419	40.491	408	1.582	0	261	18.577	196	9.660	12.117	1.177	43.852	0	10.001	4.808	30	5.170	54.367	871	3.657	364	0	4.008	93
BE	26.700	9.539	13.065		76	1.200	979	169.473	57.478	1.673	403	6.368	9.818	728	1.763	2.410	57.736	1.350	17.503	3.324	1.138	778	644	85.636	5.982	1.341	798	94	130	64.729	5.605	14.493	18.278	1.556	1.430	7	10.564	748	146	3.138	7.391	1.783	347	1.690	501	12.726	285
TH	0	17.036	0	1			32	0	0	393	6.393	0	6.084	580				0	26		7.500			5				12.593	2.455	1.274	0		4.140		2.347			3.964		41	5.540					0	925
AU	101.320	2.245	6.631	4.397			6.801	54.212	8.035	61.147	114	4.040	24.949	297	87	2.354	10.810	7.303	30.379	513	87	8.892	63	10.250	2.173	156	5.270	2.325	0	4.339	1.878	322	7.260	1.161	645	100	578	1.883		787	2.218	360	8.315	1.015	428	14.490	186
CL	1.902	954	116	476	0			0	172	25.455	0		96.863	0	349	10	283		216	0	260			72	20			465		0	69	0	0	605		653						250			15.847		2.119
FR	47.966	8	11.612	125.672	0	57	249		16.009	242	60	1.970	140	2	3.867	131	7.789	804	53.573	5.974	29	85		8.902	522	523	4	4		2.781	71	446	249	2	199	59	385	11		340	370	160	242	204	39	4.182	0
SP	4.455	121	6.220	1.215	0	91	1.633	34.730		272	11	938	8.730	98	376	3.964	567	435	15.050	84.863	23	11	0	23.360	2.980	1	6	0		43.836	471	1.919	35	315	0	0	1.464	412		0	129	589	81	572	39	1.016	0
CA	0	106	59	2.218	0	4	43	6.799	266		0	432	207.064	194	0	0	0		0	12				1.889	0					1.731	0		0	0	14		0				0	0		0			2
MA		4.175			1.212		30	0		244		166	11.083	95					0		27.982			740					17.338	3.813	10.789			4.085		313			5.630		0	12.194	109					83.693
TU	165	0	82	67		0	0	17	175	15	0		74	0	0	0	13.388	2.197	391		0	23	168	28	50	0	0	96	679	152	7	11	0	31	1		0	3.895	0	0	3.695	2.925	3.550	636	0		
US	1.092	2.140	60	341	71	19	650	825	134	163.859	71	417		560	645	64	6.604	52	253		26	26		112	2.654			76	80	3.768	4.211	284	50	40	62	1.436	393	0	0	48	0	1.880		32	168	64	331
NZ	0	21.332			988		0			1.087	5.727		11.969				0				16.816			0					17	0	5.253			316		379			0			2.931			1.496		94.957
BR	0	0	0	3.970			94	3.262		758	0	0	22.177	0			3.244	0	710	69	0			71	1			1.630	7	124	155	0		13.835	40	2			0	0	306	0			847	218	0
IR	6.850	4	926	4.033		0	0	12.496	337	0	169	149	80	124	0		1.565		3.067	7	106	57	0	11.547	861			0		104.896	7	5.043	430	148	174	57	163			1.275		1.135	31			514	0
RU	1.018	0	0	6		35		206	0	0		1.573	0					94	114			90	0	18	410				0	110			4		121	0	1.409	62		540	7.854	0	1				0
RO	402	0	1.346	9		0	0	1.928	79	0	45	76.858	0				794		11.046			8.170	1.951	93	281	0	7		1.056	1.172	0	15	1.120	0	0	0		2.227		0	5.024	1.338	7.251	9.474		10	
IT	8.949	5.405	343	447	0	1.194	0	5.111	11.601	484	0	21.858	1.556	2	791	62	5.418	1.434		97	21	419	5	489	453	4	5.320	361	9	1.524	385	115	141	30	36	0	886	102		237	211	835	206	1.109	0	6.488	664
PR	8.677	311	7.495	1.627	0	716	157	8.955	49.523	0	0	115	225	0	97	61	18	3	7.661		34	453		7.123	3.859	147	109	0	0	4.093	16	76	0	457	112	174	84	29		0	0	132		91	137	69	2
IS	0	3.301			0	0		0			1.717		146	0					0									381		4				4	0		0				6.519					911
HU	9.566	0	962	2.385		196		2.586	103			1.002	0				0	18.814	16.299	0			0	1.654	12	90	843			1.974	15	16	2.824	0			0	1.567		0	2.075		7.613	1.194		116	0
BL	28		220	7		0		0	0			0				0	26.140	0	0			31		0	0								0		130			0		2.488	2.564		21				
NE	34.527	37	276	12.869	0	975		1.713	207	42	0	43	240	0	0	244	3.445	231	282	50	4	149	0		2.215	45	206			6.669	533	672	236	129	399	18	1.144	387	55	143	36	0	118	274		552	0
SW	2.193	1.152	819	5.920	152	123		8.424	8.231	191	0	48	459		1	311	7.506	60	3.762	129	0	47		1.094		44	4			2.437	297	53.586	282	1.091	1.561	106	9.352	133	0	302	0	1.943	5	43		3.756	8
LU	10.597	0	369	10.758		1.332		62.692	5.953			0	0			0			2.350	384		0		9.192						1.528			0	0		1.046	0							10	
SV	5.608	244	472	0	21	1.070		53	60			189		0			16	620	21.924			586		1	965					0	0	105	82		19	25	1.764	237		957	0	523	2.993	1.584		365	183
AR	158	194					1.323	0	161	6.316			6.375		50.417				1		0								314	34			11.262		0								206		0
PA							0						0																0				0					296			0				
UK	654	88	47	10.113	0	0	251	790	1.976	14	141	0	994	24	0	21.498	176	1	210	48	0	0		4.340	2.603	29		1	0		0	2.022	33	5	15	0	50	10		6	4	17	16	13		39	37
AL		11.945			32		0	613	0	94	345	23	669	532							2.760			969						0				0		1.165		11			26					3.209
NO	118	34	714	3.130	110			6	0	37	0	25	157		0	294	2.026	0	0	0		2		360	16.966				15	696	43		2	0	209	1	3.194	0		325	42					0	
CZ	1.598	3	3.233	19		595		0	1	0		0	2			0	2.108	0	21	0		1.031		439	6.497	0	1.998			0		0		0	1.666		296	441		162	319					26	0
SA	0	63	2		17	127		21		0	112		0	875					0					0				20		184	16.862										0					
LI	359		6.729	175		0		4	0				0			1	2.967		46			343	188	1.260	3.493		0			587		148	288				1.242			2.866	22			0		13	
KO	587	683	0	0	66	0		0	0	0	112	1.595	58	0	59		1.289		1		195			22	0					1	566	0	23	31	0		0		0			274				5.002
FN	112	0	0	149	673	0		86	13		109	0	0	111		0	293		25		83	0		480	9.179				39	8.477	128	741		14	0				719	13	0	0			3	
BU	47	0	151	548		0				0	52	1.067	1				13	4.432	12.376	123		168	0	0	0	0				0	35	0	0	0	27	0						10	1.590	3.124		0	
SL	0							82			0								1					0					2.648		0										17.726					
ES	1.975	71	0	150	0	1		17	318		0	0	14		0	0	2.158	10	80	0	11	0	29	480	2.253		0		17	790	0	3.546	2	0	99	10	5.509	122			94	130		36		3	50
UR	153		58	51		0			0	0		280					13.308	1.935	69			574	2.888	83			81			0			43		124			0		534			0	6		0	
IN	18	112	17	0	209	0	0	9	0	73	110	0	146	0	29	0			0		91			10	5		0	0	0	27	119	9	0	0		19	0		280					15	0	8	0
SE	508	0	0	1.736		0		0	11			79					9	350	91			158	0	53	72		9			0		9	10					84						9		2	
GR	11			4		0		29				296	0				0	240	612	0				0			0		0		12							3.332			2.396	0	766			0	
EC							577	1					28		124																			80													
ST	0	0	0	0		0		0	0	0		0	0	0	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0		0		0	0	0		0	0	0	0				0
JA		3.853			22					0	46	0	9	0			0				657				0						0				175				12						

Appendix Table 4: Adjacency matrix (Exports 2015 – Wood Network)

	GE	CH	PL	BE	TH	AU	CL	FR	SP	CA	MA	TU	US	NZ	BR	IR	RU	RO	IT	PR	IS	HU	BL	NE	SW	LU	SV	AR	PA	UK	AL	NO	CZ	SA	LI	KO	FN	BU	SL	ES	UR	IN	SE	GR	EC	ST	JA
GE		23.636	102.010	91.010	580	91.963	23.035	157.301	72.430	56.253	117	46.468	86.861	482	507	9.099	64.777	37.741	71.225	13.900	984	23.520	5.349	146.360	77.848	8.238	13.154	5.266	403	121.241	9.729	24.154	28.370	10.930	12.121	319	29.956	14.833	106	7.063	14.196	4.298	15.664	3.565	1.416	72.765	275
CH	618		448	2.027	11.338	8	22.000	2.075	3.481	86.256	14.661	1.366	305.055	2.682	3.303	5.116	75.745	9.243	1.501	439	4.945	248	118	741	239		185	4.871	14.484	21.853	41.529	639	123	17.338	502	34.645	244	719	3.297	48	2.531	38.322	466	1.134	8.149	20	29.042
PL	121.499	770		4.490	541	4.419	263	19.526	7.400	1.543	196	8.260	7.911	125	565	899	21.122	38.907	22.244	578	402	12.683	9.501	12.906	30.433	473	1.184	191	452	16.200	256	18.251	12.530	801	45.493	5	7.611	6.905	0	5.396	19.931	434	3.750	67	104	5.718	72
BE	23.183	9.725	11.580		67	251	392	136.058	30.606	4.701	835	5.801	9.481	1.586	672	3.119	16.691	2.699	20.438	2.916	1.067	140	231	67.773	34.181	897	215	205	125	78.675	10.289	12.366	5.234	1.542	1.967	65	6.476	434	44	1.102	3.336	2.120	187	503	216	4.750	79
TH	18	5.927	0	0			0	11	0	299	9.228	114	8.490	122				0	0		3.838			0					6.866	3.734	380	10		2.271		5.661			4.658		0	12.724				0	875
AU	94.627	2.068	10.020	1.660			7.868	45.090	6.337	34.878	1	4.060	49.820	281	457	1.793	2.037	4.897	9.074	724	0	11.499	305	4.791	86	743	2.494	2.160	34	7.167	2.336	65	8.424	1.096	466	0	1.064	1.592		332	679	537	5.363	59	198	4.195	419
CL	1.525	103	68	594	0			18	174	26.996	44		174.146	7	7	0	860		120	0	0			0	19			520		1.203	23	700	0	0		402					122			5.585		326
FR	27.790	130	4.426	142.175	6	2.065	1		24.091	416	30	1.079	312	7	2.056	258	2.026	1.016	51.753	5.127	0	1.268		7.112	634	764	21	0		3.917	204	24	2.069	7	309	28	841	111		457	153	53	102	246	0	14.704	103
SP	2.329	540	5.259	347	262	62	4.120	21.888		3.256	0	1.432	7.330	108	270	8.391	1.560	152	11.264	71.581	215	41	155	16.230	1.938	0	0	74		44.582	694	1.330	71	442	28	21	1.058	262		66	119	834	20	379	22	1.135	0
CA	19	78	0	719	0	0	2	3.136	58		0	85	286.022	429	0	0	38		12	0				218	0					3.222	0		0	2	0		0					0	0		52			21
MA		924			191		0	2		272		215	10.768	863					29		11.151			147					20.081	1.658	12.402			1.658		783			5.498		0	4.306	0				55.325
TU	331	92	37	5		2	692	65	17	1.262	0		1.432	46	0	125	4.905	5.194	9		0	537	473	17	50	11	2	17	435	49	172	16	2	167	0		1	4.355	7	18	1.673	1.152	5.207	1.387	74		
US	432	843	6	1.443	351	0	539	475	49	155.629	12	377		766	43	28	124	0	223		5	50		86	25			45	59	3.164	3.587	18	126	15	31	136	17	0	0	47	0	1.444		61	33	22	749
NZ	0	19.008			400		2.189			1.114	3.955		15.972				0				16.830			0					428	0	3.977			41		792			16			4.099			727		92.275
BR	71	14	0	3.799			111	557		116	24	1.070	41.907	0			229	0	380	0	283			7	105			4.956	0	39	150	14		4.765	44	160			70	11	0	472			1.674	0	0
IR	6.243	0	810	2.733		54	588	7.787	655	0	158	0	83	200	0		43		1.131	0	538	166	1	11.472	4.559			0		112.159	118	479	437	1.213	251	0	204			1.153		19	0			836	0
RU	1.221	44	3.062	226		91		0	0	141		10.372	17					3.201	0			57	19.554	157	80				0	0			0		915	0	380	623		2.621	4.015	116	48				0
RO	788	58	343	2		0	118	1.060	26	2	337	49.925	4				503		16.502			1.937	782	24	166	0	23		552	2.787	0	0	935	43	2	829		2.616		1	2.078	600	6.830	8.876		0	
IT	8.824	3.893	1.312	249	199	1.525	17	4.860	6.287	376	33	4.995	3.763	46	322	166	6.260	1.841		311	174	510	24	1.102	58	4	6.373	153	497	1.626	398	178	303	247	87	75	122	674		29	83	1.516	311	3.090	5	4.151	524
PR	1.870	15	4.487	980	0	438	913	7.001	38.362	27	1	33	1.009	496	47	374	45	33	5.052		0	46		12.249	660	125	3	20	25	3.109	743	237	0	1.765	0	94	23	0		3	0	166		0	0	897	2
IS	13	2.247			19	1		132			4.939		338	0					11										865		45				2.439	0		37			9.068					2.543
HU	8.190	132	2.881	1.189		286		1.621	1.192			1.227	4				1.920	10.553	21.479	28			0	176	0	47	377			1.436	0	0	3.185	53			1	1.931		15	412		7.045	1.467		202	0
BL	2.153		14.912	0		4		23	0			4				6	37.040	0	187			167		41	1								45		1.682		7		1.216	4.096		5				
NE	32.172	22	537	13.450	7	1.185		1.860	332	344	0	190	1.525	0	35	539	1.652	157	295	134	9	225	9		2.679	124	315			5.473	27	2.549	370	4	455	0	720	535	0	69	37	61	142	104		648	5
SW	108	9	35	587	8	21		99	24	0	3	13	42		0	183	403	7	69	16	0	10		154		0	0			291	5	45.092	21	0	41	0	5.127	2	0	308	0	0	2	4		18	2
LU	10.253	25	0	9.770		6.124		19.289	4.326			3.668	0			28			2.263	0		15		4.682						134			22	85			163	623							11	
SV	3.150	793	598	26	0	445		100	0			993		0			173	864	25.250			461		28	637					0	57	22	350		1	355	979	1.076		1.078	0	784	2.598	1.002		148	0
AR	21	312					214	0	167	14.770			1.942		663				0		158									77	0			594		0								56		0
PA							0						8																	0				8					0			0					
UK	602	0	5	4.303	0	1	70	464	413	6	25	0	500	43	0	13.389	24	3	4	2	0	2		2.424	197	26		0	3		1.669	1.131	3	12	10	1	8	0		23	29	10	20	6		163	3
AL		13.368			5		27	306	0	0	175	0	790	3.082							986			859						0				180		1.941			0			256					2.822
NO	166	0	192	1.899	65			0	51	0	24	37	7		0	193	31	2	8	0		0		190	14.407				14	144	22		2	0	121	0	2.710	0		560	0					1	
CZ	2.766	30	2.506	17		868		388	582	16		15	4			79	30	192	285	0		1.049		657	4.511	0	1.205			12		6		10	335		98	502		77	68					454	0
SA	0	50	0		36	0		0		0	1.009		0	359					0					0				0		0	13.991										0					
LI	1.149		7.050	396		37		162	0				0			0	2.017		79			292	137	997	2.382		0			1.371		61	1.135				1.267			870	6			0		0	
KO	61	335	0	0	51	0		46	0	0	458	10	293	22	24		830		16		290			5	0					0	736	4	0	37	0		0		2			84					6.387
FN	736	0	10	433	0	0		65	0		0	0	4	0		0	116		93		0	0		696	8.789				0	7.085	14	633		0	0					503	0	0	0			3	
BU	3	16	0	11		6				85	0	1.373	0				0	1.443	10.714	8		108	2	0	86	0				40	27	0	4	67	1	35						144	267	2.974		0	
SL	0							0			0								0					0					7.835		1											6.936					
ES	2.806	10	22	0	0	0		47	0		39	0	0		0	10	2.122	7	0	260	0	51	31	677	2.050		9		0	1.652	46	1.428	20	309	186	9	5.854	26				151	0		16		0	0
UR	15		1.870	308		4			6	11		61					3.509	2.452	264			522	1.889	99			39			1			13		54			20		64			6	0		0	
IN	17	2	0	0	313	0	6	3	8	23	121	0	567	1	9	0			3		52			3	1		0	2	3	54	89	0	0	0		13	0		12				0	5	1	6
SE	1.675	0	0	1.341		1		48	0			27					150	1.278	804			252	0	0	583		11			2		0	1					99						432		152	
GR	24			5		3		0				18	0				0	170	27	1				1			3		16		0							3.139			0	0	213			0	
EC							127	0					50		0																				0												
ST	2.689	0	227	19			61		183	412	9		21	95	145	19	124	0	139	61		1	4	19	2	0	1		2	579	73		4	14		3	0	41		0	1	1	2				0
JA		3.575			30					0	20	0	10	0			0				340				0						13					82					78					

Appendix Table 5: Centralities (%) valued and binary 2011/2015 (Rice Network)

Id in Vis.	Country	indeg valued (2011)	indeg valued (2015)	indeg binary (2011)	indeg binary (2015)	outdeg valued (2011)	outdeg valued (2015)	outdeg binary (2011)	outdeg binary (2015)	status valued (2011)	status valued (2015)	status binary (2011)	status binary (2015)	pager valued (2011)	pager valued (2015)	pager binary (2011)	pager binary (2015)	author valued (2011)	authr valued (2015)	author binary (2011)	author binary (2015)	betwn valued (2011)	betwn valued (2015)	betwn binary (2011)	betwn binary (2015)	closen valued (2011)	closen valued (2015)	closen binary (2011)	closen binary (2015)	hub valued (2011)	hub valued (2015)	hub binary (2011)	hub binary (2015)
IN	India	0,0%	0,2%	1,3%	1,9%	18,2%	30,3%	6,3%	5,8%	0,0%	0,2%	1,5%	1,9%	0,5%	1,4%	1,3%	2,9%	0,0%	0,0%	1,6%	1,5%	0,7%	0,9%	2,6%	8,2%	2,6%	0,8%	3,6%	3,5%	36,7%	63,5%	5,4%	4,9%
TH	Thailand	0,1%	0,2%	2,0%	1,6%	33,3%	27,6%	6,3%	5,5%	0,1%	0,2%	2,0%	1,6%	1,2%	0,8%	2,0%	1,6%	0,0%	0,1%	2,0%	1,6%	0,1%	0,0%	4,6%	3,6%	0,8%	1,6%	3,6%	3,3%	36,4%	15,9%	5,4%	4,7%
US	USA	9,1%	8,2%	4,5%	4,6%	8,5%	7,0%	6,1%	5,4%	8,3%	7,8%	4,4%	4,2%	3,6%	5,1%	4,6%	4,6%	14,5%	8,4%	3,9%	3,8%	1,6%	2,2%	17,7%	20,1%	2,1%	2,4%	3,5%	3,3%	8,5%	5,7%	4,9%	4,4%
PK	Pakistan	0,6%	0,3%	1,7%	1,6%	8,4%	9,1%	5,9%	4,9%	0,8%	0,4%	1,6%	1,4%	1,6%	1,6%	2,4%	2,5%	0,4%	0,0%	1,4%	1,2%	1,4%	1,5%	9,5%	6,9%	2,1%	0,9%	3,4%	3,1%	7,5%	7,9%	5,3%	4,6%
IT	Italy	1,3%	1,6%	4,3%	4,2%	7,1%	5,6%	5,8%	6,1%	1,3%	1,6%	4,2%	4,1%	3,1%	4,2%	4,5%	3,6%	1,0%	1,1%	3,6%	4,1%	1,5%	1,2%	12,5%	13,1%	1,7%	2,4%	3,3%	3,5%	2,4%	1,3%	5,1%	5,1%
UR	Uruguay	0,0%	0,0%	0,8%	0,7%	2,7%	0,6%	3,8%	2,5%	0,0%	0,0%	0,9%	0,8%	0,4%	0,4%	0,8%	0,9%	0,0%	0,0%	1,0%	0,8%	1,3%	0,7%	1,0%	0,3%	2,2%	2,1%	2,8%	2,3%	1,0%	0,1%	3,6%	2,5%
BR	Brazil	3,7%	2,0%	2,0%	2,0%	2,2%	0,8%	3,3%	2,2%	3,3%	1,9%	1,9%	1,9%	1,1%	1,2%	1,5%	1,6%	0,1%	0,0%	2,1%	2,1%	3,6%	2,7%	2,4%	1,5%	1,6%	2,8%	2,6%	2,3%	1,7%	0,9%	3,3%	2,1%
AU	Australia	2,0%	1,7%	3,3%	3,0%	0,0%	0,0%	0,5%	0,0%	1,9%	1,7%	3,3%	3,0%	1,5%	1,2%	3,1%	3,3%	2,9%	1,8%	3,3%	2,8%	3,1%	0,0%	0,3%	0,0%	1,5%	0,0%	1,8%	0,0%	0,0%	0,0%	0,5%	0,0%
CB	Cambodia	0,1%	0,1%	0,8%	1,2%	1,3%	3,3%	3,5%	3,8%	0,1%	0,1%	0,9%	1,2%	0,4%	0,4%	1,1%	1,1%	0,1%	0,0%	0,9%	1,4%	0,5%	0,1%	0,4%	0,4%	2,0%	1,1%	2,6%	2,7%	0,5%	0,8%	3,8%	4,0%
CH	China	3,4%	8,8%	1,8%	2,6%	1,1%	0,9%	1,5%	2,6%	3,1%	8,3%	1,7%	2,5%	1,1%	2,6%	1,7%	2,4%	5,7%	4,4%	1,8%	2,5%	2,1%	1,2%	1,3%	2,1%	3,1%	1,9%	2,1%	2,3%	0,7%	0,1%	1,1%	2,5%
BE	Belgium	3,5%	3,4%	3,5%	4,1%	3,3%	2,5%	3,3%	2,5%	3,5%	3,4%	3,5%	3,9%	5,5%	5,5%	2,8%	3,4%	1,9%	1,7%	3,5%	3,8%	3,8%	3,3%	1,4%	2,2%	3,4%	3,3%	2,6%	2,3%	1,2%	0,5%	3,6%	2,7%
GU	Guyana	0,0%	0,0%	0,3%	0,6%	0,3%	1,0%	1,7%	1,5%	0,0%	0,0%	0,4%	0,6%	0,4%	0,4%	0,5%	0,9%	0,0%	0,0%	0,5%	0,6%	2,1%	0,0%	0,0%	0,1%	2,5%	0,2%	2,2%	2,1%	0,1%	0,2%	2,1%	1,8%
NT	Netherlan.	3,0%	2,6%	4,5%	4,2%	2,1%	2,1%	3,5%	2,9%	3,1%	2,6%	4,3%	4,0%	4,7%	4,9%	3,7%	3,4%	2,0%	1,8%	4,0%	3,9%	0,4%	2,4%	2,8%	2,9%	4,2%	3,8%	2,6%	2,4%	0,6%	0,4%	3,8%	3,0%
SP	Spain	1,4%	1,2%	3,6%	4,1%	2,1%	1,8%	4,1%	4,4%	1,4%	1,2%	3,5%	3,9%	2,9%	2,8%	3,4%	4,0%	0,8%	0,4%	3,4%	3,6%	6,5%	5,5%	5,0%	6,9%	3,4%	2,7%	2,8%	2,9%	1,0%	0,6%	4,2%	4,2%
AR	Argentina	0,1%	0,1%	1,5%	1,3%	2,5%	0,6%	2,6%	2,0%	0,1%	0,1%	1,4%	1,2%	0,4%	0,4%	1,0%	1,1%	0,0%	0,0%	1,8%	1,5%	0,8%	0,1%	1,2%	0,6%	0,9%	2,0%	2,5%	2,3%	0,3%	0,1%	2,7%	2,2%
PA	Paraguay	0,0%	0,0%	0,5%	0,6%	1,0%	1,3%	1,0%	1,3%	0,0%	0,0%	0,4%	0,5%	0,4%	0,4%	0,6%	0,7%	0,0%	0,0%	0,5%	0,5%	0,0%	0,9%	0,0%	0,0%	0,6%	2,2%	1,9%	2,1%	0,1%	0,0%	1,0%	1,5%
RU	Russian Fed.	1,1%	0,9%	2,6%	2,5%	0,8%	0,4%	1,0%	1,0%	1,1%	0,9%	2,6%	2,6%	1,0%	1,7%	2,2%	3,7%	0,8%	1,0%	2,8%	2,7%	0,6%	3,6%	0,3%	3,5%	3,5%	2,8%	2,1%	2,0%	0,1%	0,1%	1,3%	1,1%
GE	Germany	4,8%	4,2%	4,6%	4,4%	1,0%	0,9%	3,8%	3,6%	5,1%	4,5%	4,5%	4,3%	9,7%	10,1%	4,5%	4,4%	1,4%	0,8%	4,1%	3,9%	7,1%	10,0%	4,7%	6,1%	4,1%	3,6%	2,7%	2,6%	0,2%	0,1%	3,8%	3,5%
EG	Egypt	0,6%	0,3%	1,2%	0,9%	0,2%	0,6%	1,5%	2,0%	0,6%	0,3%	1,2%	0,9%	2,9%	0,4%	1,0%	0,9%	0,6%	0,6%	1,5%	1,2%	0,2%	0,7%	0,1%	0,0%	1,9%	3,6%	2,1%	2,3%	0,1%	0,6%	1,7%	2,5%
UK	United King.	6,5%	5,7%	5,4%	5,1%	0,5%	0,6%	4,1%	3,6%	6,6%	5,8%	5,3%	4,8%	7,2%	6,9%	6,1%	5,3%	5,0%	5,7%	4,3%	4,2%	10,8%	5,1%	10,1%	7,0%	3,9%	2,8%	2,8%	2,6%	0,1%	0,2%	4,1%	3,7%
SA	South Africa	6,6%	4,2%	3,0%	2,2%	0,0%	0,0%	0,7%	1,2%	6,2%	4,0%	2,9%	2,2%	1,1%	0,6%	2,2%	1,8%	9,8%	5,2%	2,9%	2,4%	5,0%	6,5%	1,2%	1,1%	3,1%	3,4%	2,1%	2,1%	0,0%	0,0%	0,7%	1,0%
FR	France	6,3%	5,0%	4,0%	4,5%	0,8%	0,7%	3,0%	3,9%	6,4%	5,2%	3,9%	4,4%	7,5%	7,2%	3,7%	3,9%	2,9%	1,5%	3,8%	4,2%	1,4%	11,0%	3,2%	4,6%	0,8%	3,4%	2,5%	2,6%	0,3%	0,2%	3,2%	4,0%
SI	Singapore	2,9%	2,5%	3,0%	2,6%	0,1%	0,0%	2,0%	1,9%	2,7%	2,4%	2,9%	2,6%	6,1%	3,0%	5,0%	2,5%	4,8%	3,2%	2,9%	2,6%	4,7%	1,1%	4,7%	1,1%	3,3%	1,8%	2,3%	2,2%	0,1%	0,0%	1,9%	1,7%
GR	Greece	0,3%	0,3%	2,8%	2,8%	0,8%	0,4%	2,6%	2,3%	0,3%	0,3%	3,1%	3,0%	0,8%	0,7%	3,1%	3,0%	0,1%	0,1%	2,9%	2,9%	0,2%	2,0%	0,8%	0,9%	1,9%	2,8%	2,4%	2,3%	0,1%	0,1%	3,1%	2,7%
TA	Taipei, Chin.	0,5%	0,8%	1,7%	1,6%	0,0%	0,0%	2,0%	1,9%	0,6%	1,0%	1,7%	1,6%	0,7%	1,1%	1,6%	1,4%	0,6%	0,3%	1,8%	1,9%	3,1%	3,3%	0,5%	0,2%	3,0%	2,2%	2,3%	2,2%	0,0%	0,0%	2,1%	2,0%
SE	Senegal	3,5%	5,0%	1,7%	1,9%	0,2%	0,0%	0,5%	0,3%	3,4%	4,7%	1,5%	1,9%	0,9%	1,4%	1,6%	1,6%	3,5%	8,7%	1,8%	2,1%	0,7%	5,1%	1,7%	0,0%	0,7%	2,9%	1,9%	1,7%	0,0%	0,0%	0,6%	0,4%
JA	Japan	6,5%	5,3%	1,7%	1,5%	0,1%	0,2%	3,0%	3,0%	8,4%	6,8%	1,8%	1,5%	2,3%	3,6%	1,5%	1,4%	5,4%	1,7%	1,9%	1,7%	14,1%	3,6%	0,6%	0,6%	3,9%	2,9%	2,5%	2,5%	0,1%	0,1%	3,2%	3,1%
PO	Portugal	0,7%	0,7%	3,1%	2,9%	0,2%	0,3%	1,7%	2,8%	0,7%	0,6%	3,0%	3,0%	1,0%	0,9%	2,4%	2,5%	0,1%	0,2%	3,1%	3,0%	1,7%	2,8%	0,5%	1,1%	1,9%	2,6%	2,2%	2,4%	0,1%	0,1%	2,1%	3,1%
MA	Malaysia	4,1%	4,0%	2,0%	1,9%	0,0%	0,0%	0,2%	0,6%	3,8%	3,7%	2,0%	1,8%	5,1%	2,3%	2,6%	1,5%	5,4%	2,7%	2,0%	2,1%	0,0%	1,0%	0,0%	0,1%	0,3%	0,8%	1,5%	1,9%	0,0%	0,0%	0,2%	0,5%
KA	Kazakhstan	0,0%	0,3%	1,0%	1,3%	0,1%	0,1%	0,5%	0,1%	0,0%	0,3%	1,0%	1,4%	0,4%	1,1%	1,1%	1,8%	0,0%	0,0%	1,1%	1,3%	0,0%	0,0%	0,0%	0,0%	0,4%	0,0%	2,0%	1,3%	0,0%	0,0%	0,5%	0,1%
LA	Lao, PDR	0,1%	0,9%	0,5%	0,3%	0,1%	0,4%	1,5%	1,7%	0,1%	0,8%	0,5%	0,3%	0,4%	0,4%	0,7%	0,6%	0,2%	0,6%	0,5%	0,4%	0,0%	0,0%	0,2%	0,0%	1,7%	2,0%	2,2%	2,2%	0,0%	0,2%	1,7%	2,1%
PL	Poland	1,3%	1,4%	3,3%	2,8%	0,1%	0,1%	1,5%	1,7%	1,4%	1,5%	3,4%	3,0%	5,0%	6,7%	3,3%	2,8%	0,2%	0,2%	3,3%	2,9%	0,9%	0,8%	0,4%	0,4%	3,6%	3,0%	2,2%	2,2%	0,0%	0,0%	1,9%	2,1%
TU	Turkey	3,5%	3,2%	3,5%	2,9%	0,2%	0,0%	2,6%	2,6%	3,7%	3,4%	3,3%	3,1%	3,8%	3,7%	3,6%	3,5%	1,2%	3,5%	3,0%	3,0%	5,3%	5,1%	4,6%	2,4%	4,3%	3,4%	2,5%	2,4%	0,0%	0,0%	2,6%	2,7%
UG	Uganda	0,0%	0,0%	0,7%	0,9%	0,0%	0,0%	0,3%	0,4%	0,0%	0,0%	0,6%	0,9%	0,5%	0,4%	1,2%	1,0%	0,0%	0,0%	0,6%	0,9%	0,7%	0,0%	0,6%	0,2%	0,6%	0,8%	1,4%	1,8%	0,0%	0,0%	0,1%	0,2%
ES	El Salvador	0,5%	0,2%	0,7%	0,4%	0,0%	0,0%	0,0%	0,1%	0,7%	0,3%	0,7%	0,5%	0,6%	0,5%	0,7%	0,6%	0,2%	0,0%	0,9%	0,5%	0,0%	0,0%	0,0%	0,0%	0,0%	2,1%	0,0%	1,8%	0,0%	0,0%	0,0%	0,2%
BU	Bulgaria	0,2%	0,1%	2,3%	2,5%	0,3%	0,2%	1,3%	1,7%	0,2%	0,1%	2,5%	2,7%	0,7%	0,6%	2,6%	2,5%	0,0%	0,0%	2,4%	2,6%	0,5%	5,0%	0,2%	0,2%	3,4%	3,6%	2,1%	2,2%	0,0%	0,0%	1,5%	2,1%
NI	Niger	0,2%	0,6%	0,8%	0,7%	0,1%	0,2%	0,7%	0,9%	0,3%	0,6%	0,8%	0,7%	0,4%	0,5%	0,7%	0,8%	0,3%	0,8%	1,2%	0,9%	0,0%	0,0%	0,0%	0,1%	1,3%	1,2%	2,1%	2,0%	0,0%	0,0%	0,6%	0,7%
OM	Oman	2,0%	2,8%	1,2%	1,2%	0,0%	0,0%	0,0%	0,4%	1,9%	2,7%	1,3%	1,2%	0,6%	0,6%	1,1%	1,4%	1,6%	4,2%	1,6%	1,4%	0,0%	4,2%	0,0%	0,2%	0,0%	2,8%	0,0%	1,9%	0,0%	0,0%	0,0%	0,3%
RW	Rwanda	0,0%	0,0%	0,3%	0,7%	0,0%	0,0%	0,2%	0,0%	0,0%	0,0%	0,2%	0,7%	0,8%	0,7%	1,0%	1,1%	0,0%	0,0%	0,3%	0,8%	0,0%	0,0%	1,2%	0,0%	1,1%	0,0%	1,9%	0,0%	0,0%	0,0%	0,1%	0,0%
CZ	Czech Rep.	0,8%	0,6%	3,1%	2,8%	0,0%	0,0%	0,8%	1,3%	0,8%	0,7%	3,3%	3,0%	4,2%	4,3%	3,2%	2,7%	0,3%	0,1%	3,2%	2,9%	3,9%	0,8%	0,2%	0,1%	3,7%	3,3%	2,0%	2,1%	0,0%	0,0%	1,0%	1,6%
HK	Hong Kong	3,4%	2,6%	2,1%	2,2%	0,0%	0,0%	1,3%	1,0%	3,2%	2,6%	2,2%	2,2%	1,6%	1,9%	1,9%	1,9%	5,3%	1,5%	2,4%	2,5%	0,7%	0,3%	1,1%	0,2%	3,1%	1,7%	2,2%	2,0%	0,1%	0,0%	1,2%	1,1%
DE	Denmark	0,6%	0,4%	2,6%	2,5%	0,0%	0,1%	1,0%	2,5%	0,7%	0,4%	2,8%	2,5%	3,0%	1,5%	2,1%	1,9%	0,1%	0,1%	3,0%	2,7%	4,7%	0,7%	0,3%	0,4%	3,8%	3,9%	2,2%	2,3%	0,0%	0,0%	1,2%	2,8%
RO	Romania	0,6%	0,4%	2,1%	2,5%	0,3%	0,1%	1,2%	1,5%	0,5%	0,4%	2,3%	2,7%	1,2%	1,0%	2,1%	2,5%	0,0%	0,0%	2,4%	2,6%	0,0%	1,7%	0,0%	0,1%	2,4%	3,5%	2,0%	2,1%	0,1%	0,0%	1,3%	1,8%
SL	Sri Lanka	0,2%	1,2%	0,8%	1,0%	0,0%	0,1%	2,3%	2,2%	0,2%	1,1%	0,8%	1,1%	0,4%	0,5%	0,8%	1,1%	0,2%	2,6%	1,1%	1,3%	4,5%	3,2%	0,1%	0,1%	4,2%	2,3%	2,4%	2,3%	0,0%	0,1%	2,6%	2,4%
SR	Saudi Arab.	13,8%	16,4%	2,1%	2,8%	0,0%	0,0%	0,0%	0,4%	13,5%	15,9%	2,2%	2,8%	1,5%	2,3%	1,7%	2,2%	20,8%	35,0%	2,4%	2,9%	0,0%	0,0%	0,0%	0,4%	0,0%	0,6%	0,0%	1,9%	0,0%	0,0%	0,0%	0,3%

Appendix Table 6: Centralities (%) valued and binary 2011/2015 (Wood Network)

Id in Vis.	Country	indeg valued (2011)	indeg valued (2015)	indeg binary (2011)	indeg binary (2015)	outdeg valued (2011)	outdeg valued (2015)	outdeg binary (2011)	outdeg binary (2015)	status valued (2011)	status valued (2015)	status binary (2011)	status binary (2015)	pager valued (2011)	pager valued (2015)	pager binary (2011)	pager binary (2015)	author valued (2011)	authr valued (2015)	author binary (2011)	author binary (2015)	betwn valued (2011)	betwn valued (2015)	betwn binary (2011)	betwn binary (2015)	closen valued (2011)	closen valued (2015)	closen binary (2011)	closen binary (2015)	hub valued (2011)	hub valued (2015)	hub binary (2011)	hub binary (2015)
GE	Germany	5,2%	5,6%	3,1%	3,3%	25,1%	25,0%	4,4%	4,0%	5,2%	5,4%	3,1%	3,2%	4,1%	3,9%	2,9%	3,0%	2,0%	1,8%	2,9%	3,0%	0,0%	0,0%	7,5%	7,8%	1,1%	0,2%	3,2%	3,0%	26,6%	17,3%	4,1%	3,8%
CH	China	1,3%	1,4%	2,8%	2,9%	12,3%	12,1%	4,3%	3,9%	1,1%	1,3%	2,7%	2,8%	3,3%	3,3%	3,0%	3,6%	0,5%	0,9%	2,5%	2,5%	0,2%	0,0%	9,0%	11,7%	0,9%	1,2%	3,1%	3,0%	13,9%	21,4%	4,0%	3,7%
PL	Poland	2,7%	2,7%	2,7%	2,4%	6,3%	7,4%	4,0%	3,9%	3,0%	2,8%	2,6%	2,4%	1,4%	1,8%	2,5%	2,0%	4,7%	3,2%	2,5%	2,4%	2,4%	2,3%	4,7%	3,3%	2,0%	2,1%	2,9%	3,0%	4,2%	2,8%	3,8%	3,8%
BE	Belgium	4,1%	4,5%	3,1%	2,7%	8,9%	8,0%	4,4%	4,0%	5,2%	5,0%	3,0%	2,7%	4,2%	3,5%	2,8%	2,3%	3,8%	3,3%	2,8%	2,6%	5,4%	0,0%	7,1%	4,9%	2,4%	0,4%	3,2%	3,0%	12,5%	5,7%	4,1%	3,8%
TH	Thailand	0,2%	0,2%	1,5%	1,7%	1,0%	1,0%	1,8%	1,6%	0,2%	0,2%	1,5%	1,8%	0,8%	0,7%	1,9%	2,6%	0,2%	0,4%	1,3%	1,5%	0,1%	6,0%	1,1%	1,1%	2,6%	1,9%	2,0%	1,9%	0,3%	0,7%	1,7%	1,6%
AU	Austria	1,4%	1,7%	1,8%	2,3%	5,7%	5,2%	4,1%	3,7%	1,6%	1,8%	1,9%	2,2%	0,7%	0,7%	1,7%	1,9%	3,2%	2,7%	1,9%	2,2%	0,0%	2,0%	2,4%	3,2%	0,6%	1,3%	3,0%	2,8%	5,7%	5,1%	4,0%	3,6%
CL	Chile	0,7%	1,0%	1,5%	1,8%	2,1%	3,3%	2,0%	1,9%	0,7%	1,0%	1,5%	1,8%	0,8%	0,9%	1,5%	2,3%	1,1%	1,5%	1,6%	1,9%	0,7%	1,3%	1,1%	2,2%	1,8%	1,2%	2,1%	2,0%	3,0%	10,8%	2,0%	2,0%
FR	France	8,7%	6,7%	3,0%	3,0%	4,2%	4,7%	3,9%	3,5%	9,0%	7,0%	2,9%	2,9%	3,5%	2,6%	3,5%	2,9%	11,2%	6,6%	2,7%	2,8%	1,9%	3,2%	9,3%	5,3%	2,8%	1,4%	2,9%	2,7%	3,4%	2,0%	3,8%	3,5%
SP	Spain	3,6%	3,1%	2,4%	2,2%	3,5%	3,3%	3,5%	3,5%	3,8%	3,2%	2,3%	2,2%	2,3%	1,7%	2,0%	1,9%	4,1%	2,7%	2,4%	2,3%	2,1%	0,0%	2,6%	2,7%	2,3%	1,0%	2,7%	2,7%	3,4%	1,9%	3,5%	3,4%
CA	Canada	5,9%	6,1%	2,1%	2,3%	3,2%	4,6%	1,4%	1,4%	6,7%	7,6%	2,1%	2,3%	7,8%	13,1%	2,0%	2,1%	4,5%	6,2%	2,1%	2,3%	0,4%	0,3%	1,0%	0,8%	2,2%	1,2%	1,9%	1,8%	5,8%	17,1%	1,5%	1,5%
MA	Malaysia	0,4%	0,6%	2,0%	2,2%	2,6%	2,0%	1,7%	1,6%	0,3%	0,5%	2,0%	2,2%	0,9%	0,9%	2,4%	2,9%	0,2%	0,6%	1,8%	2,0%	0,6%	2,6%	1,5%	1,3%	0,9%	1,3%	2,0%	1,9%	0,7%	1,0%	1,6%	1,6%
TU	Turkey	3,6%	2,3%	2,5%	2,6%	0,5%	0,5%	2,5%	3,2%	3,7%	2,2%	2,5%	2,6%	3,2%	2,3%	2,4%	2,4%	4,5%	1,6%	2,4%	2,5%	0,3%	0,5%	2,1%	3,9%	3,3%	3,6%	2,2%	2,5%	0,4%	0,2%	2,6%	3,2%
US	USA	10,4%	15,9%	3,0%	3,1%	2,8%	2,7%	3,6%	3,2%	9,7%	15,5%	2,8%	3,0%	9,1%	15,2%	3,2%	4,5%	8,5%	25,4%	2,6%	2,7%	0,0%	3,2%	7,3%	11,9%	1,3%	1,7%	2,7%	2,5%	2,6%	2,3%	3,5%	3,1%
NZ	New Zeal.	0,1%	0,2%	1,5%	1,9%	2,3%	2,5%	1,2%	1,3%	0,1%	0,2%	1,6%	2,0%	0,5%	0,7%	1,7%	2,6%	0,0%	0,2%	1,6%	1,9%	0,0%	0,0%	0,5%	0,9%	0,2%	0,8%	1,8%	1,8%	0,6%	1,4%	1,1%	1,1%
BR	Brazil	1,1%	0,1%	1,5%	1,4%	0,7%	1,0%	1,9%	2,2%	0,8%	0,1%	1,5%	1,4%	0,8%	0,4%	1,5%	1,3%	0,4%	0,2%	1,7%	1,6%	2,5%	0,9%	1,0%	0,7%	3,7%	1,6%	2,0%	2,1%	0,9%	2,6%	1,9%	2,2%
IR	Ireland	0,6%	0,7%	1,5%	1,8%	2,2%	2,4%	2,8%	2,4%	0,7%	0,7%	1,6%	1,8%	2,1%	2,6%	1,3%	1,4%	0,4%	0,5%	1,9%	2,0%	1,4%	0,3%	0,4%	0,6%	2,0%	3,1%	2,3%	2,2%	2,7%	1,9%	2,9%	2,5%
RU	Russian Fed.	6,3%	3,9%	2,8%	2,7%	0,2%	0,7%	1,7%	1,8%	6,0%	3,6%	2,7%	2,7%	7,5%	2,9%	2,4%	2,3%	7,3%	4,9%	2,8%	2,7%	0,4%	0,0%	1,0%	1,2%	2,9%	0,9%	2,0%	1,9%	0,1%	0,1%	1,8%	1,8%
RO	Romania	1,8%	1,9%	2,1%	2,0%	1,9%	1,5%	2,3%	2,6%	1,6%	1,9%	2,2%	2,1%	1,8%	1,8%	1,9%	1,7%	2,0%	1,7%	2,3%	2,1%	2,2%	2,5%	0,9%	1,1%	2,2%	2,4%	2,1%	2,3%	1,4%	0,4%	2,4%	2,7%
IT	Italy	4,3%	4,3%	3,1%	3,1%	1,2%	1,1%	3,8%	3,9%	4,5%	4,3%	3,0%	3,0%	2,9%	3,0%	3,4%	2,8%	3,8%	2,7%	2,9%	2,8%	4,9%	0,9%	8,1%	6,1%	1,8%	1,5%	2,8%	3,0%	1,0%	0,6%	3,7%	3,7%
PR	Portugal	1,6%	1,5%	1,5%	1,4%	1,5%	1,3%	3,2%	3,1%	1,8%	1,5%	1,6%	1,5%	1,2%	0,9%	1,4%	1,2%	1,1%	0,7%	1,7%	1,6%	1,0%	0,3%	1,0%	0,9%	2,3%	2,1%	2,5%	2,5%	1,5%	0,7%	3,3%	3,1%
IS	Indonesia	0,9%	0,7%	2,1%	1,6%	0,2%	0,4%	0,8%	1,2%	0,7%	0,5%	2,1%	1,6%	1,1%	0,8%	2,2%	2,0%	0,2%	0,3%	2,1%	1,5%	6,2%	0,9%	0,2%	0,7%	3,0%	1,4%	1,7%	1,8%	0,0%	0,1%	0,7%	1,2%
HU	Hungary	0,8%	0,9%	2,3%	2,4%	1,0%	1,1%	2,1%	2,3%	0,8%	0,9%	2,3%	2,4%	0,8%	0,7%	2,0%	1,9%	1,0%	0,9%	2,4%	2,5%	1,2%	1,4%	1,0%	1,1%	2,2%	3,2%	2,1%	2,1%	0,6%	0,4%	2,2%	2,3%
BL	Belarus	0,5%	0,6%	1,0%	1,5%	0,5%	1,0%	0,9%	1,5%	0,5%	0,6%	1,1%	1,5%	1,1%	1,6%	1,1%	1,3%	0,5%	0,2%	1,2%	1,6%	3,5%	2,9%	0,0%	0,2%	1,9%	3,5%	1,8%	1,9%	0,6%	0,6%	0,9%	1,6%
NE	Netherlands	4,9%	4,6%	3,2%	3,0%	1,0%	1,1%	3,3%	3,3%	5,3%	4,8%	3,2%	2,9%	2,4%	2,2%	3,0%	2,8%	7,2%	5,1%	3,0%	2,8%	3,2%	0,7%	4,5%	4,8%	2,5%	1,8%	2,6%	2,6%	0,7%	0,5%	3,4%	3,3%
SW	Sweden	2,9%	2,9%	2,6%	2,5%	1,7%	0,8%	3,4%	2,6%	3,0%	3,0%	2,6%	2,5%	3,8%	4,3%	2,2%	2,1%	3,7%	2,8%	2,6%	2,6%	3,8%	4,2%	2,4%	1,8%	3,6%	3,6%	2,6%	2,3%	1,1%	0,1%	3,5%	2,7%
LU	Luxembourg	0,1%	0,2%	1,1%	1,0%	1,5%	1,0%	1,1%	1,5%	0,2%	0,2%	1,2%	1,0%	0,4%	0,4%	1,0%	0,9%	0,3%	0,3%	1,5%	1,2%	0,2%	0,6%	0,0%	0,0%	0,1%	1,7%	1,8%	1,9%	2,8%	0,6%	1,3%	1,6%
SV	Slovenia	0,5%	0,4%	1,5%	1,6%	0,6%	0,7%	2,5%	2,2%	0,5%	0,4%	1,6%	1,6%	0,6%	0,7%	1,4%	1,4%	0,6%	0,4%	1,7%	1,7%	3,9%	1,0%	0,6%	0,5%	2,6%	2,0%	2,2%	2,1%	0,4%	0,2%	2,6%	2,3%
AR	Argentina	0,3%	0,3%	1,1%	1,1%	1,1%	0,3%	1,1%	1,0%	0,3%	0,3%	1,2%	1,2%	0,4%	0,4%	1,2%	1,1%	0,4%	0,4%	1,3%	1,4%	0,4%	0,0%	0,2%	0,1%	1,7%	0,3%	1,8%	1,7%	0,4%	0,3%	1,2%	0,9%
PA	Pakistan	0,6%	0,8%	1,6%	1,8%	0,0%	0,0%	0,1%	0,2%	0,4%	0,7%	1,6%	1,7%	0,8%	0,8%	2,3%	2,2%	0,1%	0,6%	1,5%	1,7%	0,2%	0,0%	0,1%	0,2%	0,2%	1,2%	1,1%	1,4%	0,0%	0,0%	0,0%	0,2%
UK	United King.	5,6%	6,9%	2,9%	2,9%	0,7%	0,4%	3,1%	3,1%	5,5%	6,8%	2,8%	2,8%	4,1%	4,6%	2,7%	2,6%	5,5%	5,8%	2,7%	2,8%	13,5%	7,2%	3,7%	3,8%	3,5%	4,2%	2,5%	2,5%	0,4%	0,1%	3,1%	3,1%
AL	Australia	1,2%	1,6%	2,8%	2,8%	0,3%	0,4%	1,3%	1,1%	1,0%	1,5%	2,7%	2,7%	1,7%	2,1%	2,8%	3,6%	0,9%	1,9%	2,5%	2,6%	1,3%	2,8%	1,6%	2,1%	1,6%	1,4%	1,9%	1,8%	0,1%	0,1%	1,2%	1,1%
NO	Norway	1,7%	1,7%	2,2%	2,1%	0,4%	0,3%	2,2%	1,9%	1,7%	1,7%	2,3%	2,1%	2,5%	4,0%	1,9%	1,9%	1,3%	1,0%	2,4%	2,2%	2,4%	11,6%	0,9%	0,9%	4,0%	5,0%	2,1%	2,0%	0,3%	0,1%	2,3%	2,0%
CZ	Czech Rep.	1,1%	1,0%	2,2%	2,3%	0,3%	0,3%	1,8%	2,4%	1,2%	1,0%	2,3%	2,3%	0,7%	0,6%	1,9%	1,8%	1,7%	1,0%	2,3%	2,4%	2,8%	0,5%	0,6%	0,9%	2,4%	2,5%	2,0%	2,2%	0,2%	0,1%	2,0%	2,5%
SA	South Africa	1,0%	0,7%	2,3%	2,6%	0,3%	0,2%	1,0%	0,4%	0,8%	0,7%	2,2%	2,6%	0,8%	0,9%	2,1%	3,4%	0,7%	1,0%	2,3%	2,5%	2,3%	0,0%	0,9%	0,6%	2,0%	0,6%	1,8%	1,6%	0,1%	0,1%	0,9%	0,4%
LI	Lithuania	1,0%	1,0%	2,3%	2,0%	0,3%	0,3%	1,7%	1,5%	1,0%	1,0%	2,3%	2,0%	0,7%	0,7%	2,0%	1,7%	0,9%	0,6%	2,4%	2,2%	2,3%	1,7%	0,8%	0,3%	2,8%	2,1%	2,0%	1,9%	0,3%	0,1%	1,9%	1,6%
KO	Korea, Rep.	0,7%	0,8%	2,1%	2,1%	0,2%	0,2%	1,6%	1,7%	0,6%	0,6%	2,0%	2,1%	0,7%	0,8%	2,3%	2,4%	0,8%	1,3%	1,9%	2,0%	15,4%	5,3%	1,2%	1,2%	3,5%	3,2%	1,9%	1,9%	0,1%	0,1%	1,7%	1,7%
FN	Finland	1,3%	1,0%	2,0%	2,0%	0,3%	0,3%	1,9%	1,2%	1,4%	1,0%	2,1%	2,1%	2,1%	1,6%	1,7%	1,7%	1,7%	1,0%	2,2%	2,2%	0,0%	1,9%	0,7%	0,2%	1,7%	3,5%	2,0%	1,8%	0,3%	0,2%	2,0%	1,4%
BU	Bulgaria	0,5%	0,6%	2,0%	2,0%	0,3%	0,3%	1,5%	1,8%	0,5%	0,6%	2,1%	2,0%	1,1%	1,6%	1,8%	1,7%	0,5%	0,5%	2,2%	2,1%	0,3%	0,7%	0,5%	0,7%	2,2%	3,0%	1,9%	2,0%	0,2%	0,1%	1,6%	1,9%
SL	Sri Lanka	0,2%	0,2%	1,0%	1,0%	0,3%	0,2%	0,4%	0,3%	0,1%	0,2%	1,0%	1,0%	1,0%	1,6%	0,4%	3,1%	1,3%	0,0%	0,1%	0,9%	0,9%	1,8%	2,6%	4,1%	0,0%	1,8%	1,4%	1,7%	1,3%	0,1%	0,0%	0,4%	0,3%
ES	Estonia	0,4%	0,4%	1,9%	2,3%	0,3%	0,3%	2,6%	2,2%	0,4%	0,4%	2,0%	2,3%	1,0%	0,8%	1,7%	1,9%	0,4%	0,3%	2,0%	2,4%	2,5%	0,6%	1,2%	1,1%	2,8%	1,9%	2,2%	2,1%	0,2%	0,1%	2,7%	2,2%
UR	Ukraine	2,0%	0,8%	2,2%	1,7%	0,3%	0,2%	1,4%	1,8%	2,0%	0,8%	2,2%	1,7%	5,0%	0,9%	2,1%	1,4%	2,0%	0,6%	2,2%	1,9%	0,8%	5,6%	0,8%	0,2%	1,8%	3,8%	1,9%	1,9%	0,3%	0,1%	1,5%	1,8%
IN	India	1,4%	1,4%	2,6%	2,5%	0,0%	0,0%	1,8%	2,1%	1,1%	1,2%	2,5%	2,5%	2,7%	1,4%	3,2%	3,0%	0,8%	1,6%	2,4%	2,4%	2,2%	4,5%	3,1%	5,0%	3,1%	5,2%	2,0%	2,1%	0,0%	0,0%	1,8%	2,0%
SE	Serbia	0,8%	0,8%	2,0%	1,8%	0,0%	0,1%	1,5%	1,4%	0,8%	0,7%	2,0%	1,9%	1,0%	1,0%	1,9%	1,6%	0,8%	0,5%	2,1%	2,0%	1,4%	2,1%	0,6%	0,3%	2,8%	3,5%	1,9%	1,8%	0,0%	0,0%	1,7%	1,5%
GR	Greece	0,4%	0,4%	2,1%	1,8%	0,1%	0,1%	1,0%	1,1%	0,3%	0,4%	2,2%	1,8%	0,8%	1,0%	1,9%	1,5%	0,2%	0,2%	2,3%	2,0%	1,2%	0,3%	0,2%	0,3%	2,2%	2,4%	1,8%	1,7%	0,0%	0,0%	1,0%	1,1%
EC	Ecuador	0,4%	0,3%	1,1%	1,2%	0,0%	0,0%	0,5%	0,2%	0,3%	0,2%	1,1%	1,2%	0,5%	0,4%	1,1%	1,3%	0,3%	0,4%	1,3%	1,3%	0,0%	0,0%	0,1%	0,0%	2,8%	0,4%	1,6%	1,4%	0,0%	0,0%	0,5%	0,2%
ST	Switzerland	1,8%	1,7%	2,4%	1,9%	0,0%	0,1%	0,0%	2,6%	2,0%	1,9%	2,4%	2,0%	1,0%	0,9%	2,0%	1,7%	3,1%	2,3%	2,5%	2,1%	0,0%	14,4%	0,0%	1,3%	0,0%	5,4%	0,0%	2,3%	0,0%	0,0%	0,0%	2,7%
JA	Japan	3,2%	3,0%	1,9%	1,8%	0,1%	0,1%	0,7%	0,7%	2,2%	2,4%	1,9%	1,9%	1,6%	1,9%	2,0%	2,2%	0,8%	1,4%	1,9%	1,8%	0,8%	0,1%	0,2%	0,1%	1,9%	1,1%	1,7%	1,6%	0,0%	0,0%	0,6%	0,7%

Appendix Table 7: Non network variables (Rice Network)

Code in Visone	Country	Exports (2011)	Exports (2015)	Imports (2011)	Imports (2015)	Grubel - Lloyd index (2011)	Grubel - Lloyd index (2015)	GDP per capita (2015)	GDP PPP per capita (2015)
IN	**India**	4.073.331	6.380.082	1.181	1.137	0,001	0	1.582	6.089
TH	**Thailand**	6.507.473	4.544.023	8.913	15.402	0,003	0,007	5.816	16.305
US	**USA**	2.112.653	2.065.876	686.304	792.220	0,49	0,554	55.837	55.837
PK	**Pakistan**	2.062.063	1.927.200	40.940	21.222	0,039	0,022	1.429	5.042
IT	**Italy**	692.298	591.831	98.927	137.324	0,25	0,377	29.847	35.896
UR	**Uruguay**	472.052	361.419	1.831	540	0,008	0,003	15.574	21.201
BR	**Brazil**	612.754	350.179	273.050	157.686	0,617	0,621	8.539	15.359
AU	**Australia**	272.892	301.199	164.060	147.922	0,751	0,659	56.328	45.514
CB	**Cambodia**	106.368	284.905	3.699	10.995	0,067	0,074	1.159	3.483
CH	**China**	426.959	267.393	386.750	1.472.411	0,951	0,307	7.925	14.239
BE	**Belgium**	289.989	242.270	310.142	271.037	0,966	0,944	40.231	43.992
GU	**Guyana**	148.110	212.007	120	62	0,002	0,001	4.127	7.506
NT	**Netherlands**	179.957	191.315	224.683	194.169	0,889	0,993	44.433	48.459
SP	**Spain**	190.397	168.457	96.002	81.168	0,67	0,65	25.832	34.527
AR	**Argentina**	361.811	156.189	5.468	4.401	0,03	0,055	13.432	20.323
PA	**Paraguay**	85.102	129.825	913	1.103	0,021	0,017	4.161	9.184
RU	**Russian Fed.**	87.026	103.549	112.401	100.285	0,873	0,984	9.057	24.451
GE	**Germany**	109.307	96.771	371.238	368.649	0,455	0,416	41.219	47.268
EG	**Egypt**	17.102	77.064	52.920	28.246	0,488	0,536	3.615	10.891
UK	**United Kingdom**	55.264	75.052	623.906	580.453	0,163	0,229	43.734	41.325
SA	**South Africa**	75.941	70.283	507.808	319.014	0,26	0,361	5.692	13.165
FR	**France**	74.274	68.627	505.334	468.793	0,256	0,255	36.248	39.678
SI	**Singapore**	52.625	62.825	284.363	263.852	0,312	0,385	52.889	85.209
GR	**Greece**	87.391	54.324	22.397	21.601	0,408	0,569	18.036	26.680
TA	**Taipei, Chinese**	3.352	38.626	83.902	81.944	0,077	0,641	38.181	44.173
SE	**Senegal**	52.528	37.992	376.440	382.629	0,245	0,181	911	2.431
JA	**Japan**	21.260	35.704	584.641	507.126	0,07	0,132	32.477	37.322
PO	**Portugal**	17.732	35.167	73.515	74.332	0,389	0,642	19.223	29.214
MA	**Malaysia**	422	31.889	605.911	535.140	0,001	0,112	9.766	26.891
KA	**Kazakhstan**	33.601	30.065	11.887	14.539	0,523	0,652	10.508	25.877
LA	**Lao, PDR**	4.348	29.454	12.189	69.455	0,526	0,596	1.812	5.675
PL	**Poland**	14.048	25.486	81.551	77.581	0,294	0,495	12.494	26.135
TU	**Turkey**	78.268	25.031	152.439	166.058	0,679	0,262	9.130	19.618
UG	**Uganda**	18.442	24.186	37.075	48.232	0,664	0,668	676	1.825
ES	**El Salvador**	5.960	22.297	34.931	29.848	0,292	0,855	4.219	8.602
BU	**Bulgaria**	21.465	22.195	18.900	19.455	0,936	0,934	6.820	17.512
NI	**Niger**	4.774	19.389	55.342	160.115	0,159	0,216	359	954
OM	**Oman**	4.301	16.841	167.971	255.050	0,05	0,124	15.645	38.234
RW	**Rwanda**	121	16.618	18.796	23.088	0,013	0,837	697	1.759
CZ	**Czech Republic**	15.407	16.455	60.863	57.352	0,404	0,446	17.231	32.167
HK	**Hong Kong**	11.075	14.098	318.232	280.087	0,067	0,096	42.423	56.719
DE	**Denmark**	7.472	11.291	47.545	39.139	0,272	0,448	52.002	46.635
RO	**Romania**	27.240	10.358	64.284	33.947	0,595	0,468	8.973	21.403
SL	**Sri Lanka**	5.673	10.074	18.397	131.941	0,471	0,142	3.926	11.739
SR	**Saudi Arabia**	12.815	9.916	1.124.695	1.504.728	0,023	0,013	20.482	53.430

Source of Data: World Bank national accounts data, and OECD National Accounts data files/ UN COMTRADE database

Appendix Table 8: Non network variables (Wood Network)

Code in Visone	Country	Exports (2011)	Exports (2015)	Imports (2011)	Imports (2015)	Grubel - Lloyd index (2011)	Grubel - Lloyd index (2015)	GDP per capita (2015)	GDP PPP per capita (2015)
GE	**Germany**	1.939.478	1.764.444	461.046	401.758	0,384	0,371	41.219	47.268
CH	**China**	1.435.604	1.425.517	107.114	108.395	0,139	0,141	7.925	14.239
PL	**Poland**	514.690	556.614	191.987	156.048	0,543	0,438	12.494	26.135
BE	**Belgium**	664.219	555.063	319.179	265.845	0,649	0,648	40.231	43.992
TH	**Thailand**	401.651	496.384	16.867	17.321	0,081	0,067	5.816	16.305
AU	**Austria**	442.080	363.497	95.867	105.475	0,356	0,45	43.439	47.824
CL	**Chile**	310.220	324.027	35.627	48.677	0,206	0,261	13.384	22.316
FR	**France**	306.016	312.861	559.376	364.839	0,707	0,923	36.248	39.678
SP	**Spain**	304.337	304.667	187.143	139.444	0,762	0,628	25.832	34.527
CA	**Canada**	228.193	296.506	412.169	410.626	0,713	0,839	43.249	44.310
MA	**Malaysia**	368.908	290.929	26.048	33.964	0,132	0,209	9.766	26.891
TU	**Turkey**	286.842	276.231	289.802	164.079	0,995	0,745	9.130	19.618
US	**USA**	265.199	219.198	742.882	1.145.778	0,526	0,321	55.837	55.837
NZ	**New Zealand**	190.153	179.984	5.324	9.087	0,054	0,096	37.808	36.982
BR	**Brazil**	67.790	172.435	74.171	10.607	0,955	0,116	8.539	15.359
IR	**Ireland**	161.676	159.012	27.267	43.041	0,289	0,426	51.290	54.654
RU	**Russian Fed.**	74.680	143.211	362.223	232.275	0,342	0,763	9.057	24.451
RO	**Romania**	147.890	130.078	138.091	127.518	0,966	0,99	8.973	21.403
IT	**Italy**	168.771	127.666	305.776	277.554	0,711	0,63	29.847	35.896
PR	**Portugal**	138.517	119.681	112.196	83.234	0,895	0,82	19.223	29.214
IS	**Indonesia**	42.406	96.347	68.305	45.037	0,766	0,637	3.346	11.035
HU	**Hungary**	83.658	78.893	48.089	53.121	0,73	0,805	12.259	25.582
BL	**Belarus**	39.043	74.999	61.139	41.617	0,779	0,714	5.740	17.661
NE	**Netherlands**	70.482	72.528	289.318	260.444	0,392	0,436	44.433	48.459
SW	**Sweden**	130.213	63.305	176.711	166.846	0,849	0,55	50.273	46.420
LU	**Luxembourg**	106.210	61.756	7.347	6.549	0,129	0,192	101.450	101.926
SV	**Slovenia**	53.423	52.019	32.495	25.066	0,756	0,65	20.713	31.122
AR	**Argentina**	92.539	38.784	26.990	22.081	0,452	0,726	13.432	20.323
PA	**Pakistan**	34.091	35.190	38.138	48.677	0,944	0,839	1.429	5.042
UK	**United King.**	61.696	29.413	405.842	419.803	0,264	0,131	43.734	41.325
AL	**Australia**	28.936	28.420	90.633	92.289	0,484	0,471	56.328	45.514
NO	**Norway**	35.201	28.289	141.854	123.206	0,398	0,373	74.735	61.472
CZ	**Czech Rep.**	35.063	26.928	90.992	68.835	0,556	0,562	17.231	32.167
SA	**South Africa**	33.291	22.773	56.628	37.372	0,74	0,757	5.692	13.165
LI	**Lithuania**	26.737	22.532	56.949	65.864	0,639	0,51	14.172	27.730
KO	**Korea, Rep.**	22.840	21.812	56.829	56.560	0,573	0,557	27.222	34.549
FN	**Finland**	24.133	20.585	93.726	66.983	0,41	0,47	41.921	40.601
BU	**Bulgaria**	27.995	20.399	47.839	45.478	0,738	0,619	6.820	17.512
SL	**Sri Lanka**	27.533	19.535	12.839	14.661	0,636	0,857	3.926	11.739
ES	**Estonia**	19.081	19.157	20.469	20.200	0,965	0,973	17.295	28.095
UR	**Ukraine**	28.616	16.266	107.591	56.074	0,42	0,45	2.115	7.916
IN	**India**	11.354	11.782	84.458	87.164	0,237	0,238	1.582	6.089
SE	**Serbia**	6.121	11.044	43.166	36.137	0,248	0,468	5.144	13.482
GR	**Greece**	23.374	10.299	28.131	26.903	0,908	0,554	18.036	26.680
EC	**Ecuador**	10.306	9.404	31.087	24.585	0,498	0,553	6.248	11.388
ST	**Switzerland**	0	6.791	0	114.830	-	0,112	80.215	60.535
JA	**Japan**	6.350	6.053	260.066	222.614	0,048	0,053	32.477	37.322

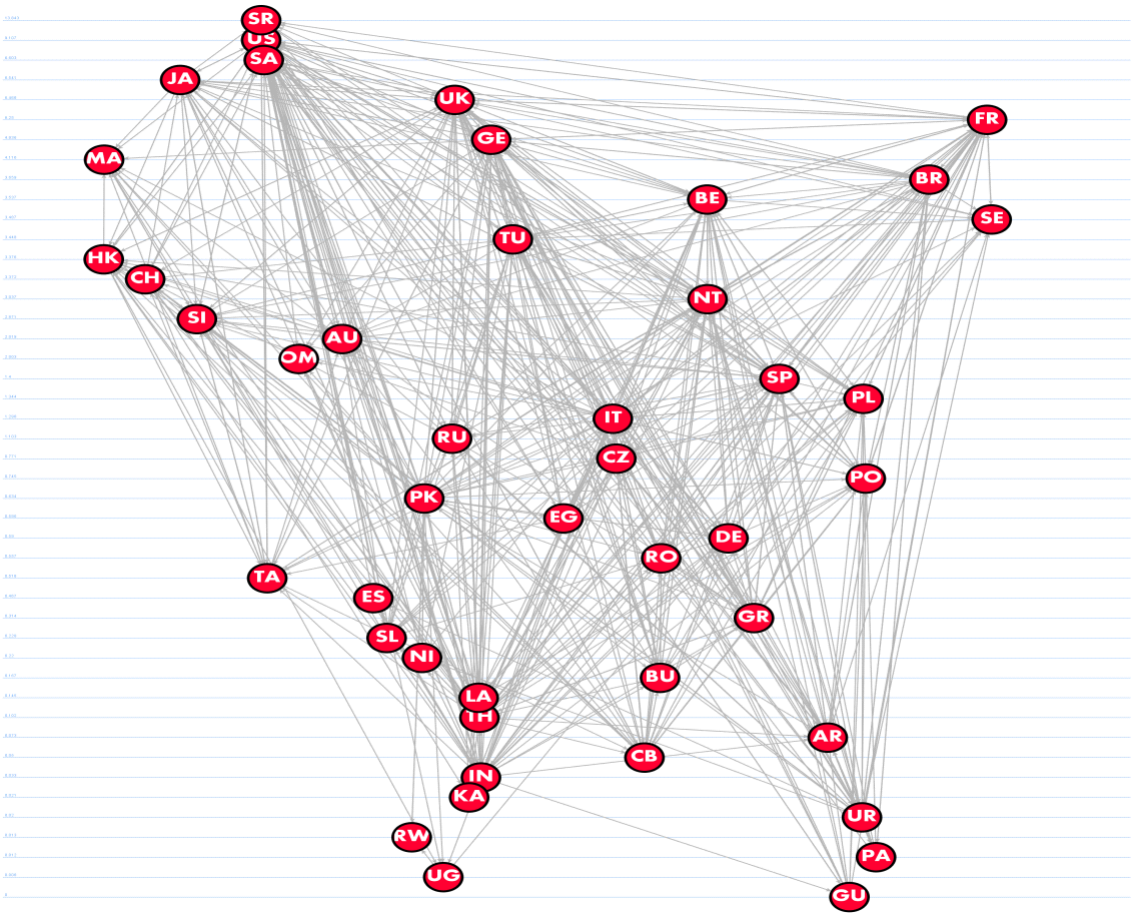
Source of Data: World Bank national accounts data, and OECD National Accounts data files/ UN COMTRADE database

Appendix Figure 1: Visualization of centrality scores (valued and binary, Rice/Wood Networks, 2011/2015)

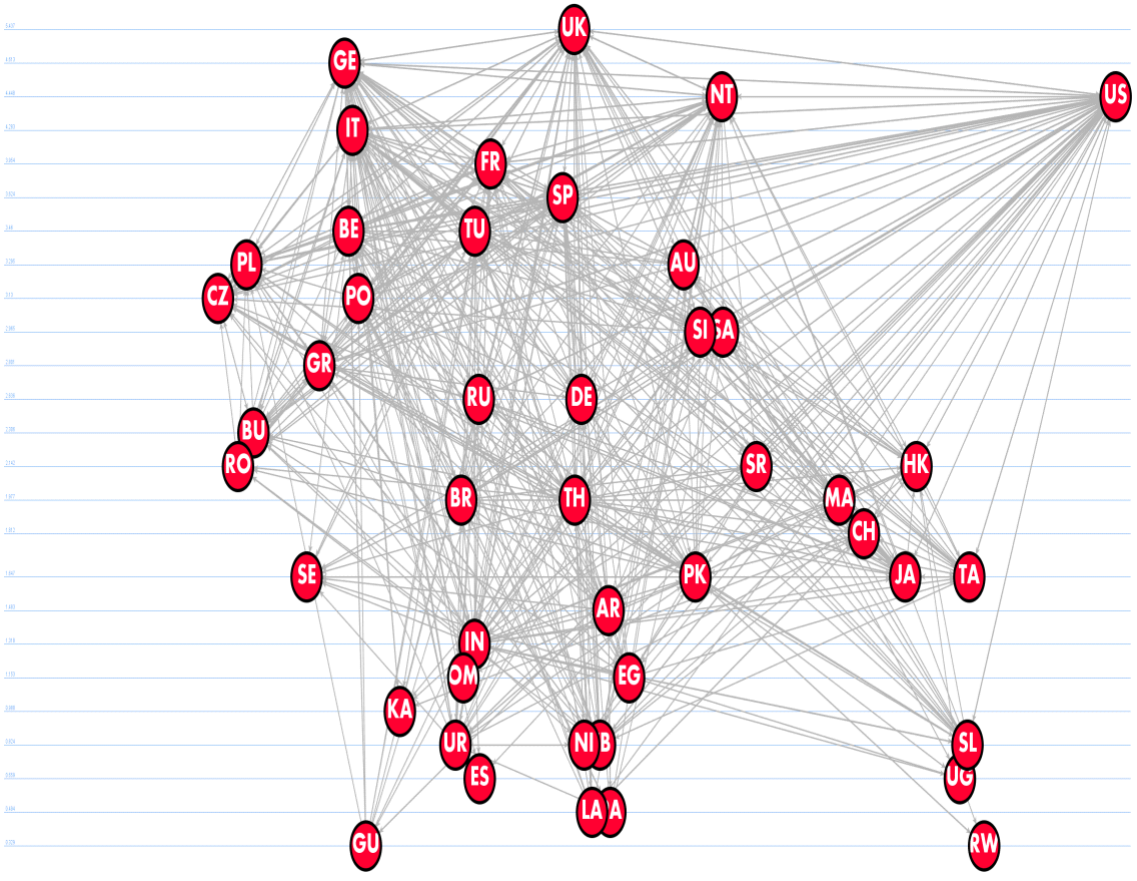
Network: RICE2011 - Visualization - Centrality measures	Network: RICE2015 - Visualization - Centrality measures	Network: WOOD2011 - Visualization - Centrality measures	Network: WOOD2015 - Visualization - Centrality measures
Indegree valued	Indegree valued	Indegree valued	Indegree valued
Indegree binary	Indegree binary	Indegree binary	Indegree binary
Outdegree valued	Outdegree valued	Outdegree valued	Outdegree valued
Outdegree binary	Outdegree binary	Outdegree binary	Outdegree binary
Closeness valued	Closeness valued	Closeness valued	Closeness valued
Closeness binary	Closeness binary	Closeness binary	Closeness binary
Betweenness valued	Betweenness valued	Betweenness valued	Betweenness valued
Betweenness binary	Betweenness binary	Betweenness binary	Betweenness binary
Status valued	Status valued	Status valued	Status valued
Status binary	Status binary	Status binary	Status binary
Pagerank valued	Pagerank valued	Pagerank valued	Pagerank valued
Pagerank binary	Pagerank binary	Pagerank binary	Pagerank binary
Authority valued	Authority valued	Authority valued	Authority valued
Authority binary	Authority binary	Authority binary	Authority binary
Hub valued	Hub valued	Hub valued	Hub valued
Hub binary	Hub binary	Hub binary	Hub binary

In the following visualizations, nodes with the same attribute value are arranged on horizontal lines, where nodes with higher value are closer to the top, and nodes with lower value are closer to the bottom of the drawing.

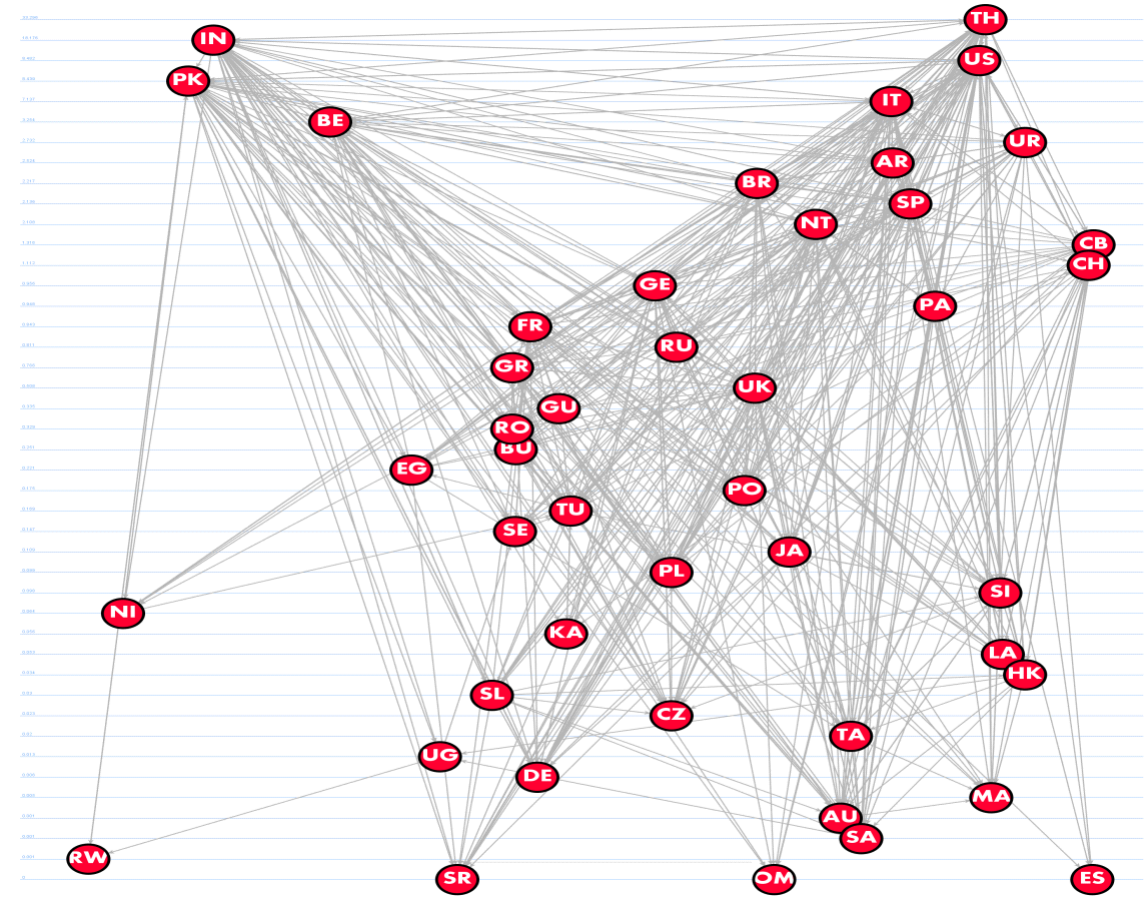
INDEGREE VALUED RICE2011



INDEGREE BINARY RICE2011



OUTDEGREE VALUED RICE2011



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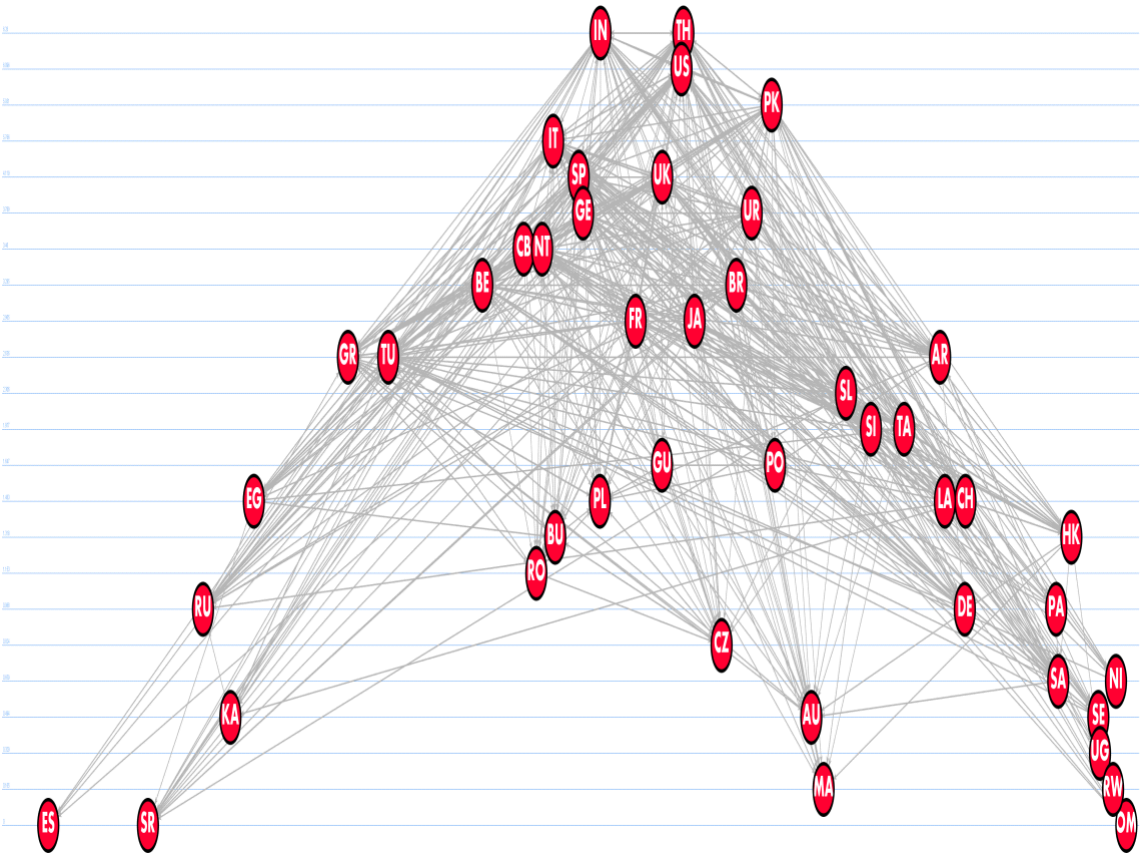
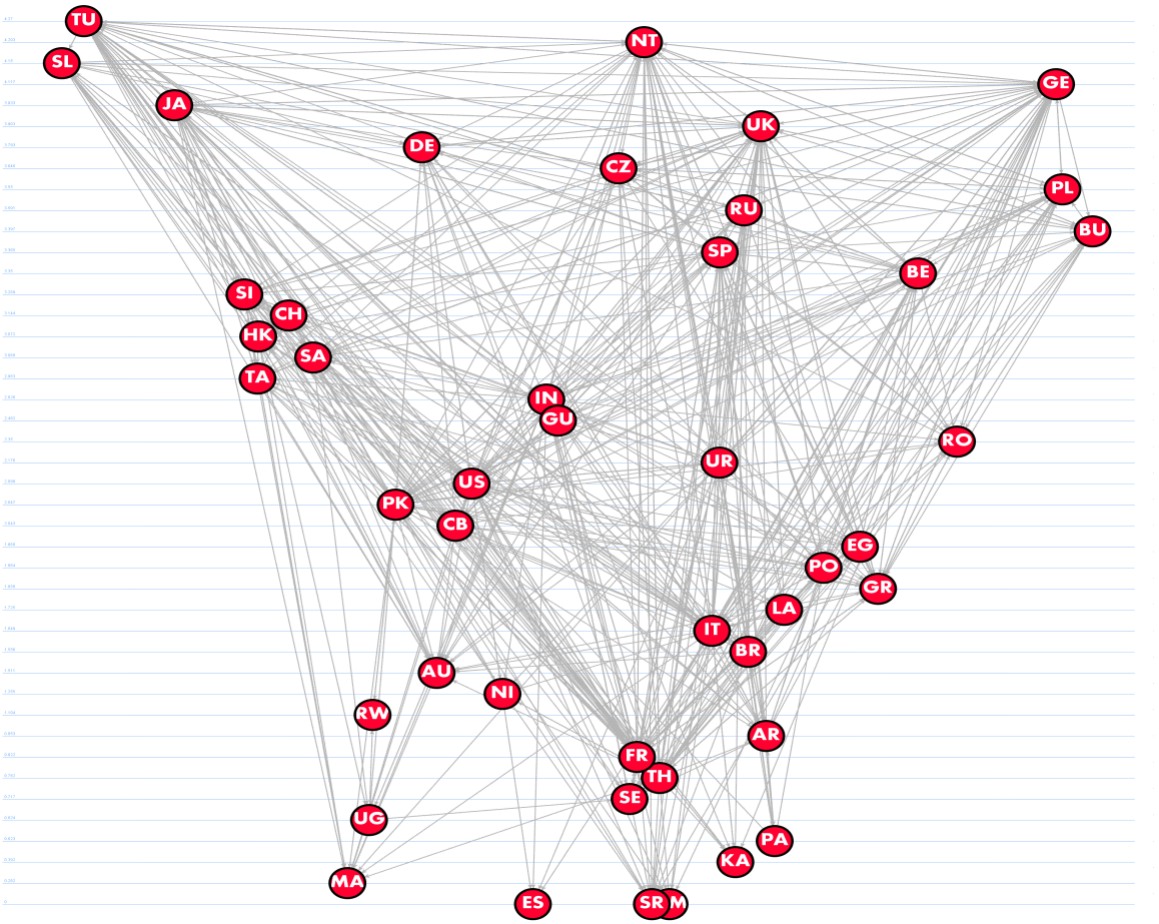
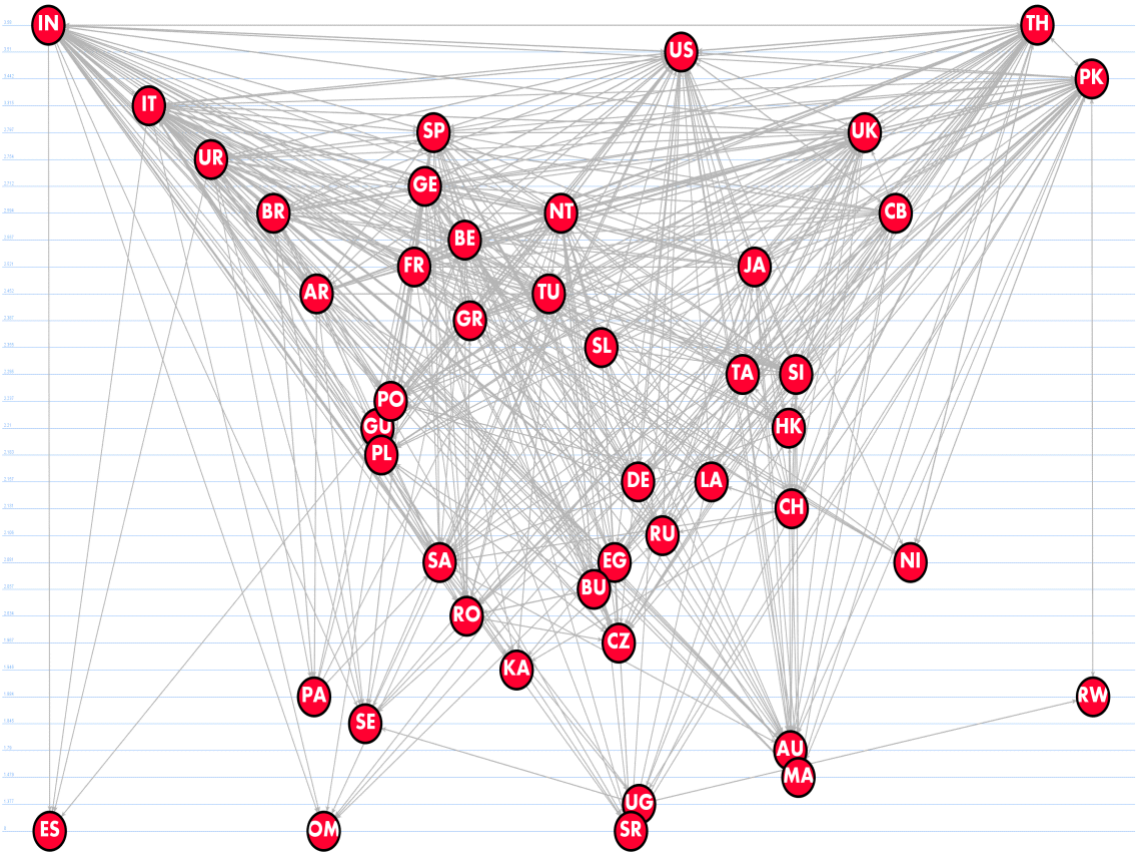


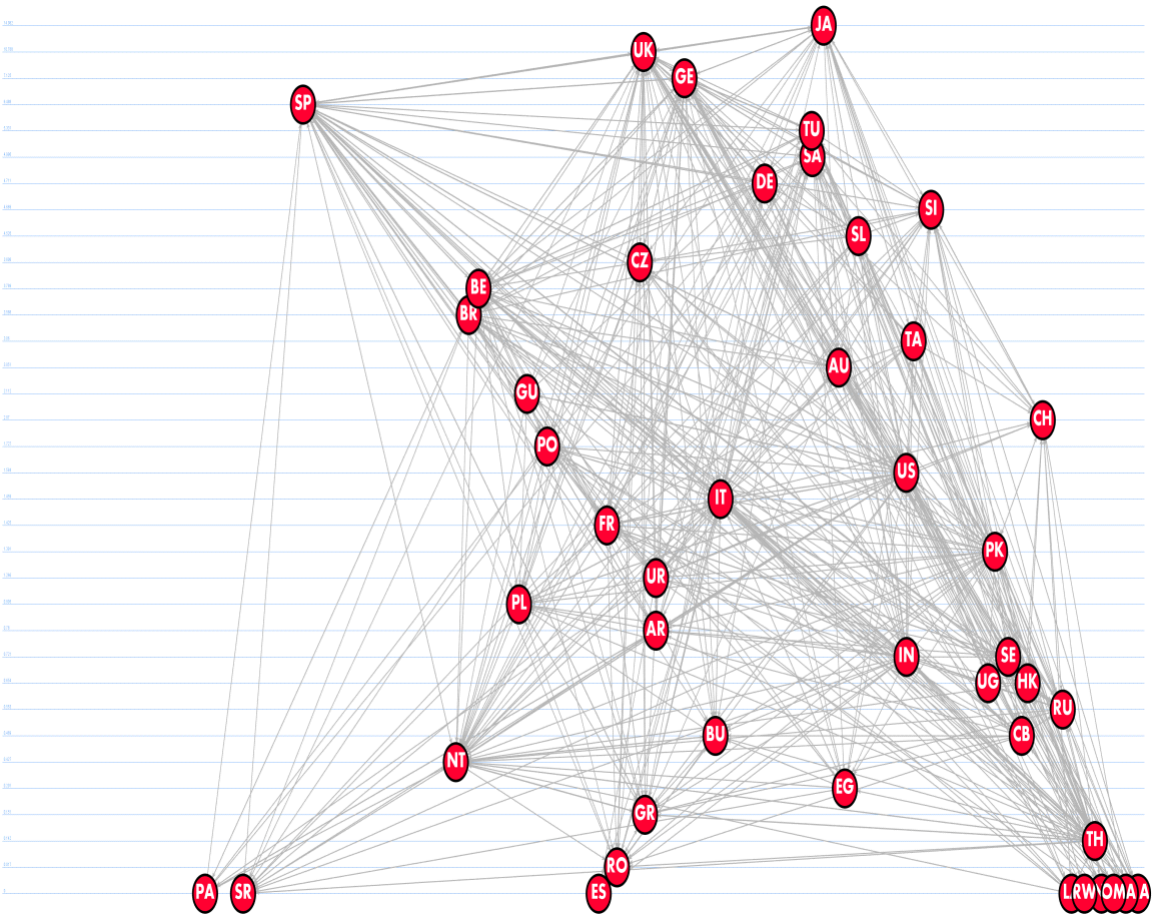
CLOSENESS VALUED RICE2011



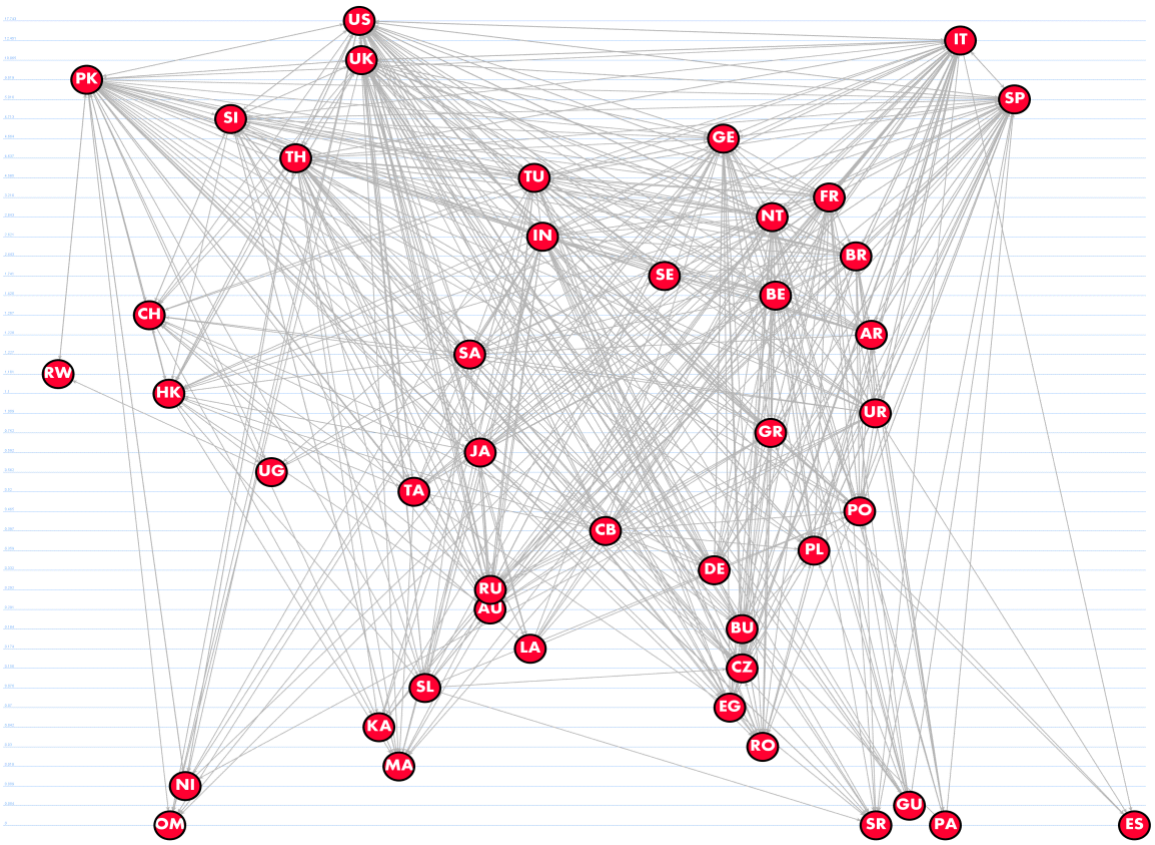
CLOSENESS BINARY RICE2011



BETWEENNESS VALUED RICE2011



BETWEENNESS BINARY RICE2011



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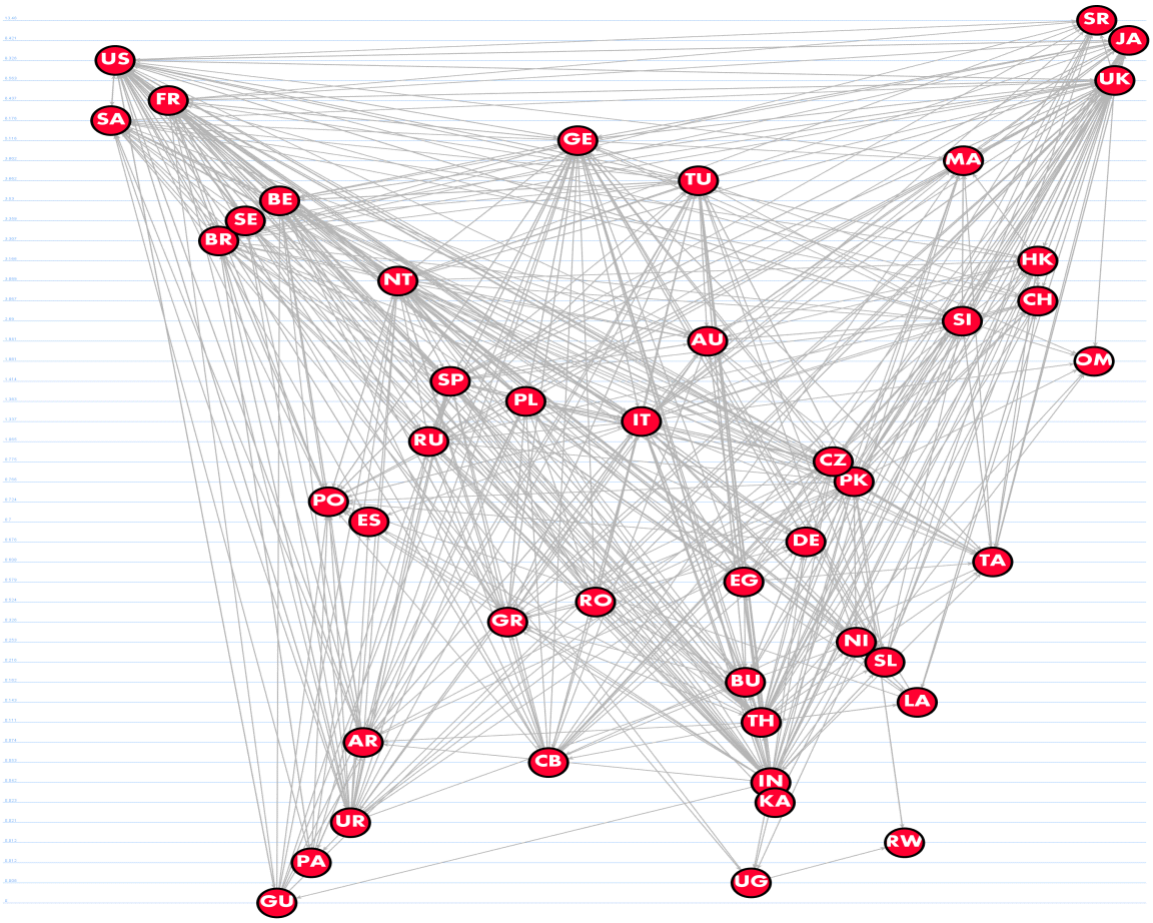

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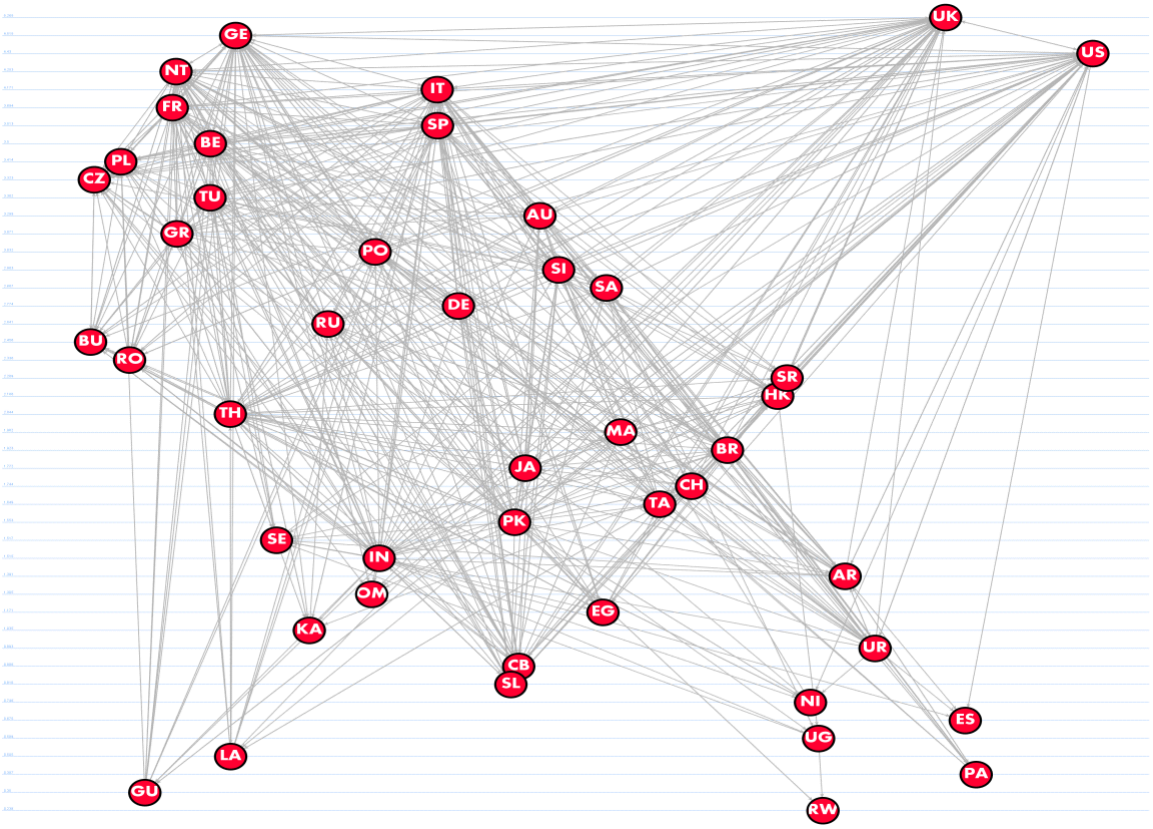

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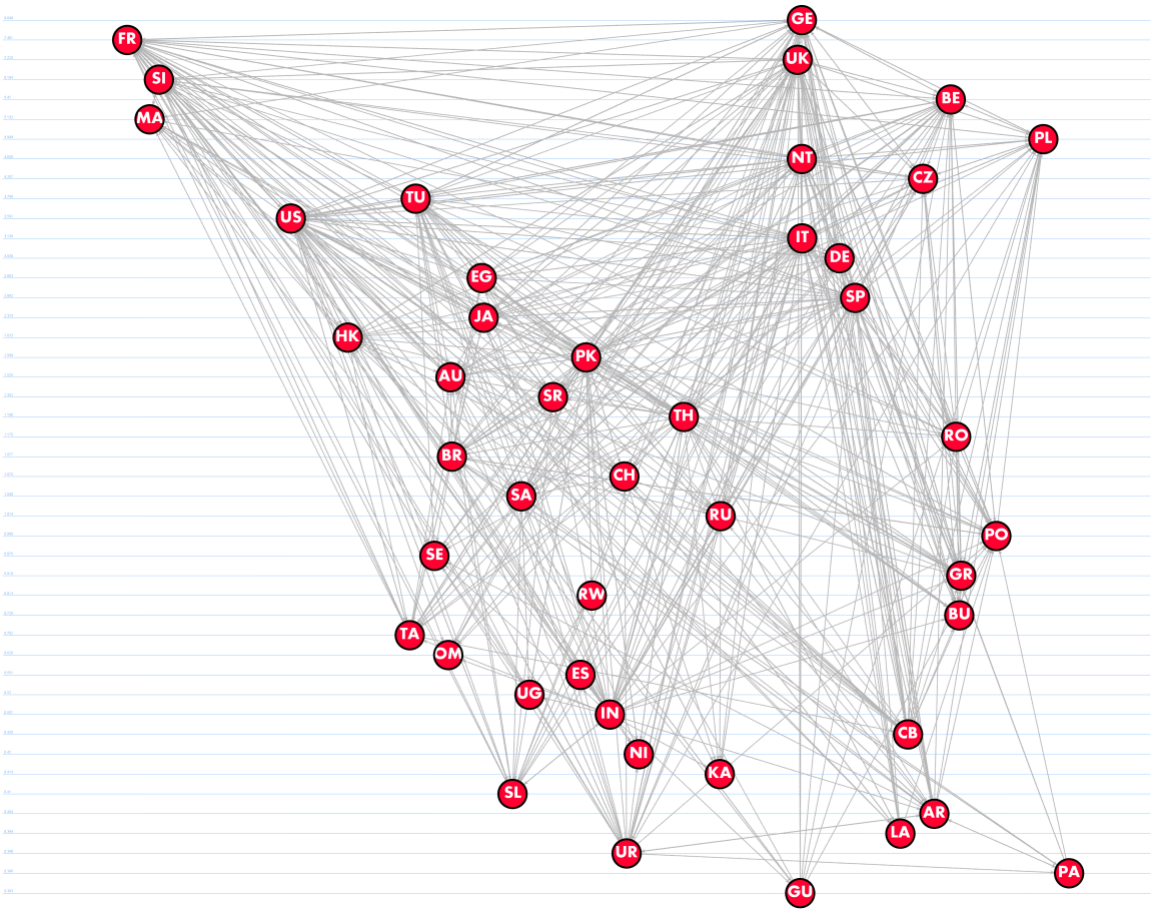

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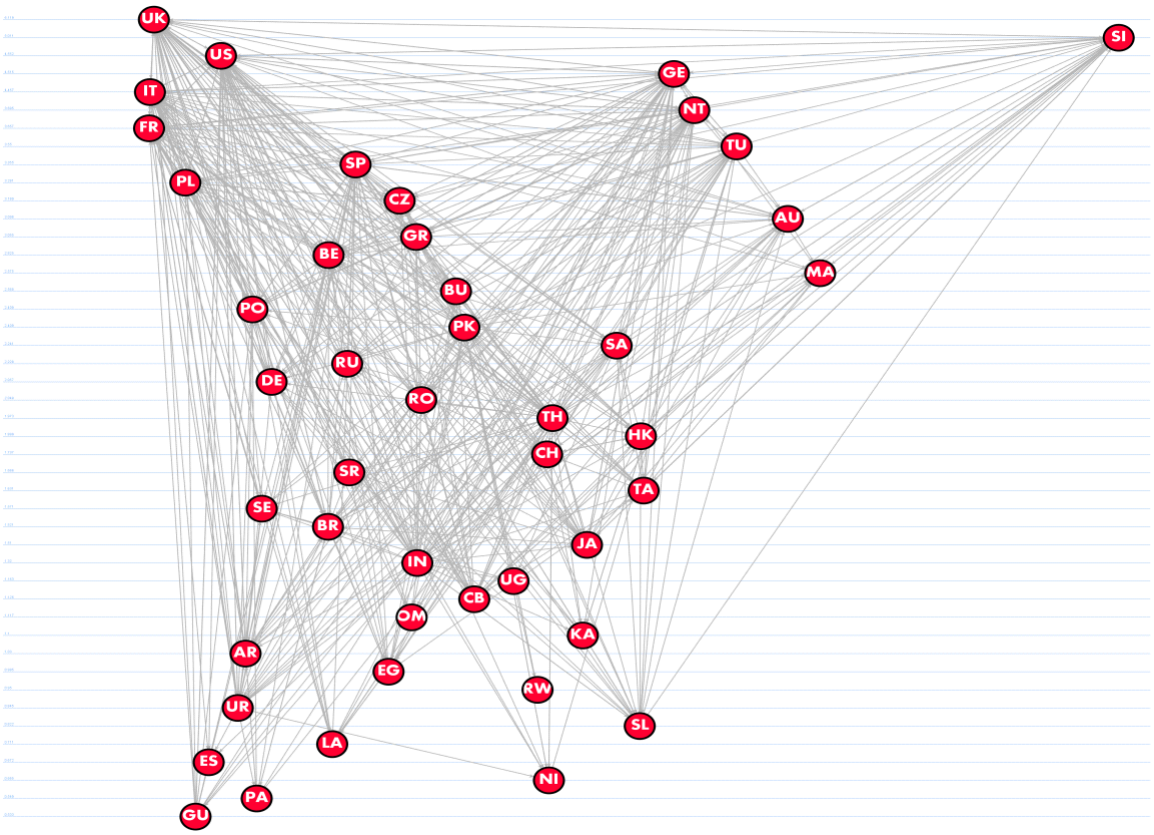
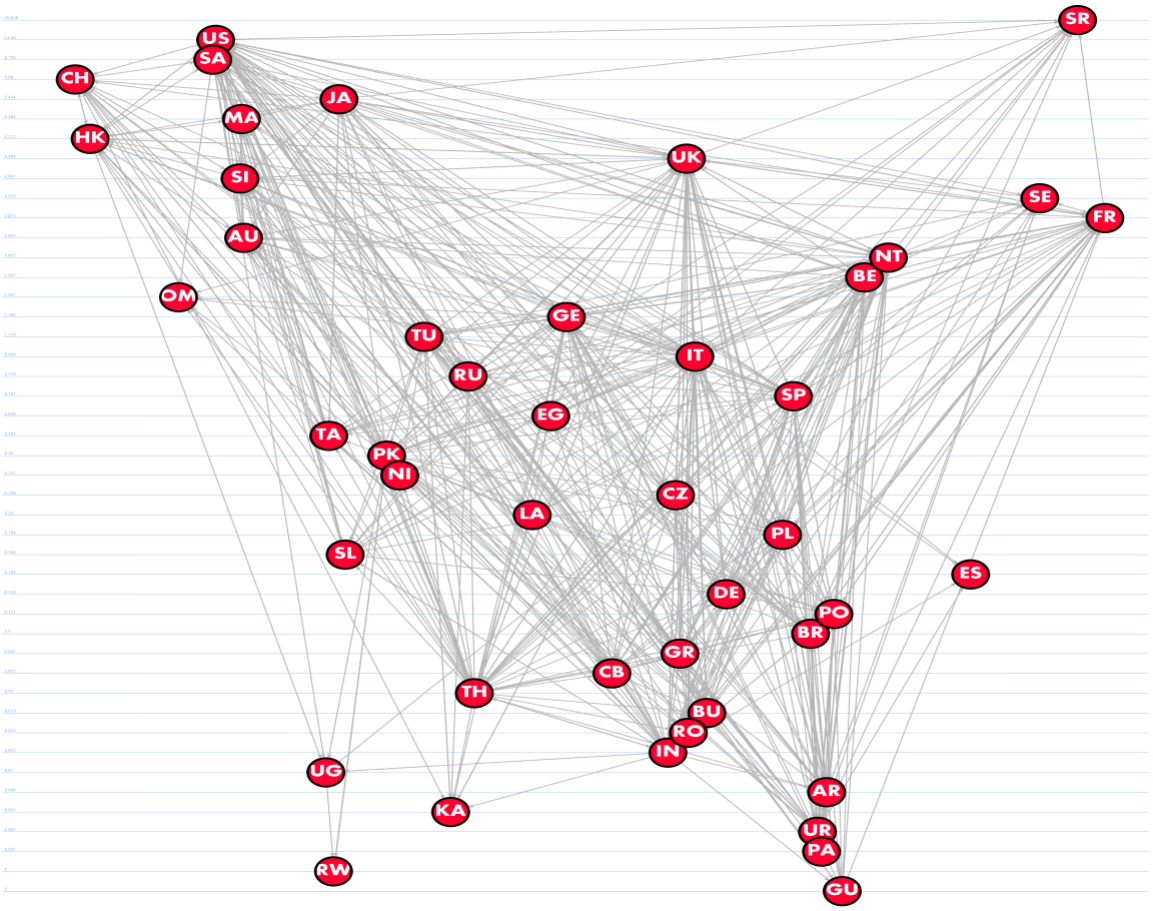


AUTHORITY VALUED RICE2011



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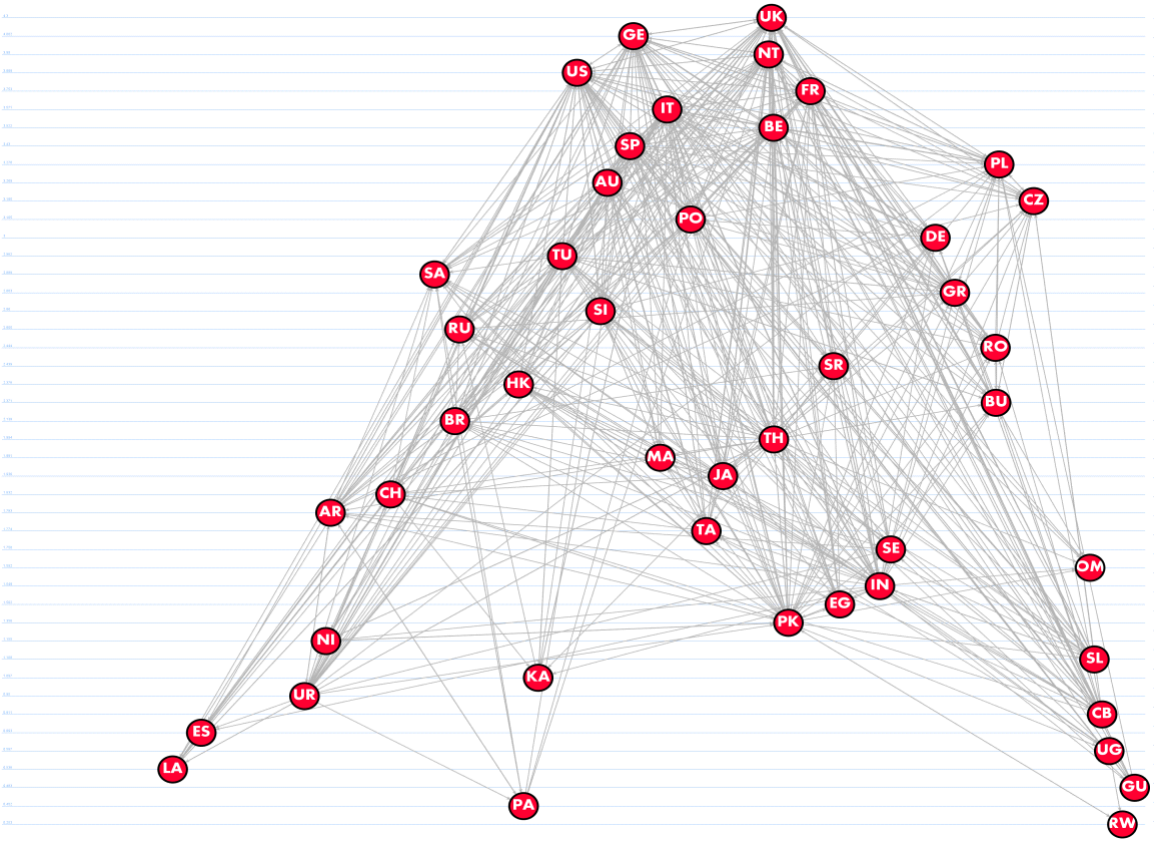
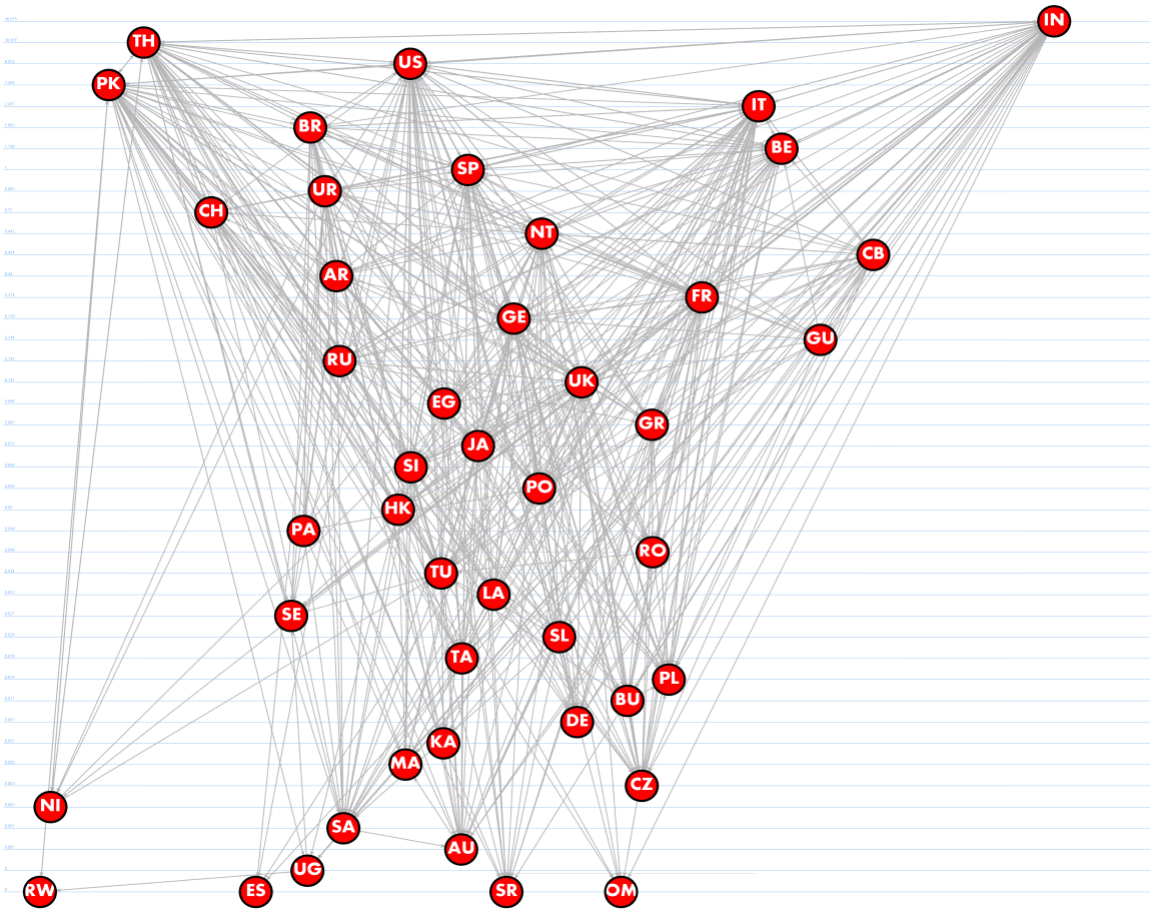


HUB VALUED RICE2011



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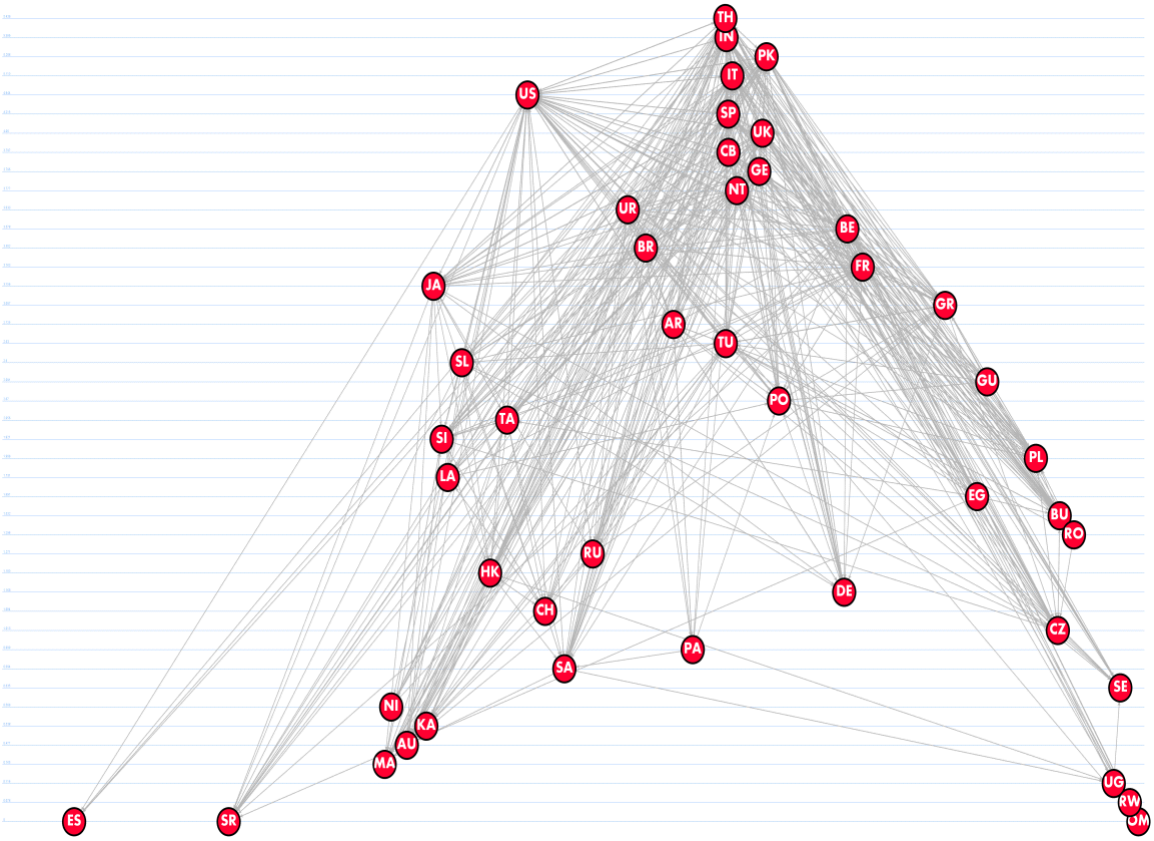

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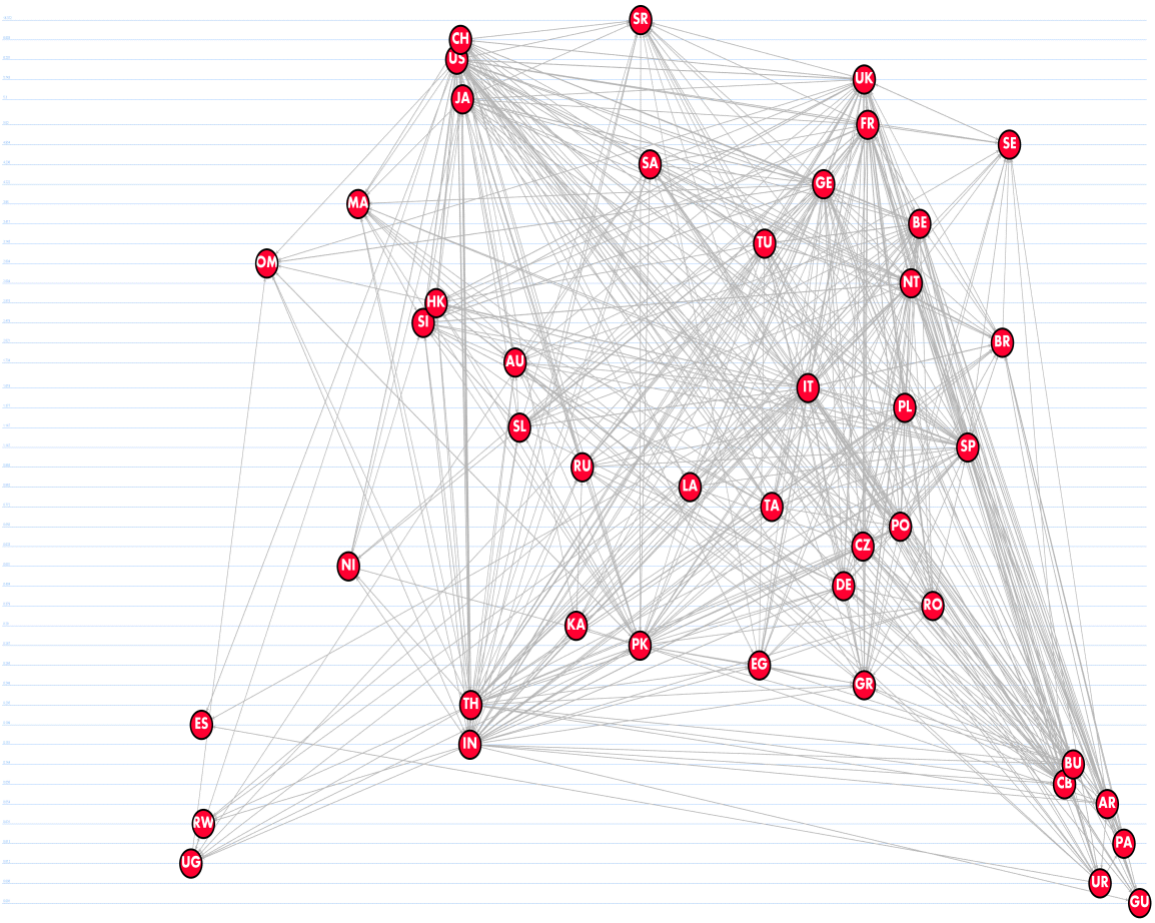

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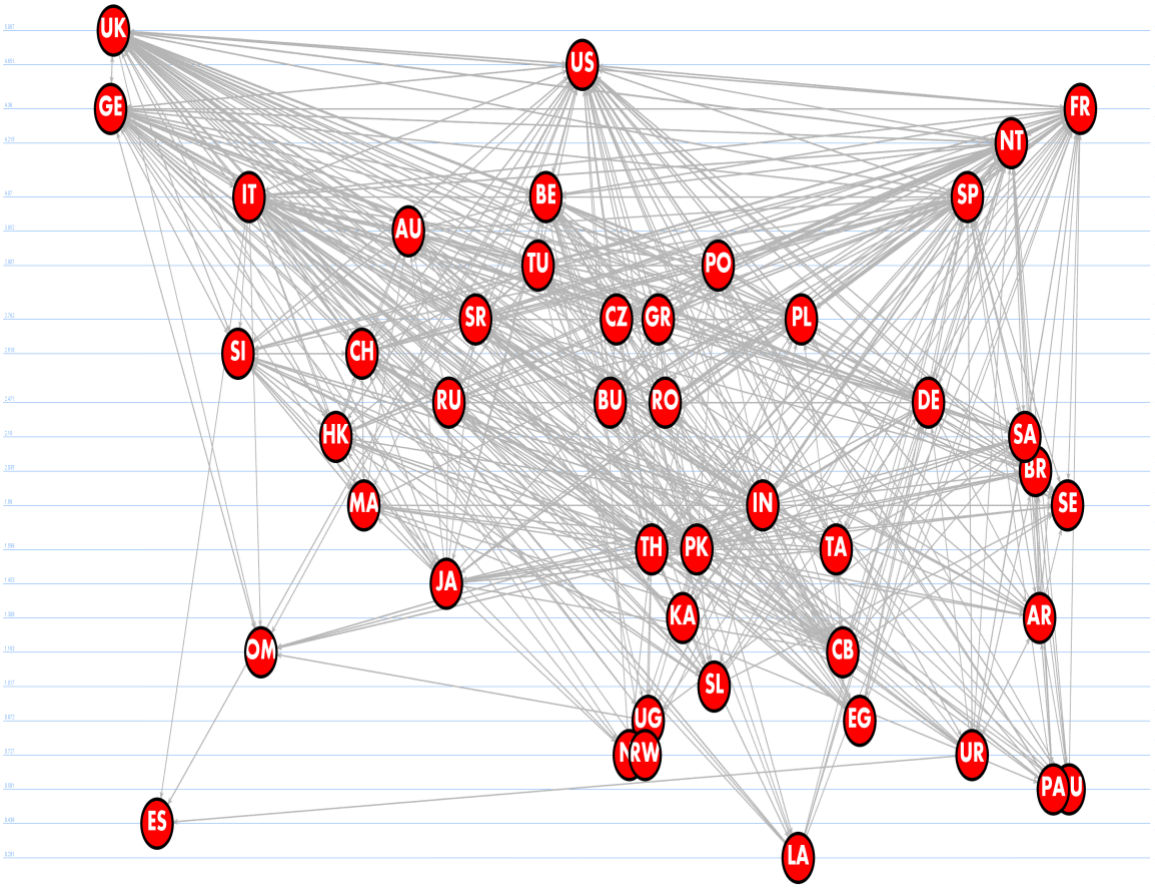

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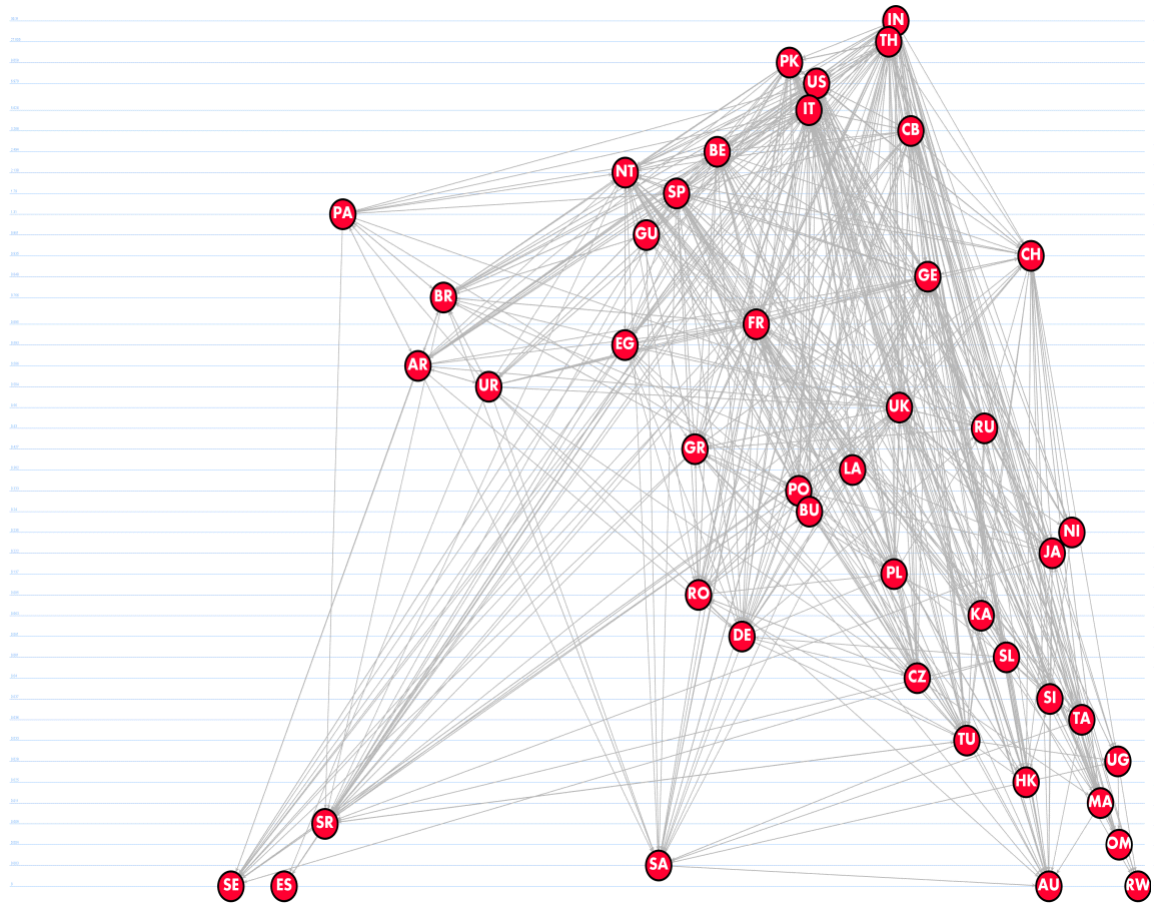

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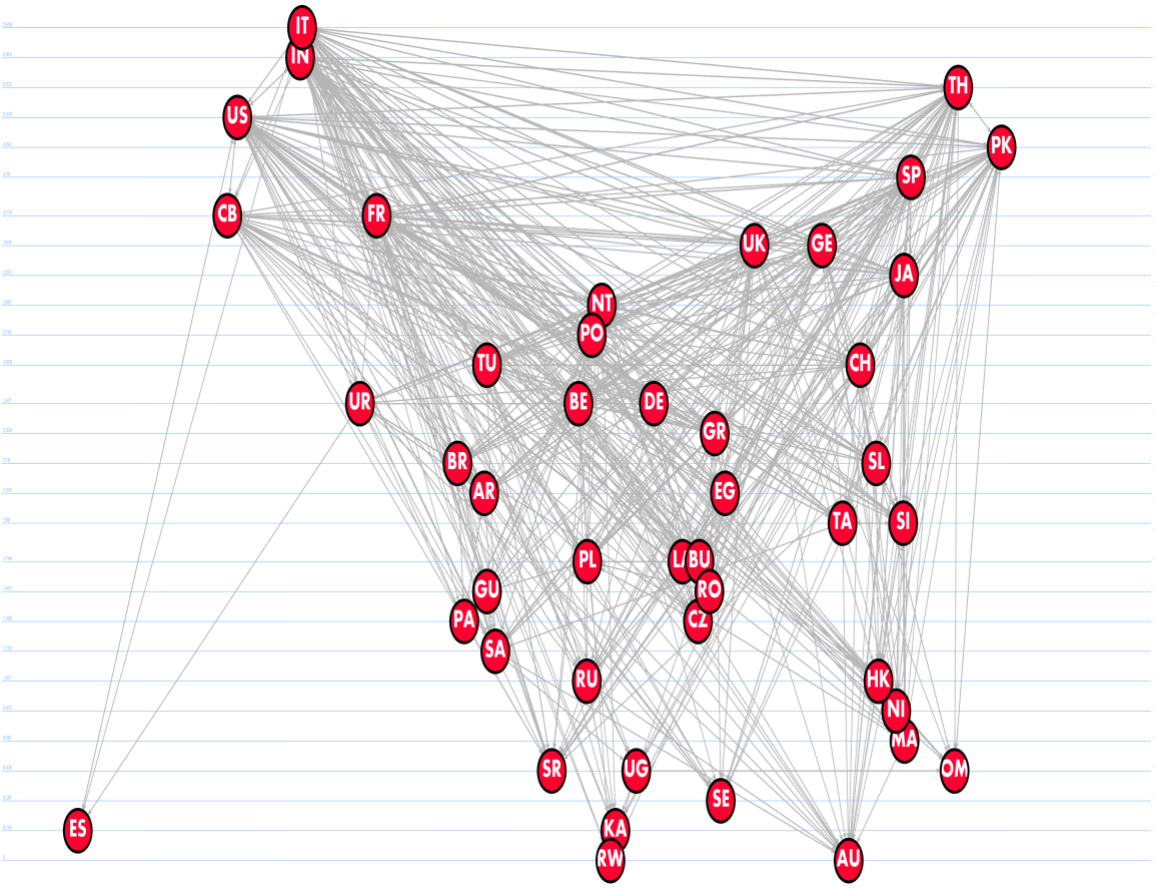

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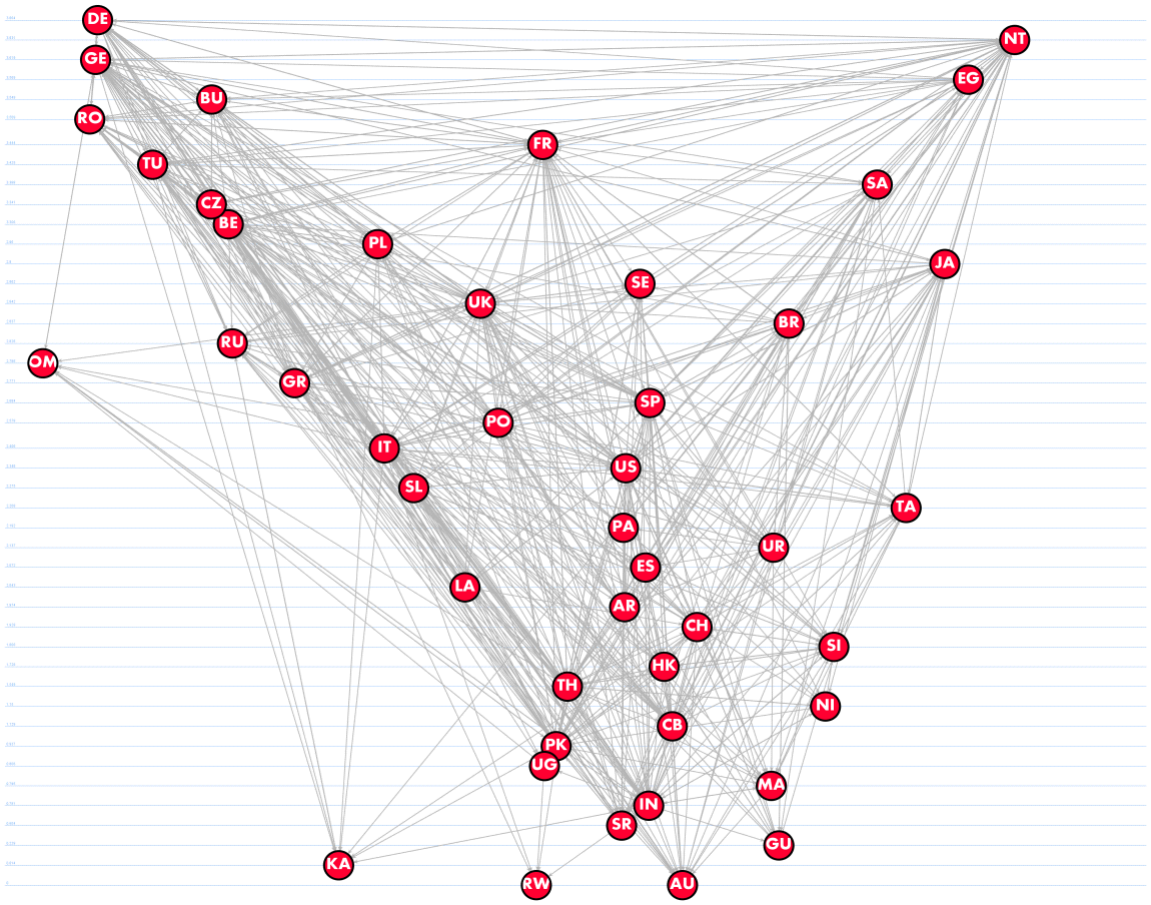

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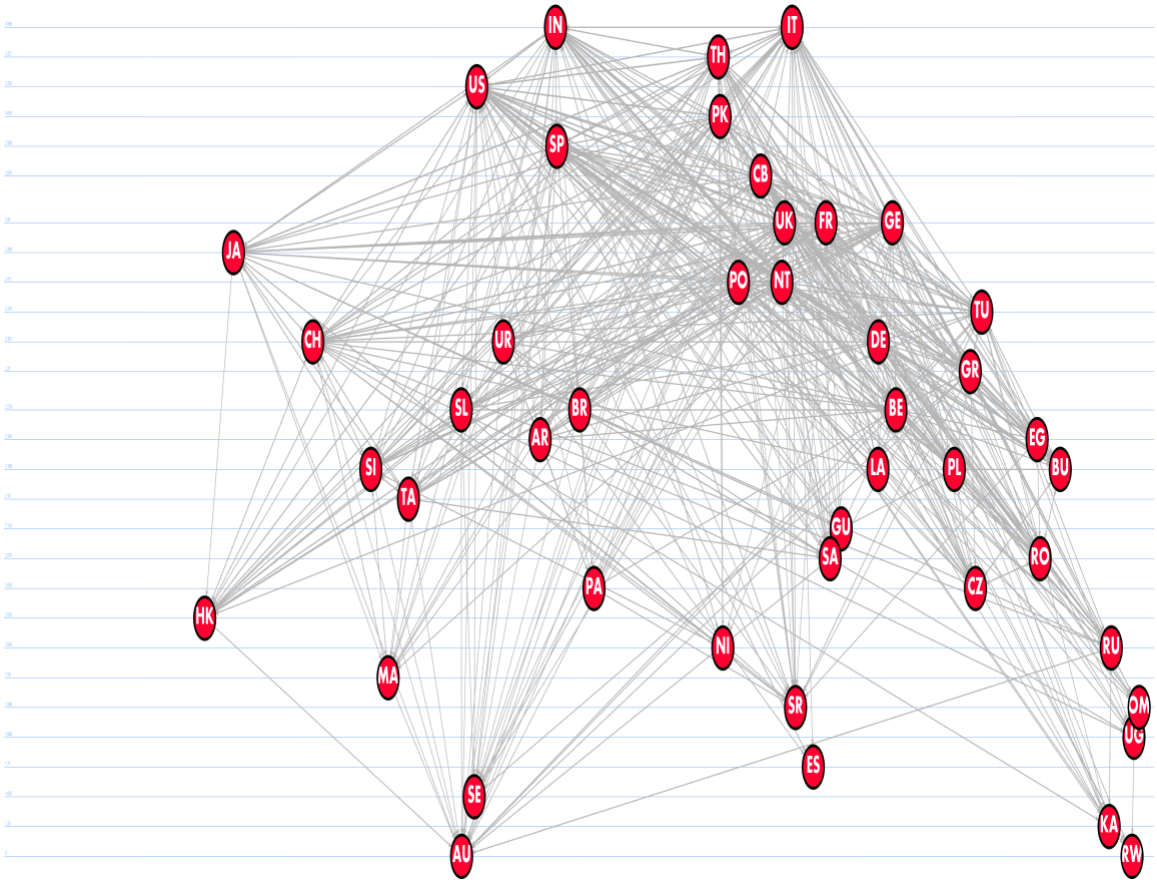

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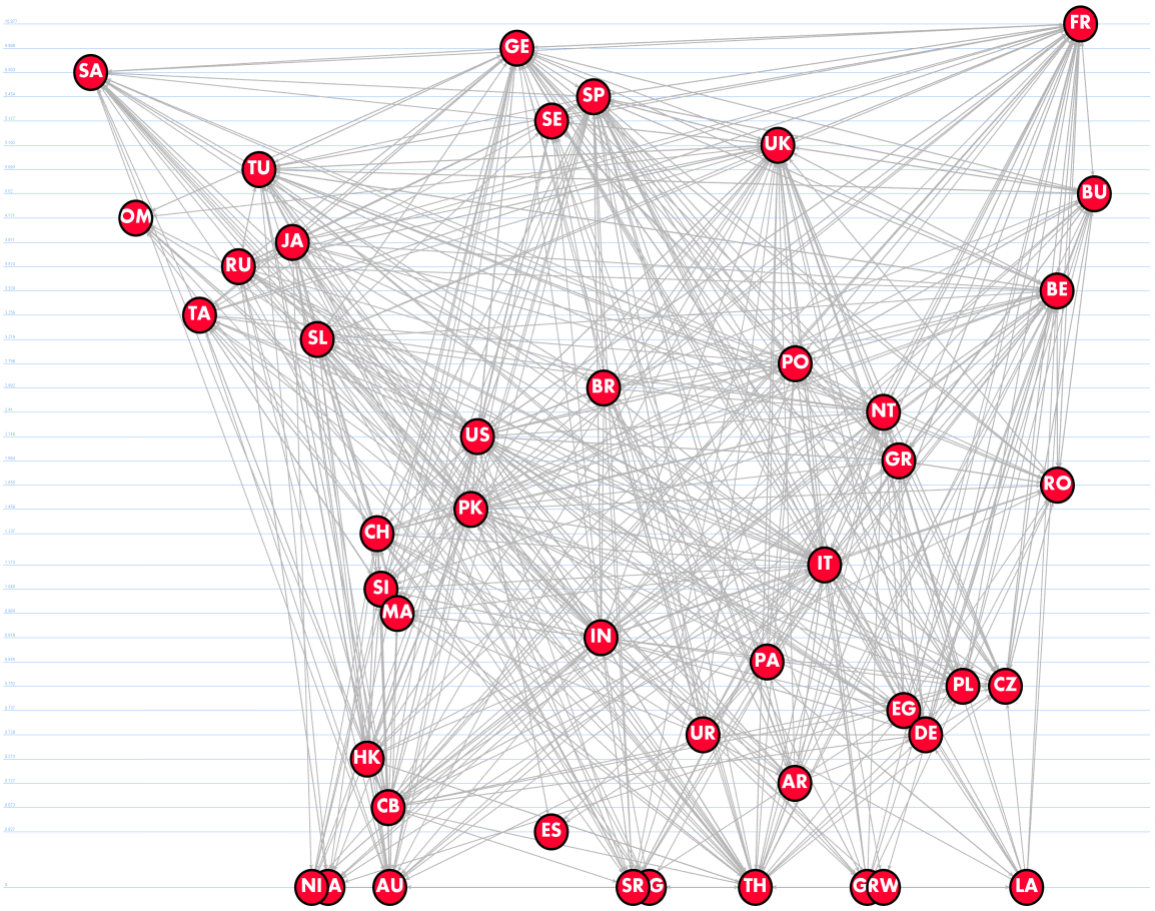

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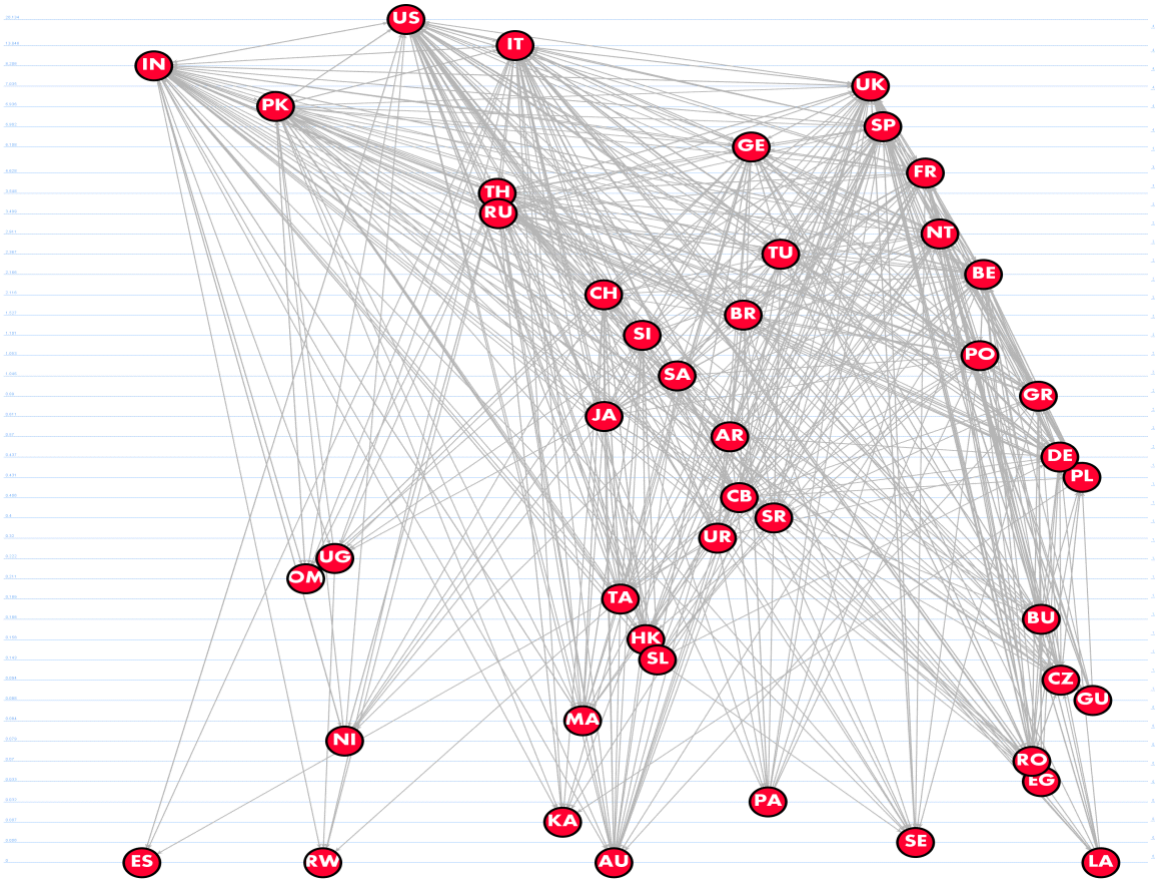

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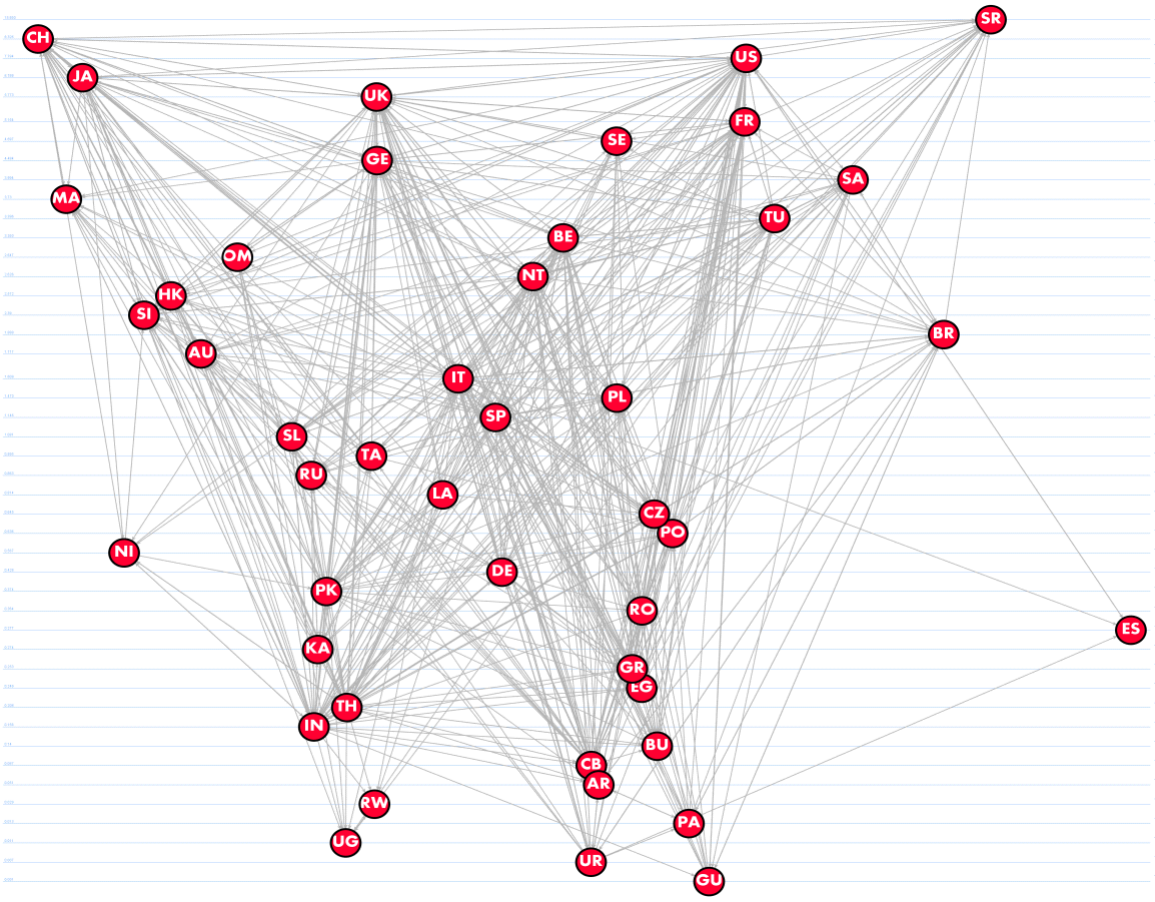

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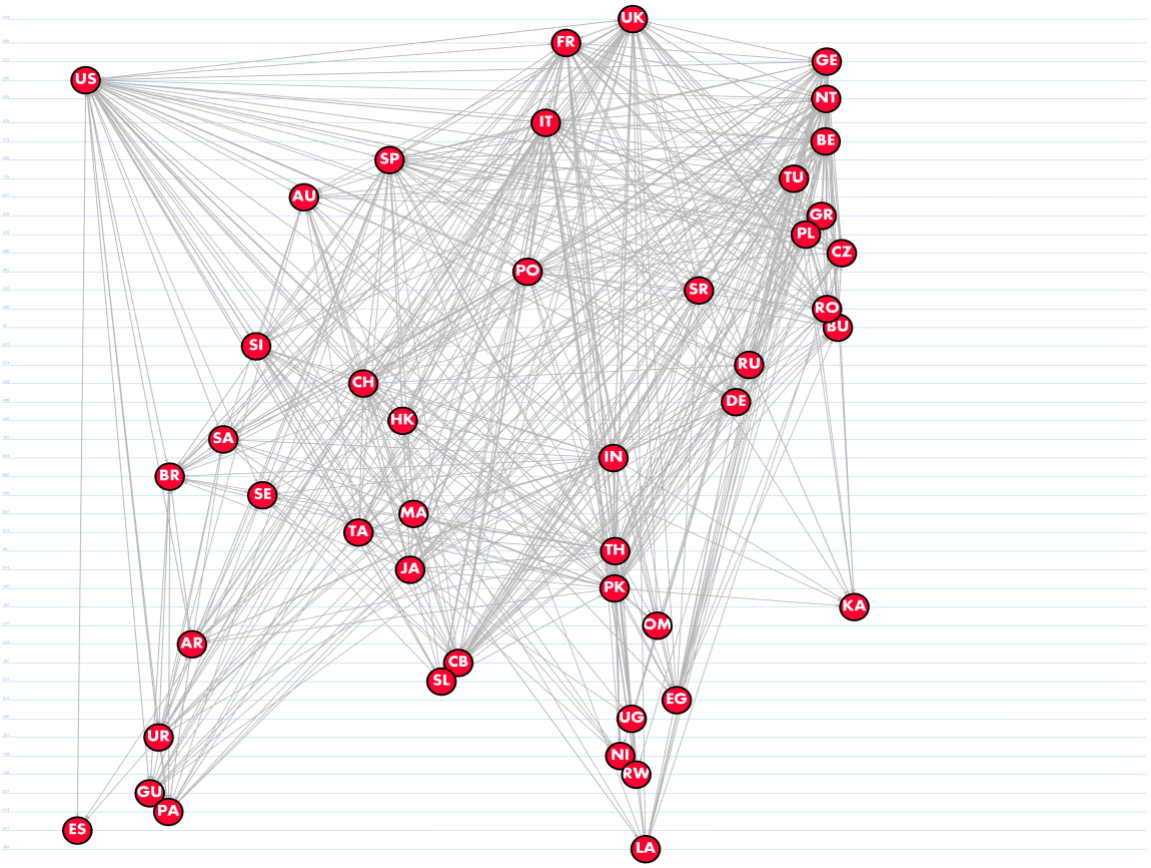

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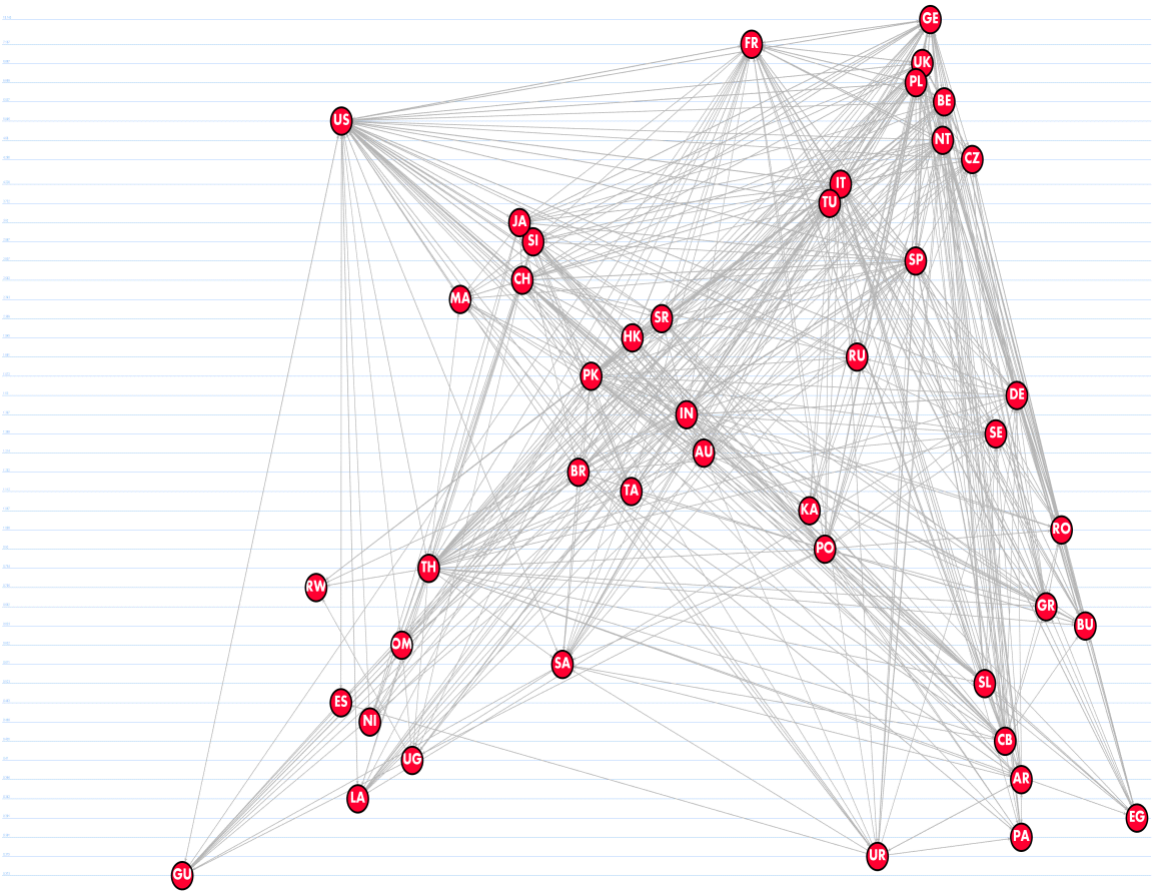

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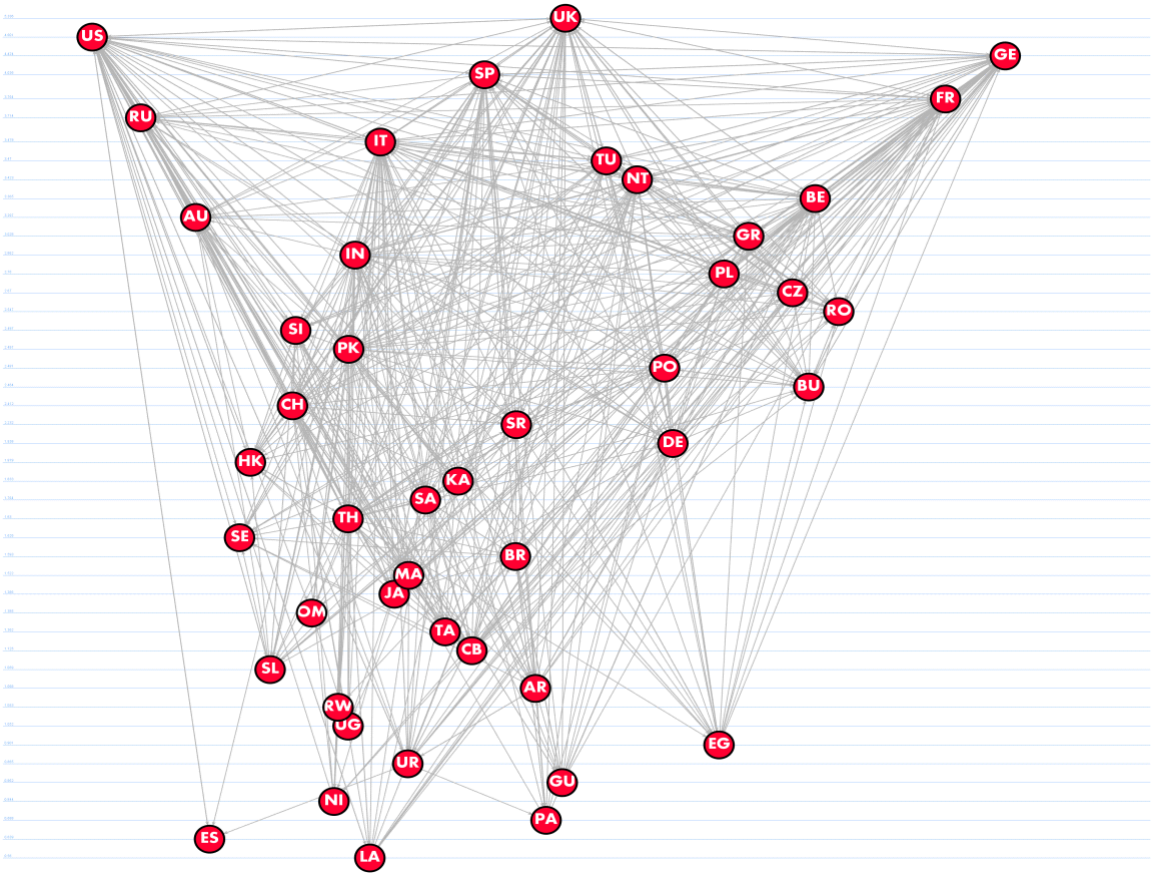

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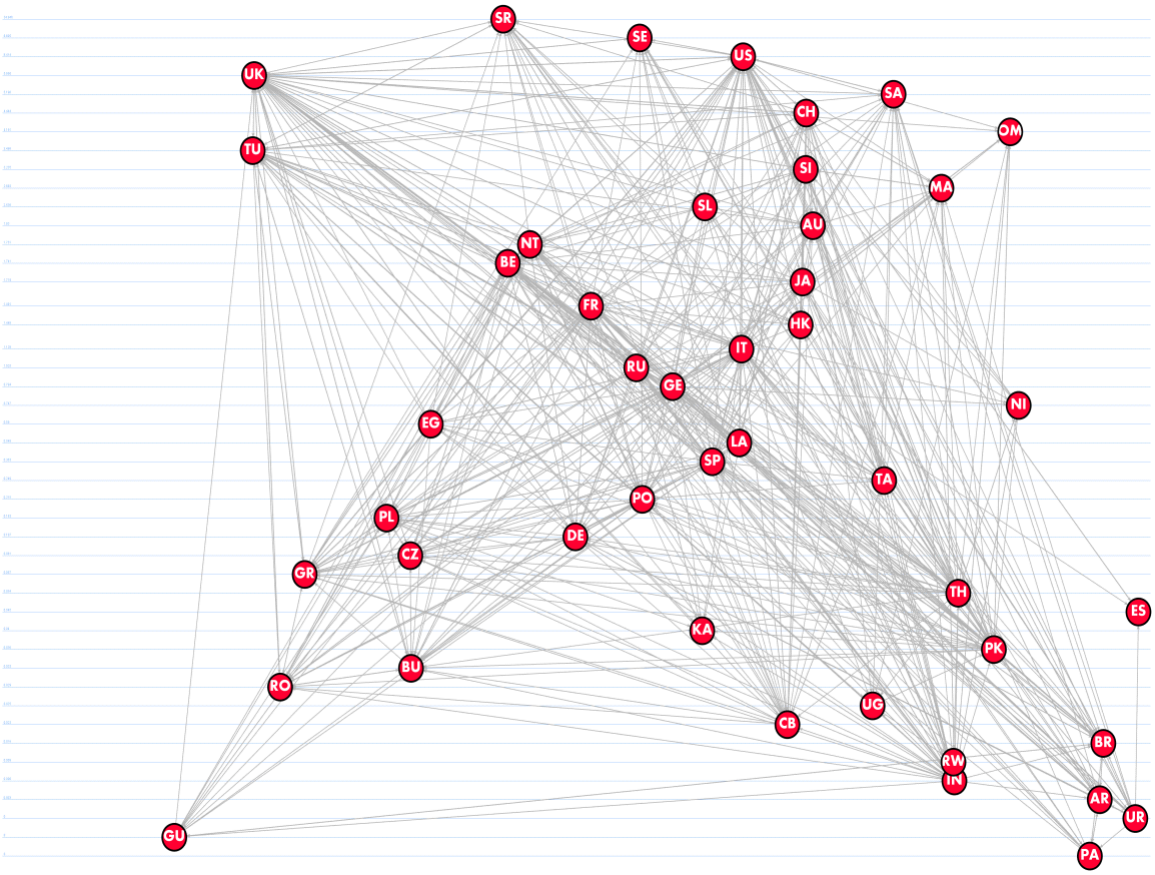

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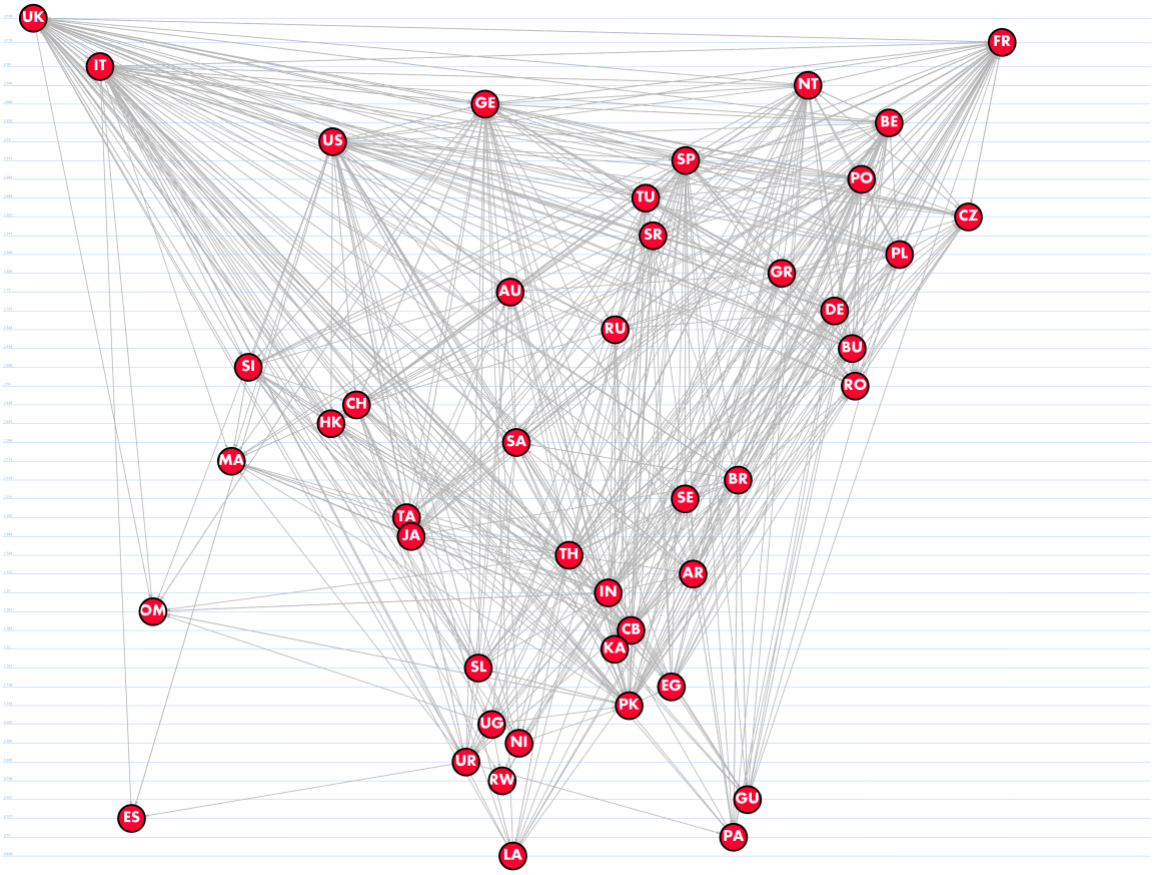

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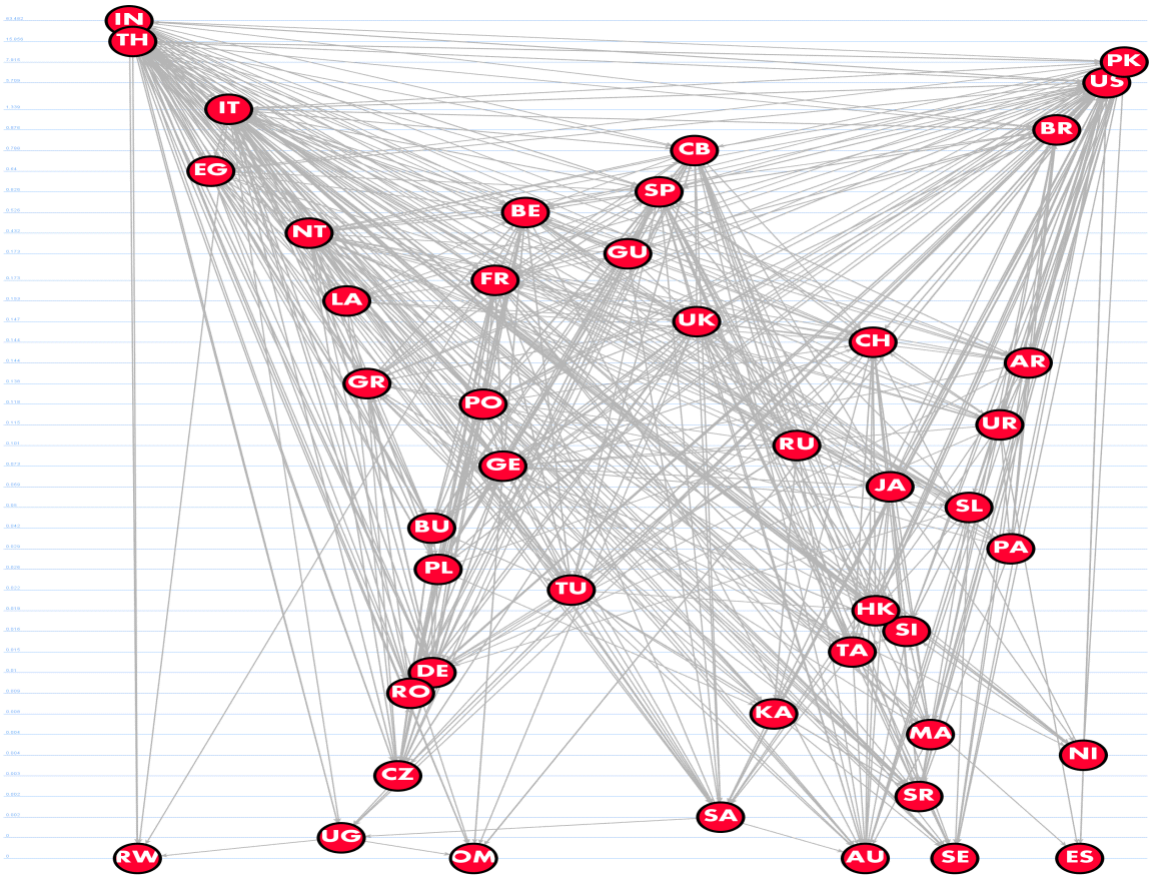

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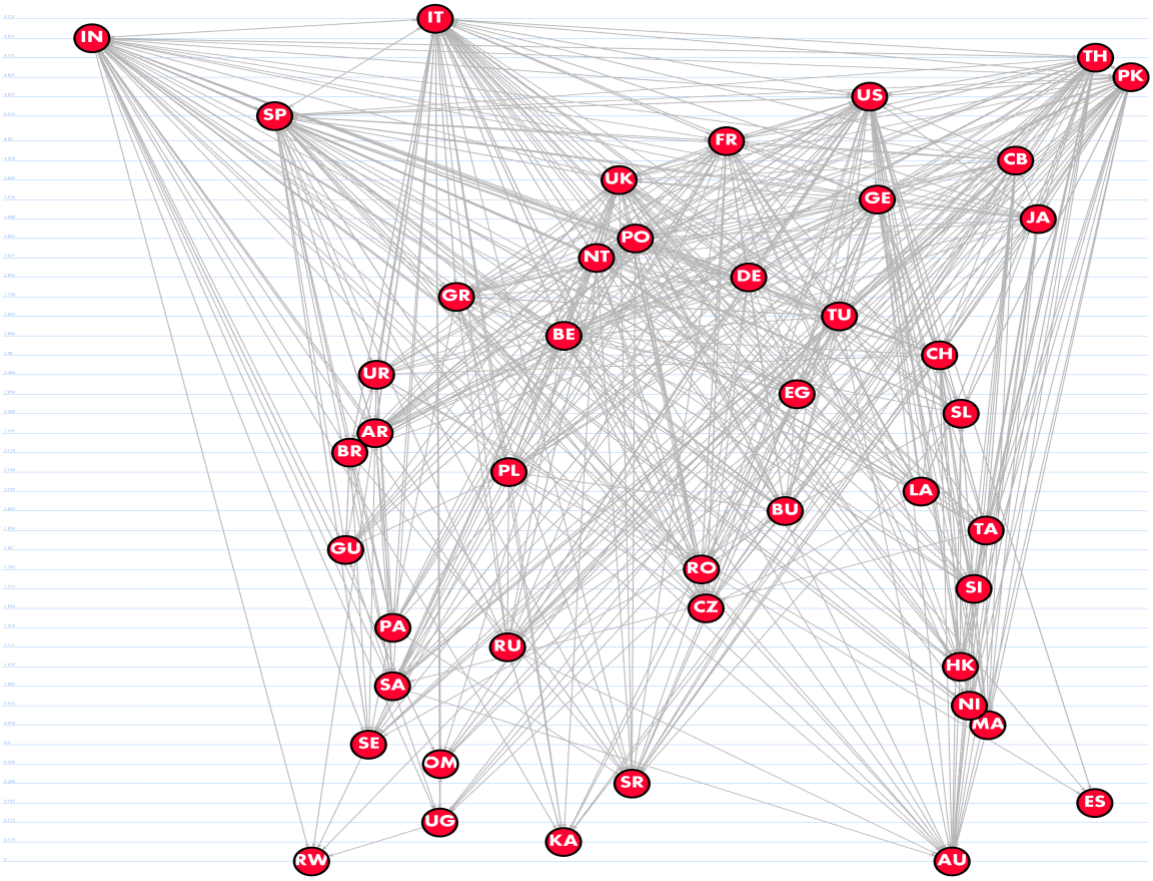
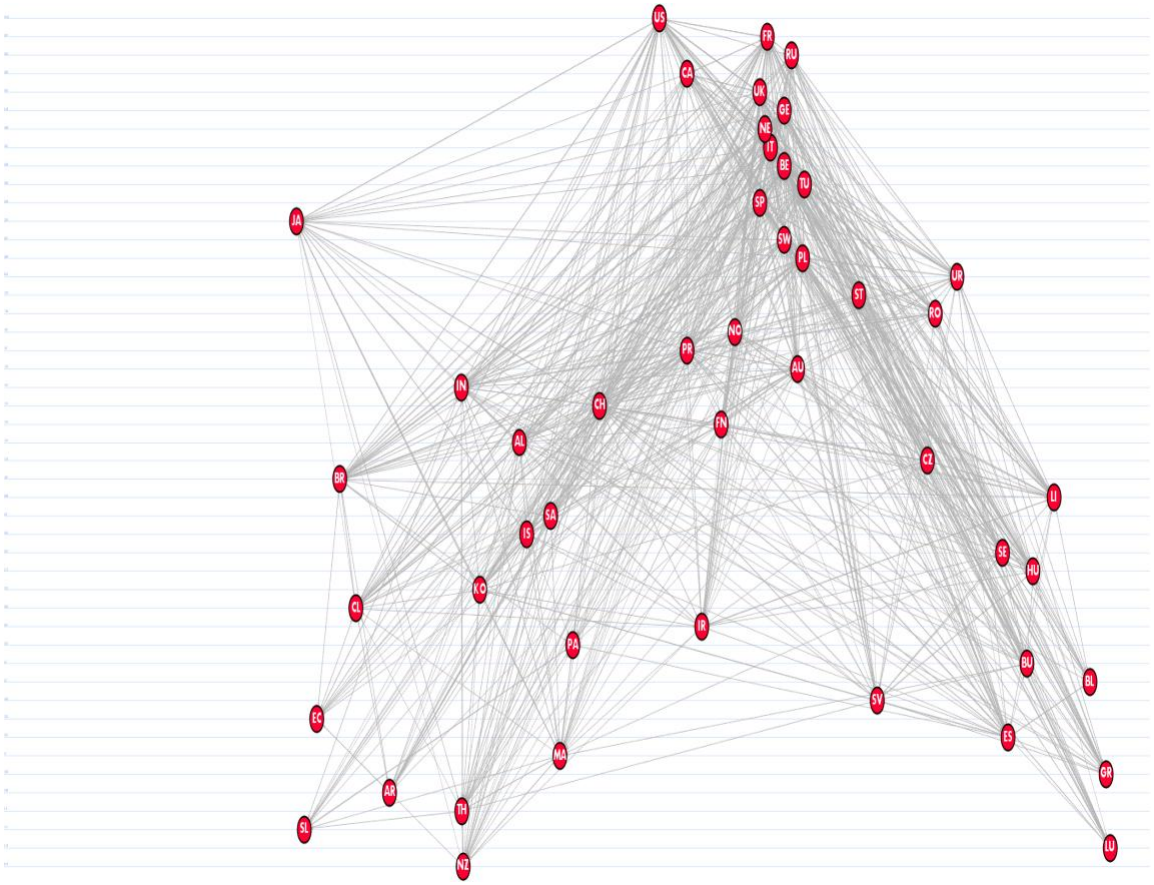


INDEGREE VALUED WOOD2011



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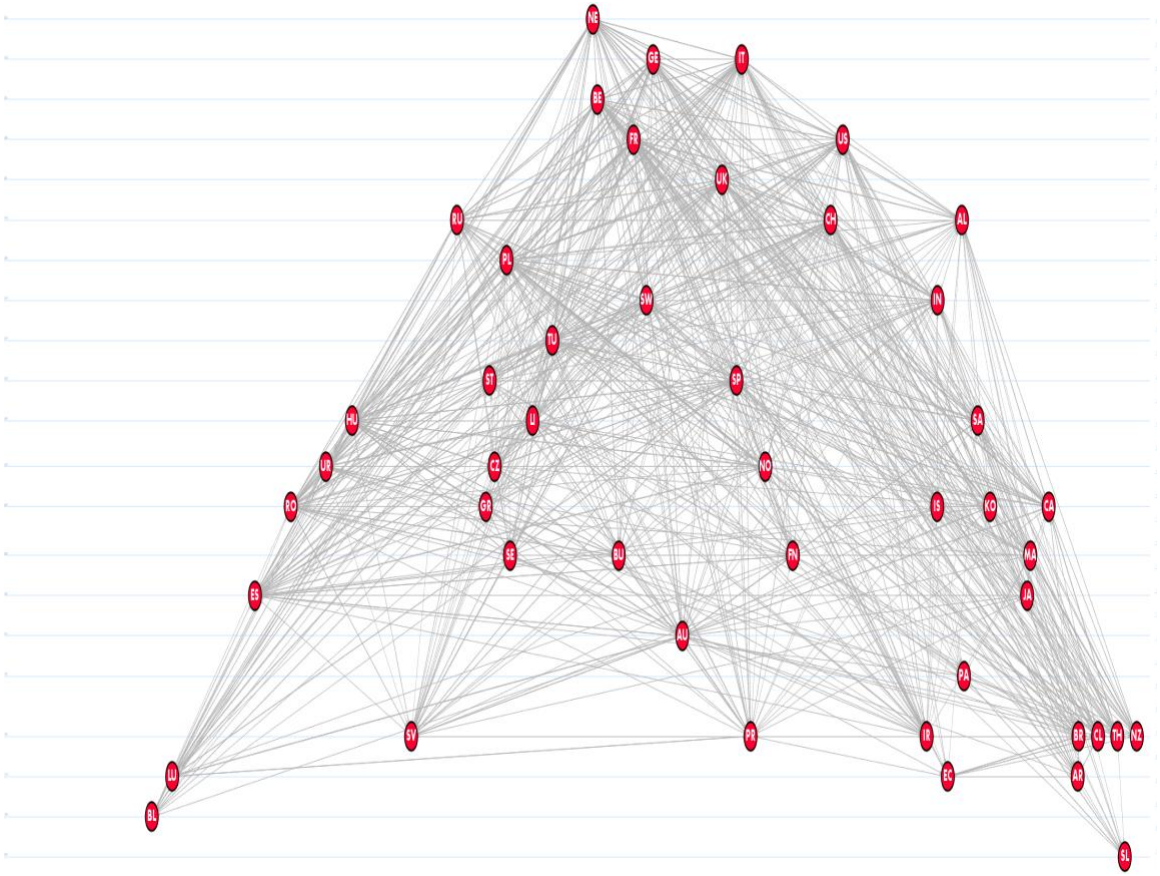

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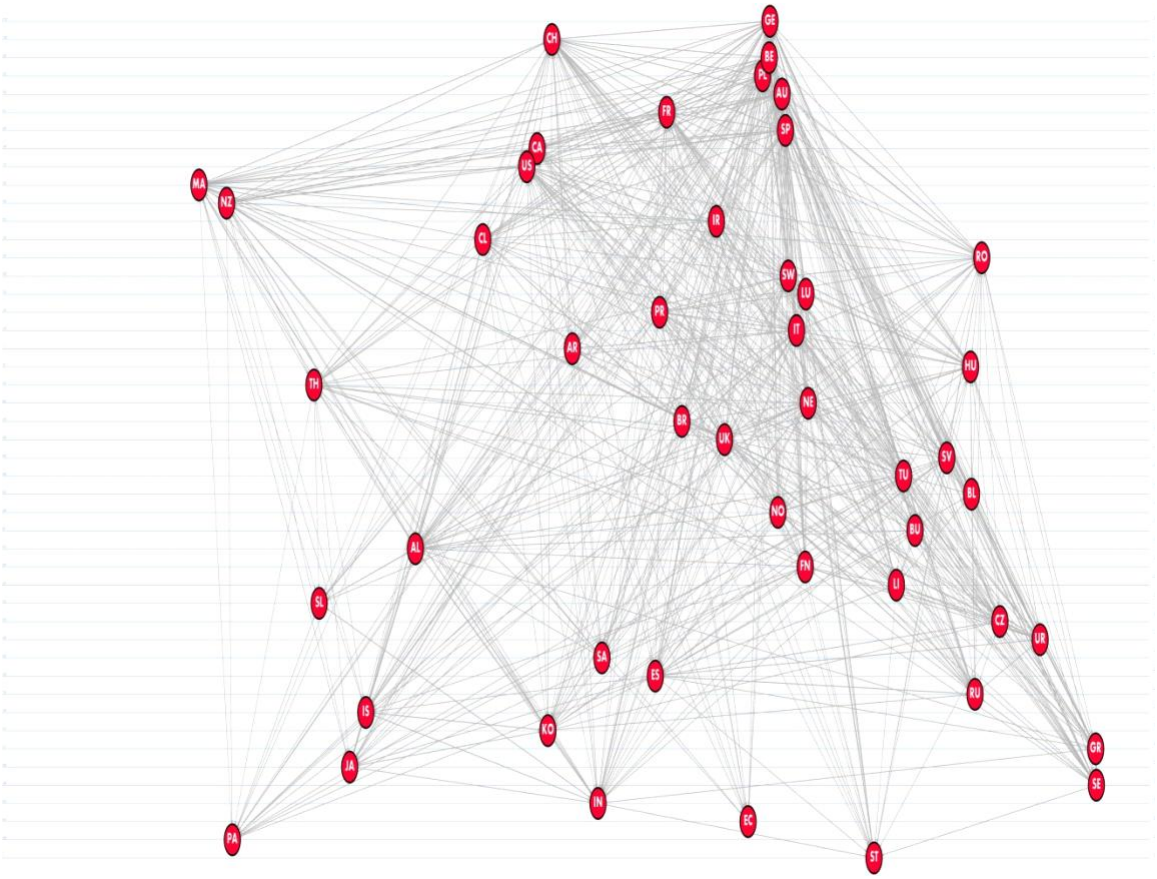
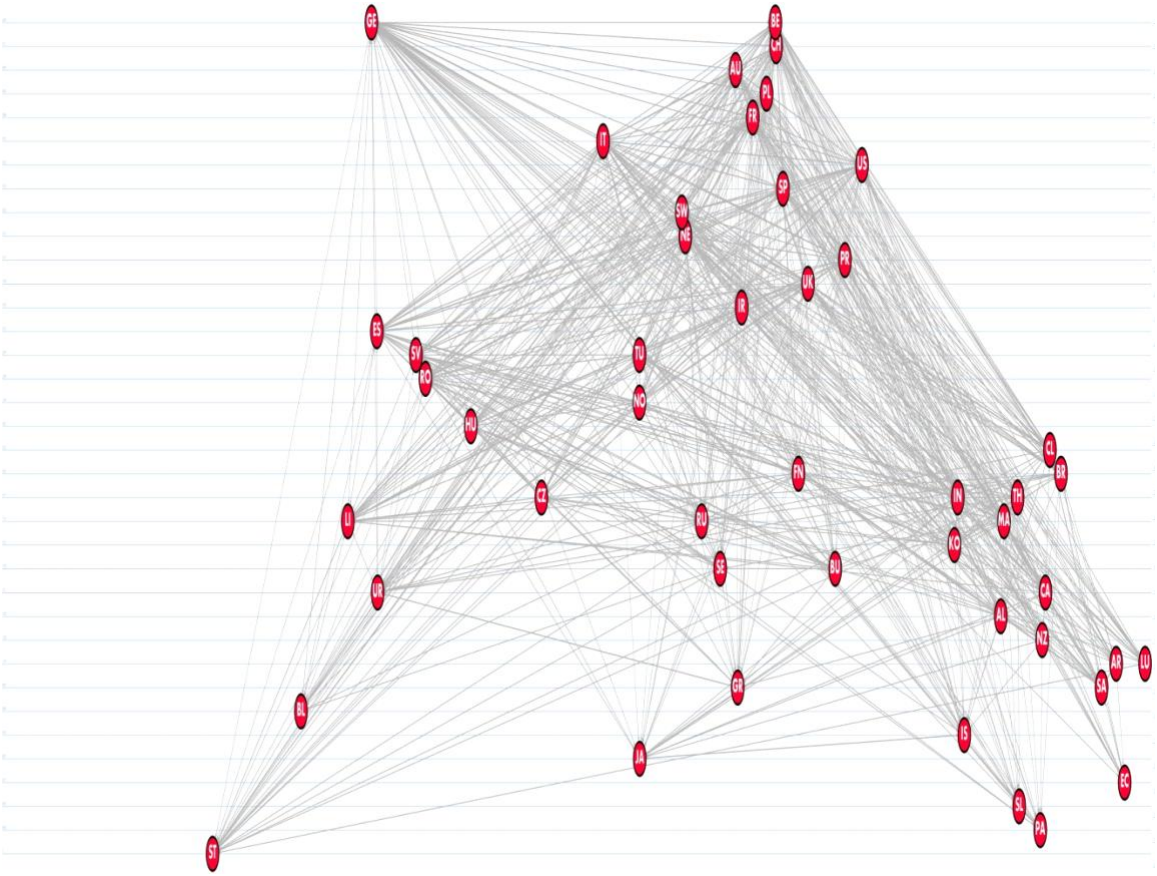


OUTDEGREE BINARY WOOD2011



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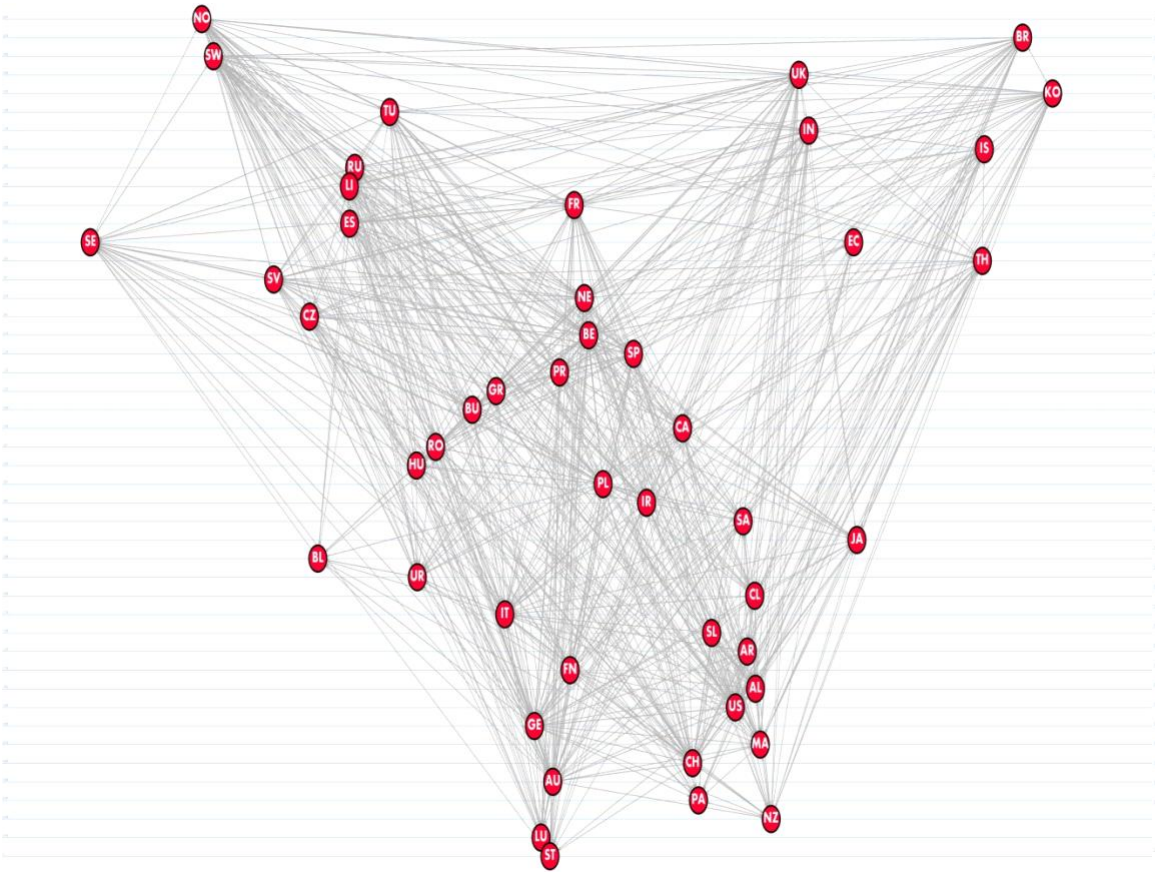

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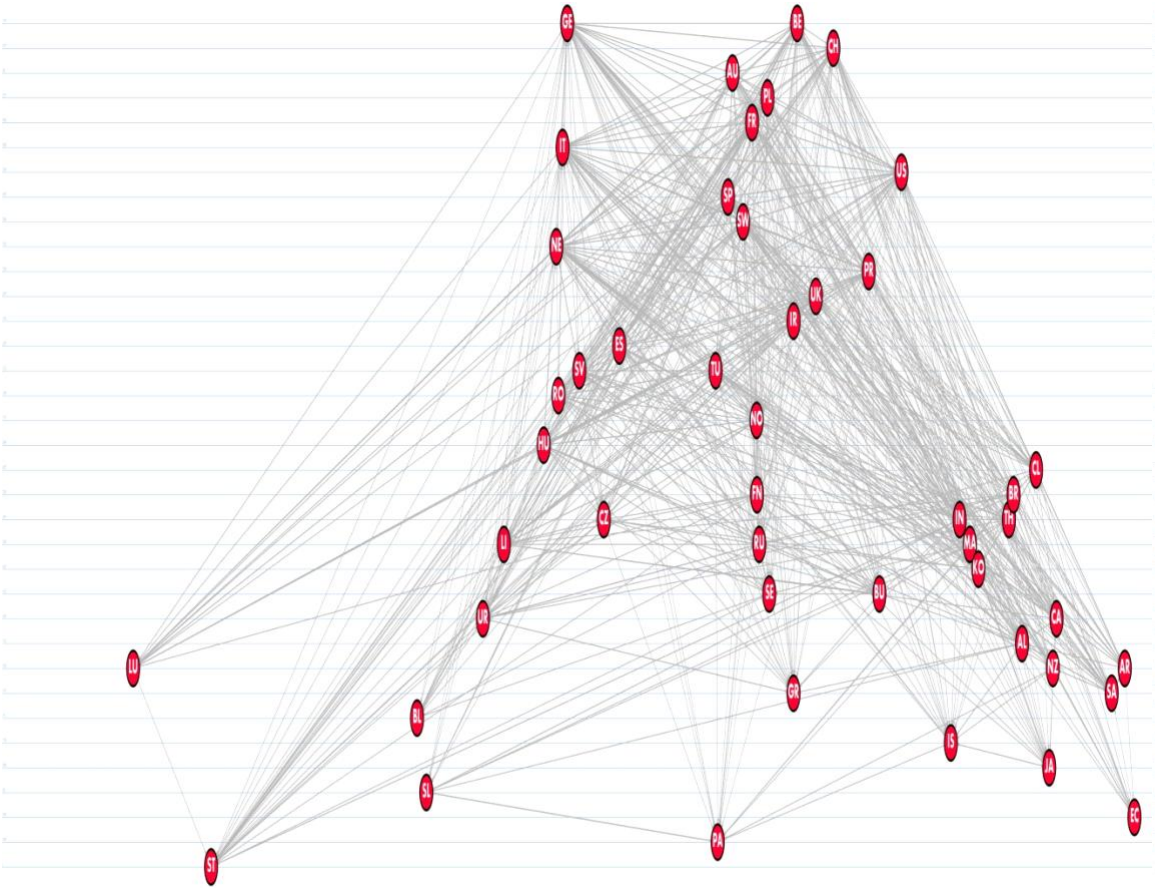

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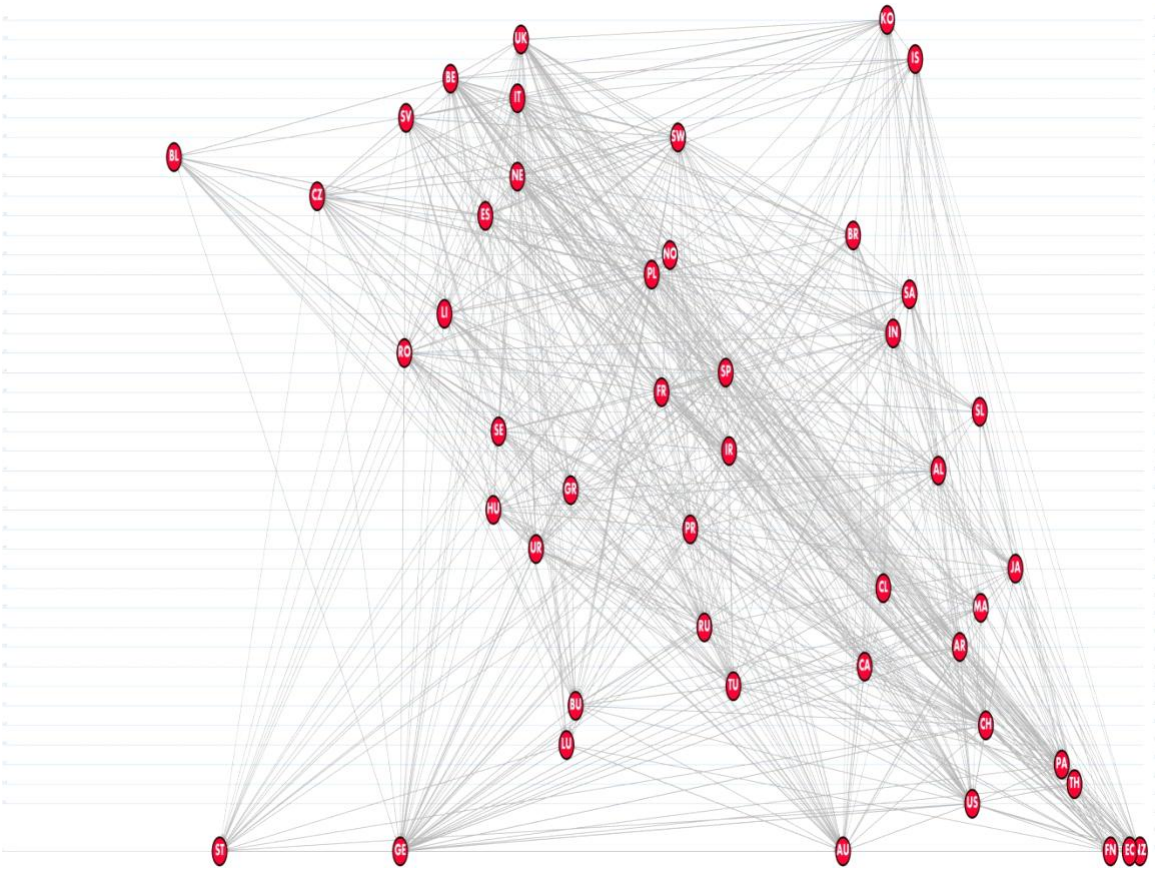

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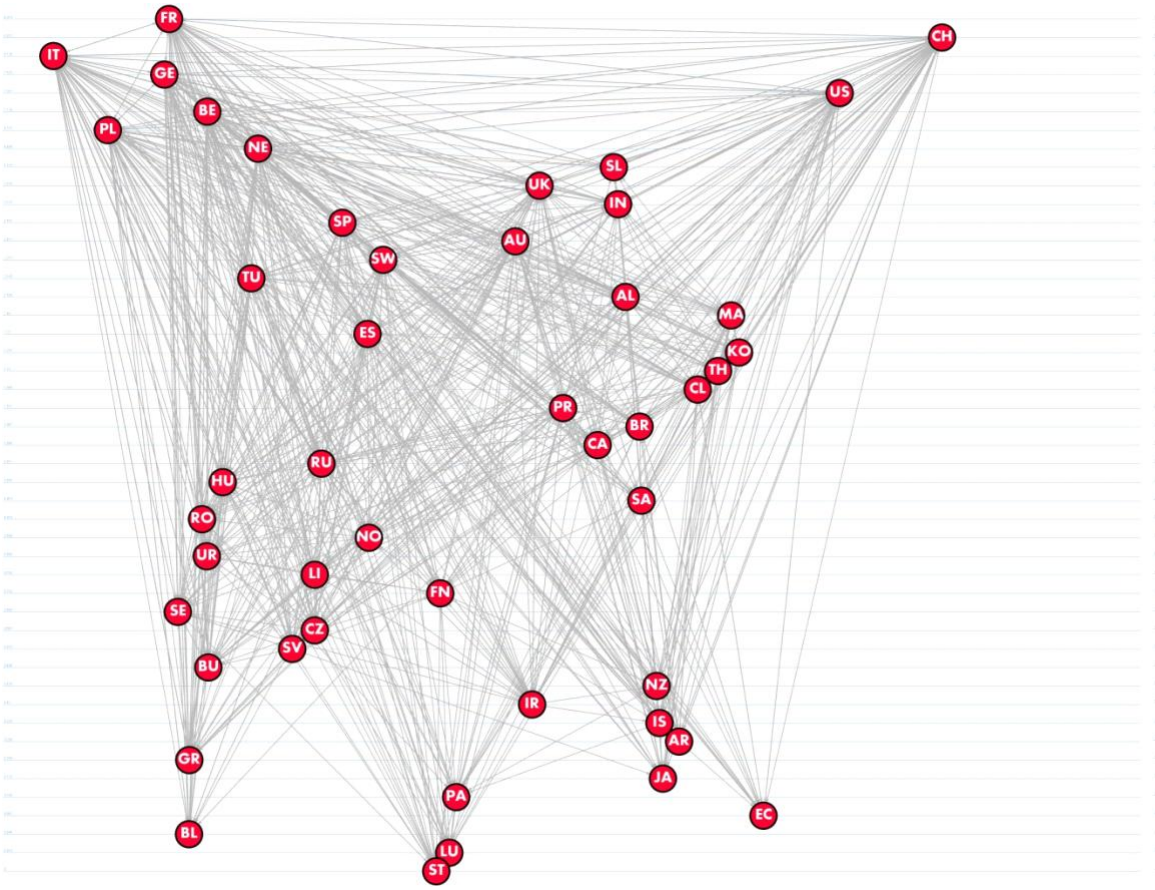

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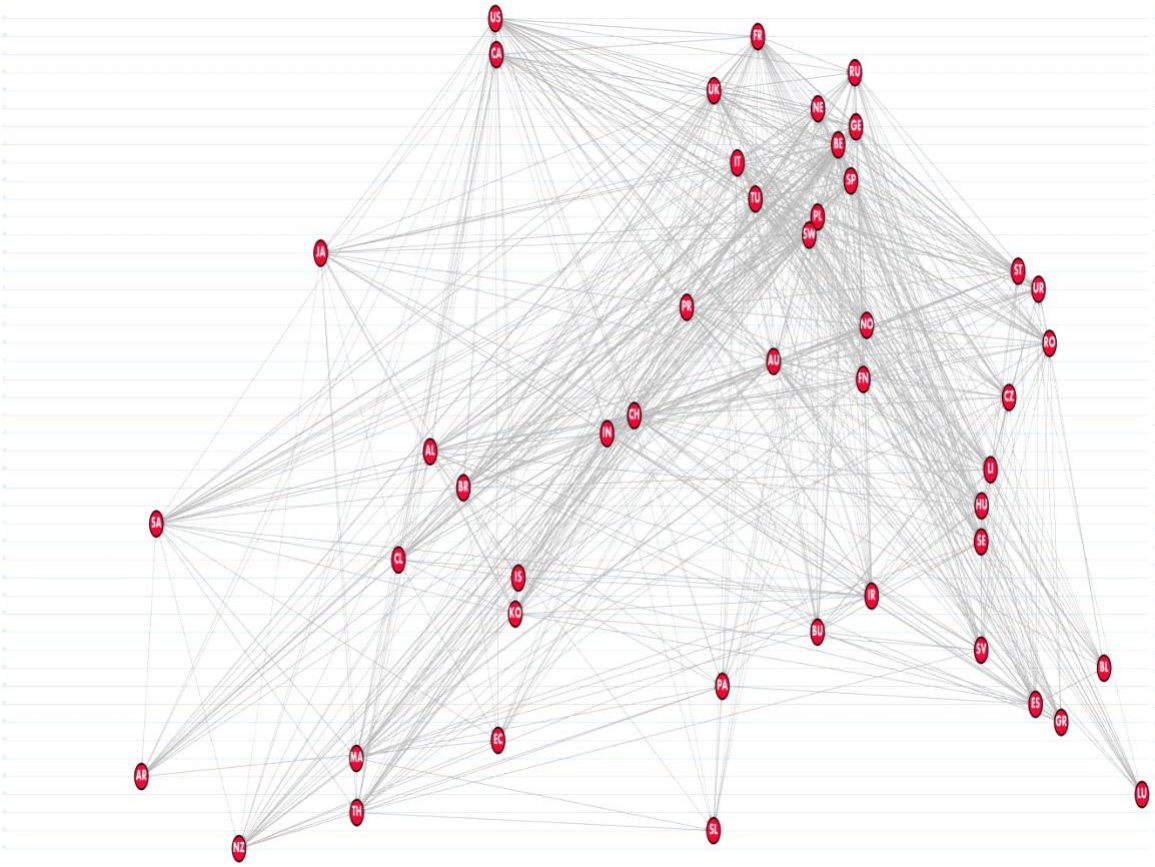
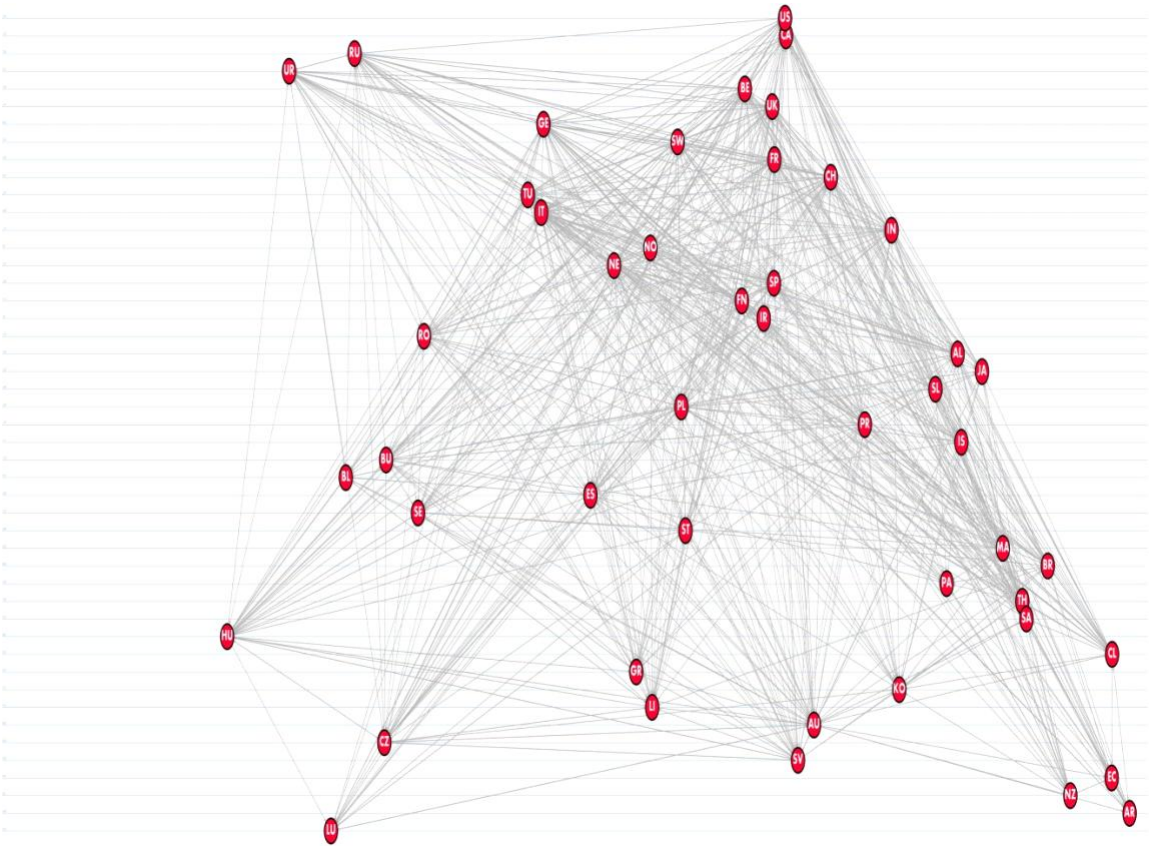


STATUS BINARY WOOD2011

PAGERANK VALUED WOOD2015



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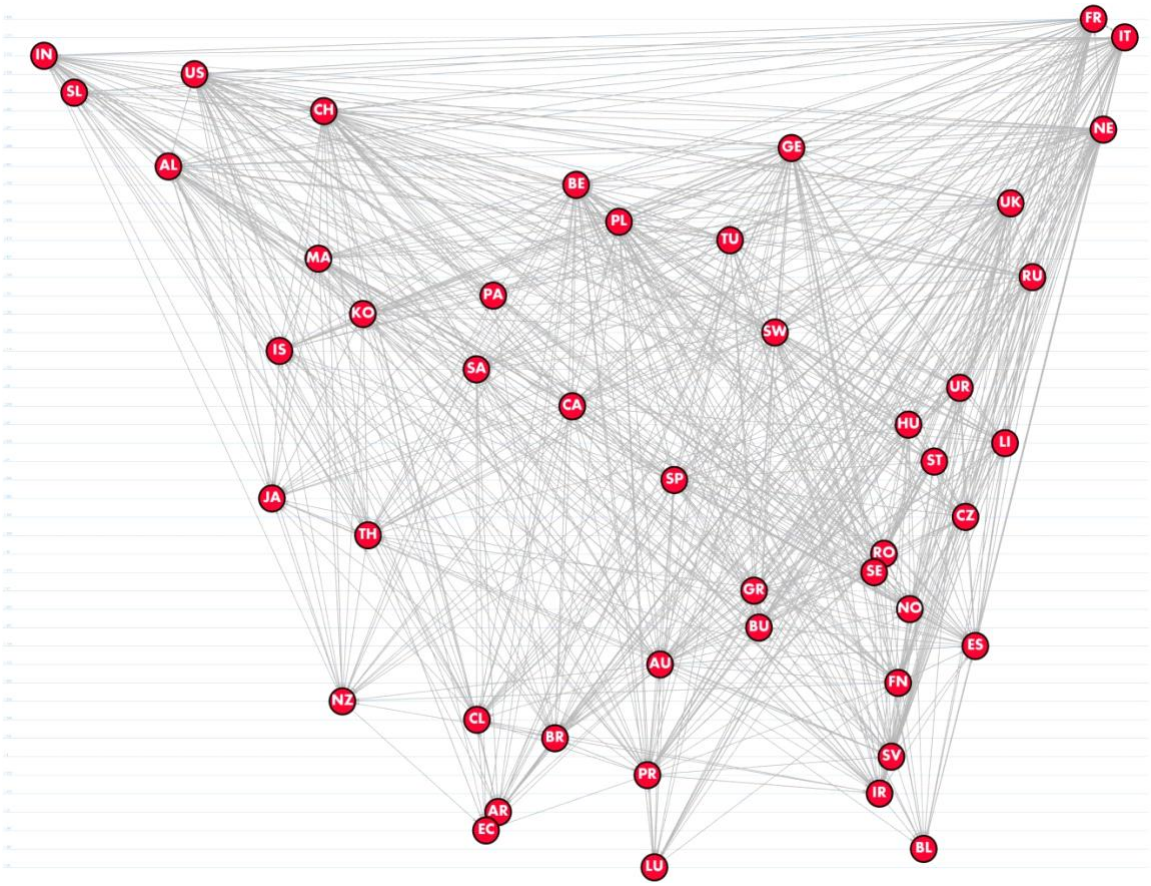

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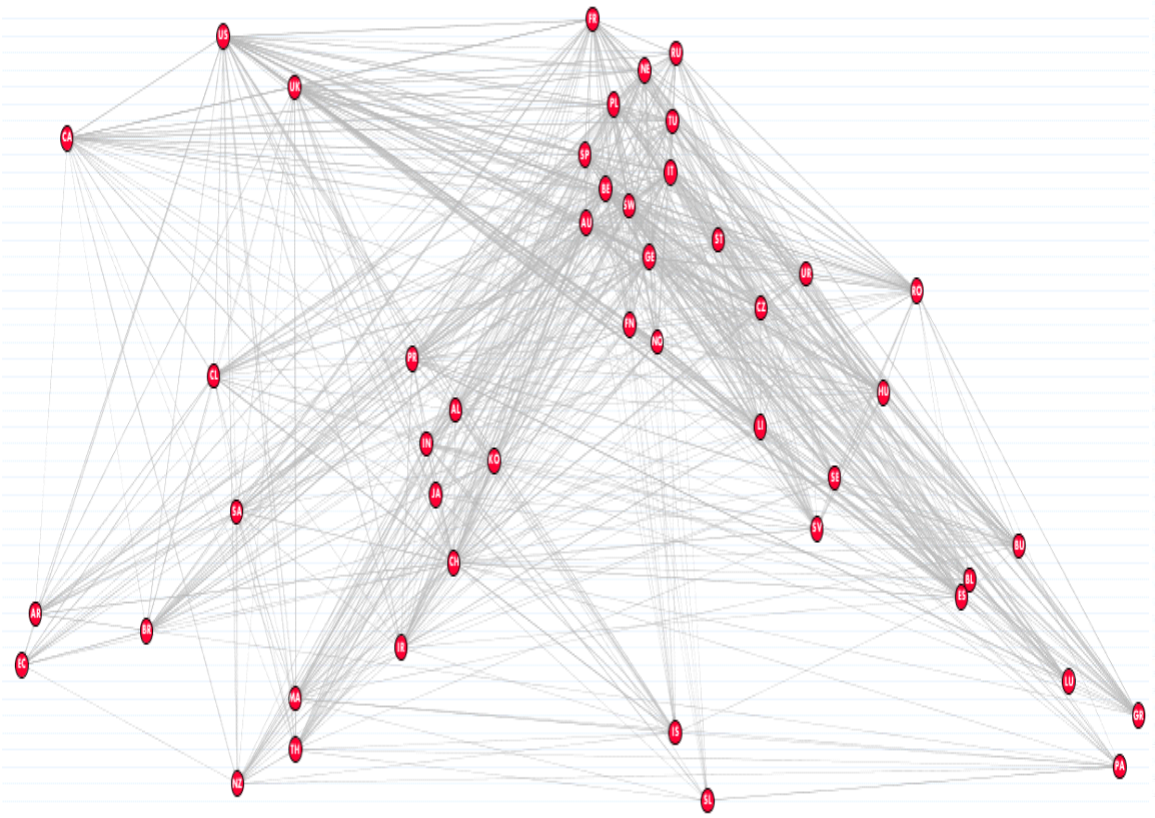

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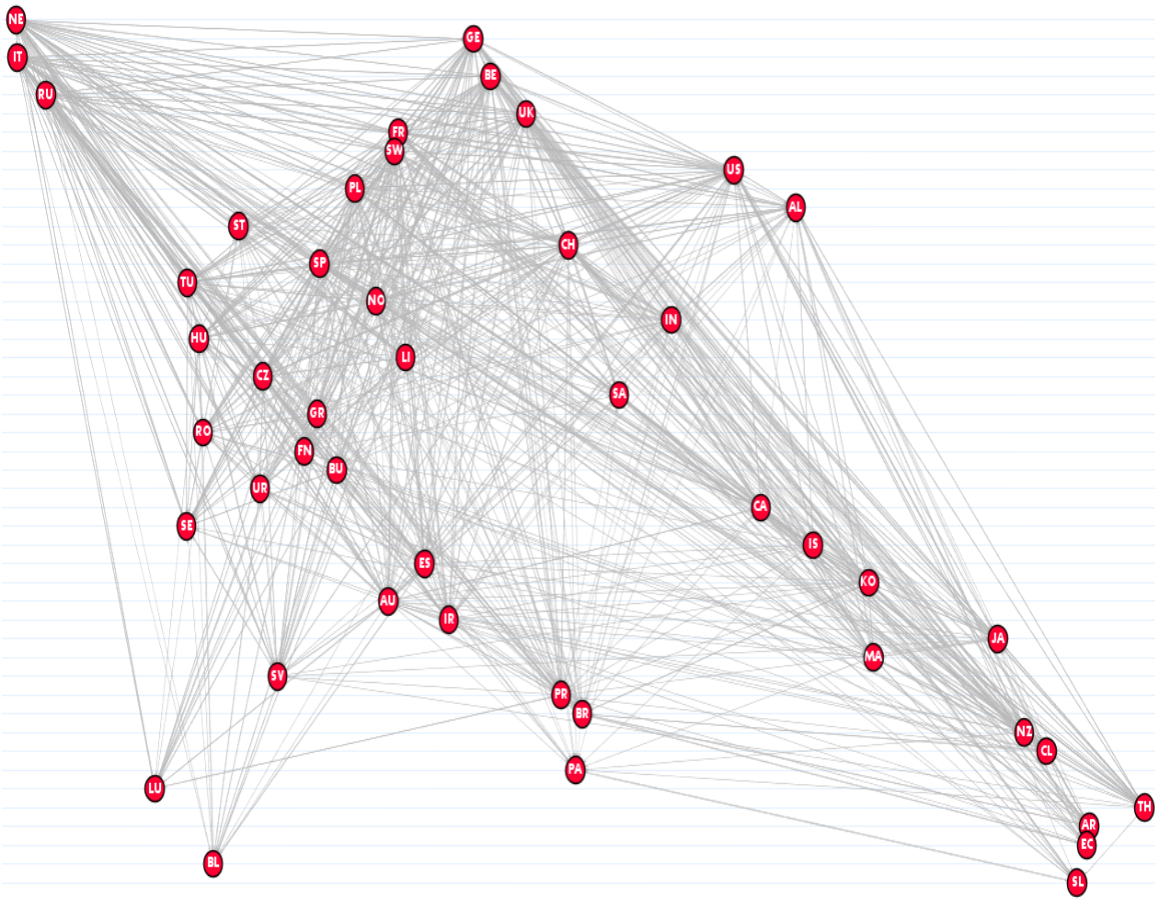

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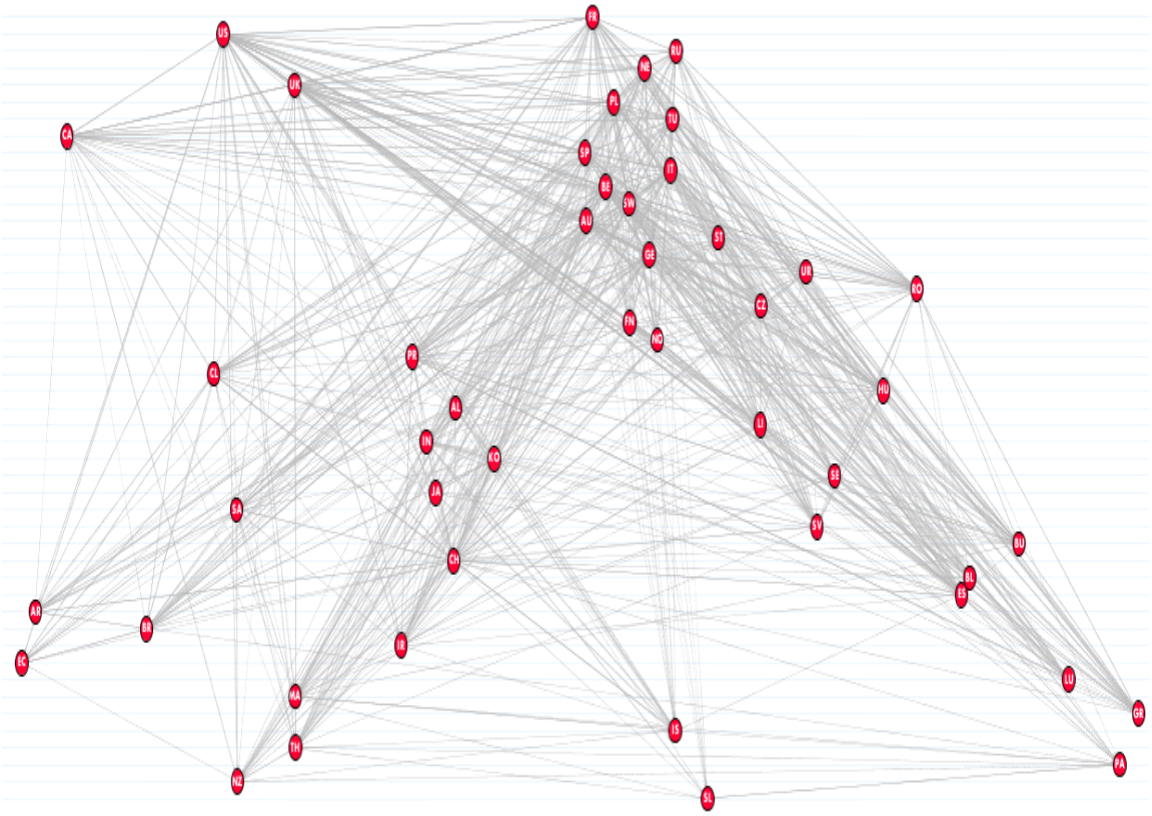

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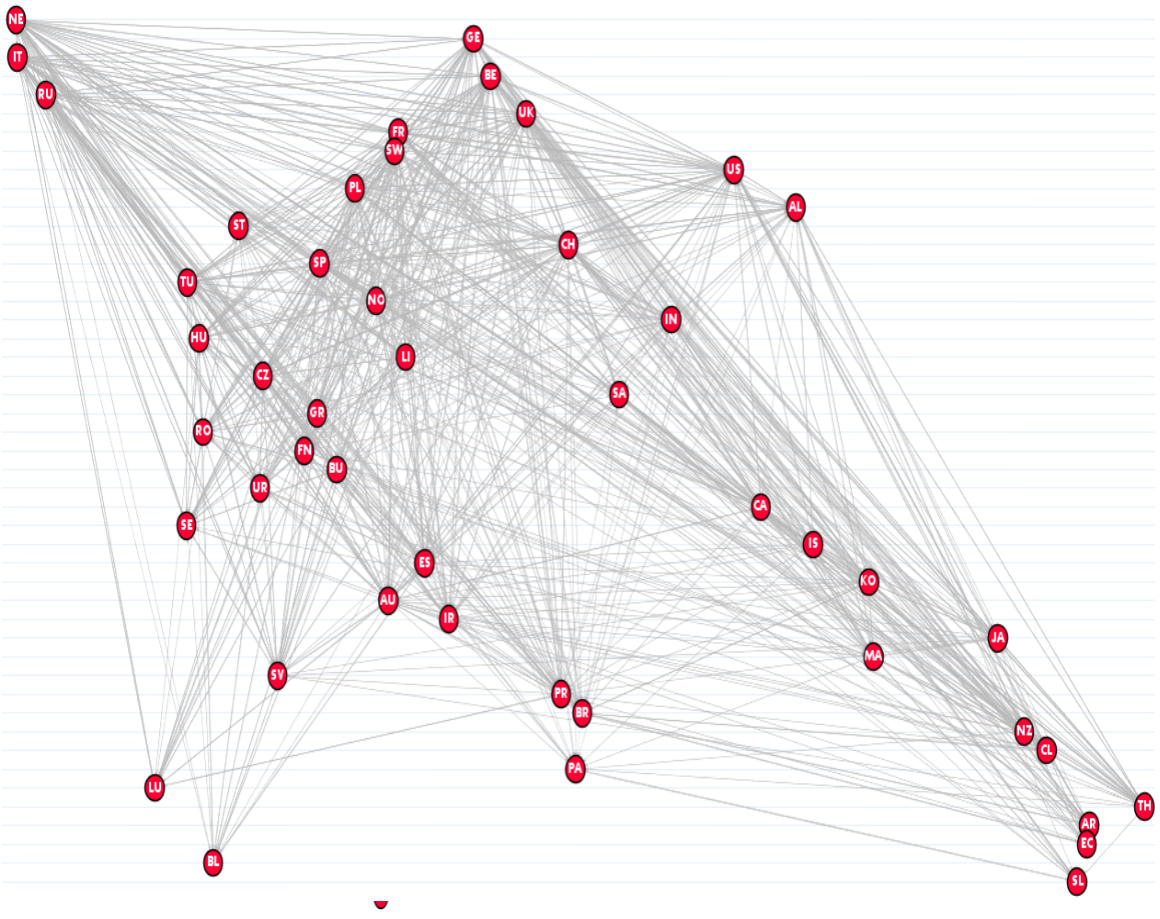
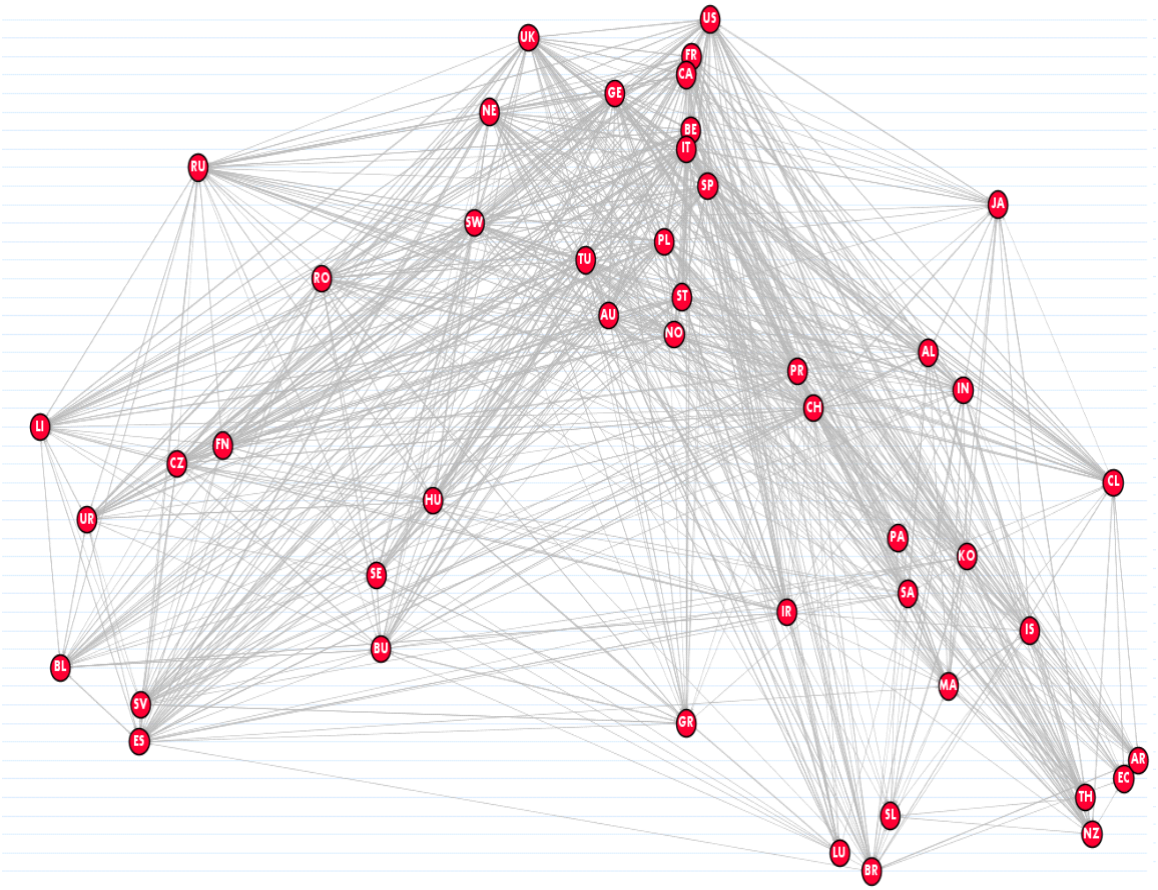


INDEGREE VALUED WOOD2015



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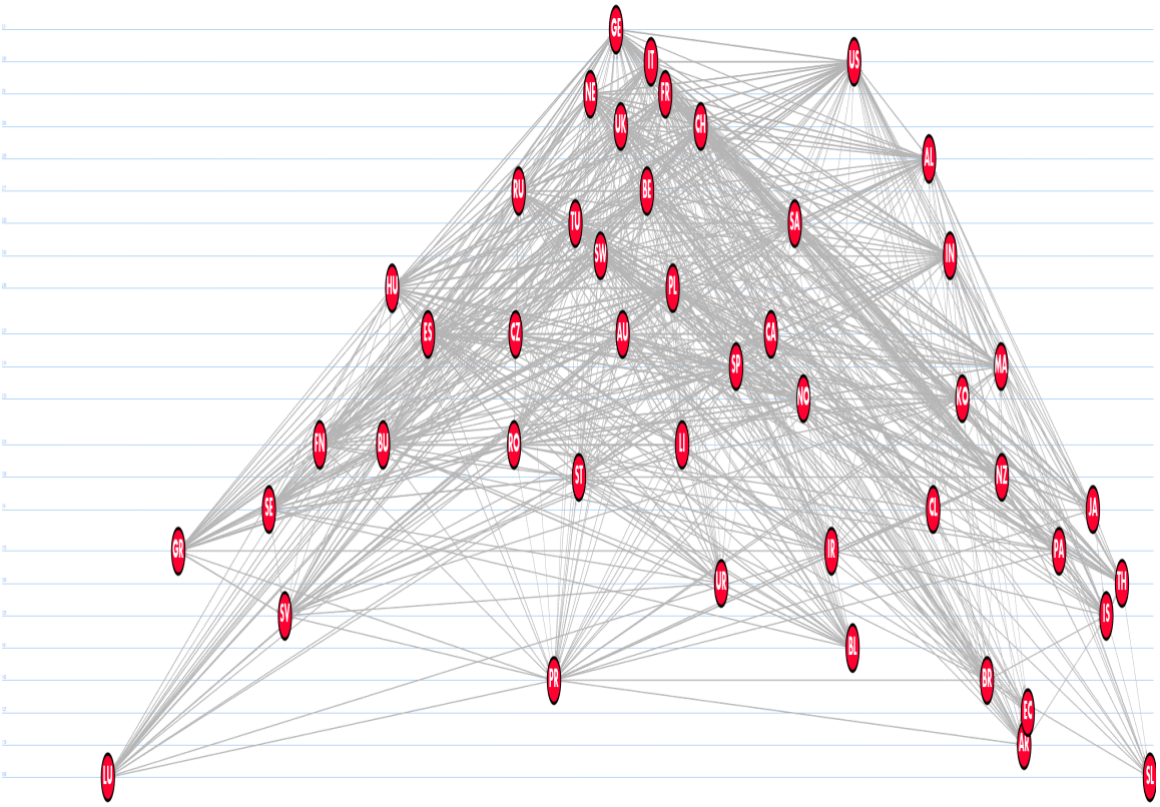

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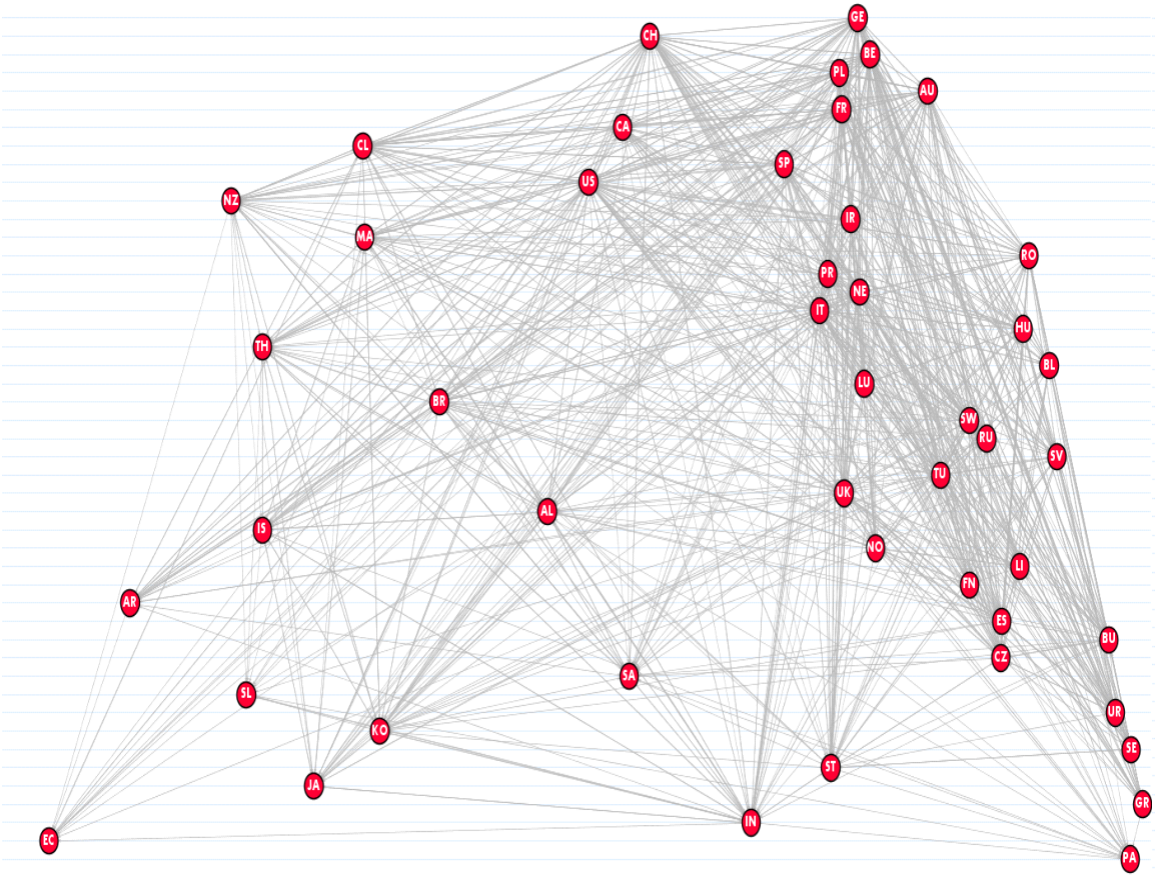

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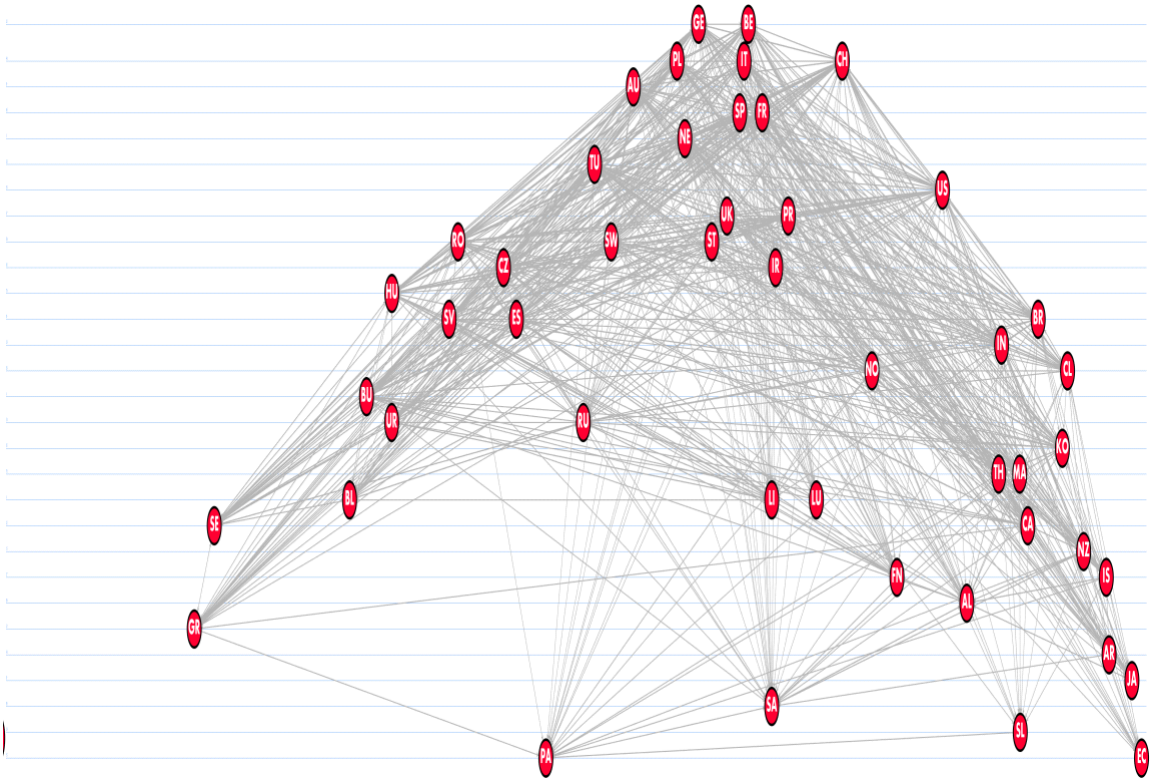
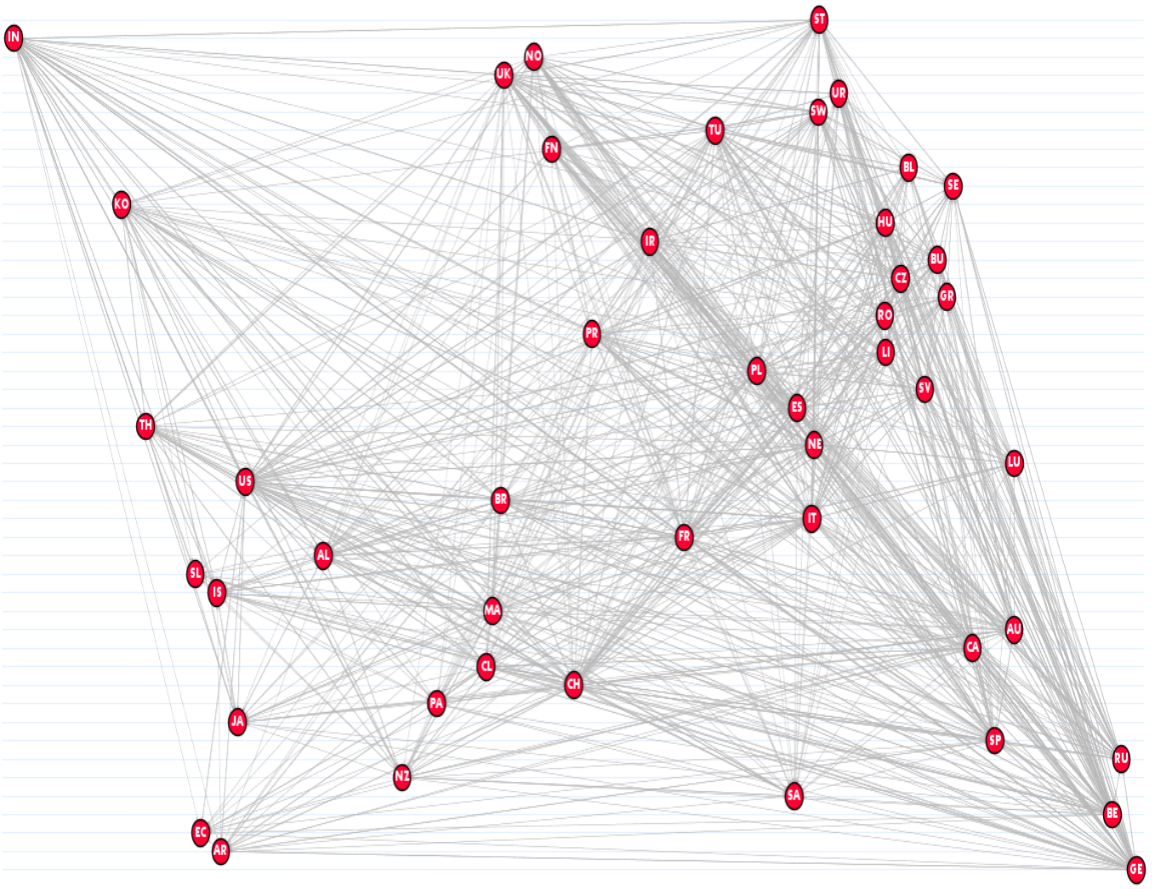


CLOSENESS VALUED WOOD2015



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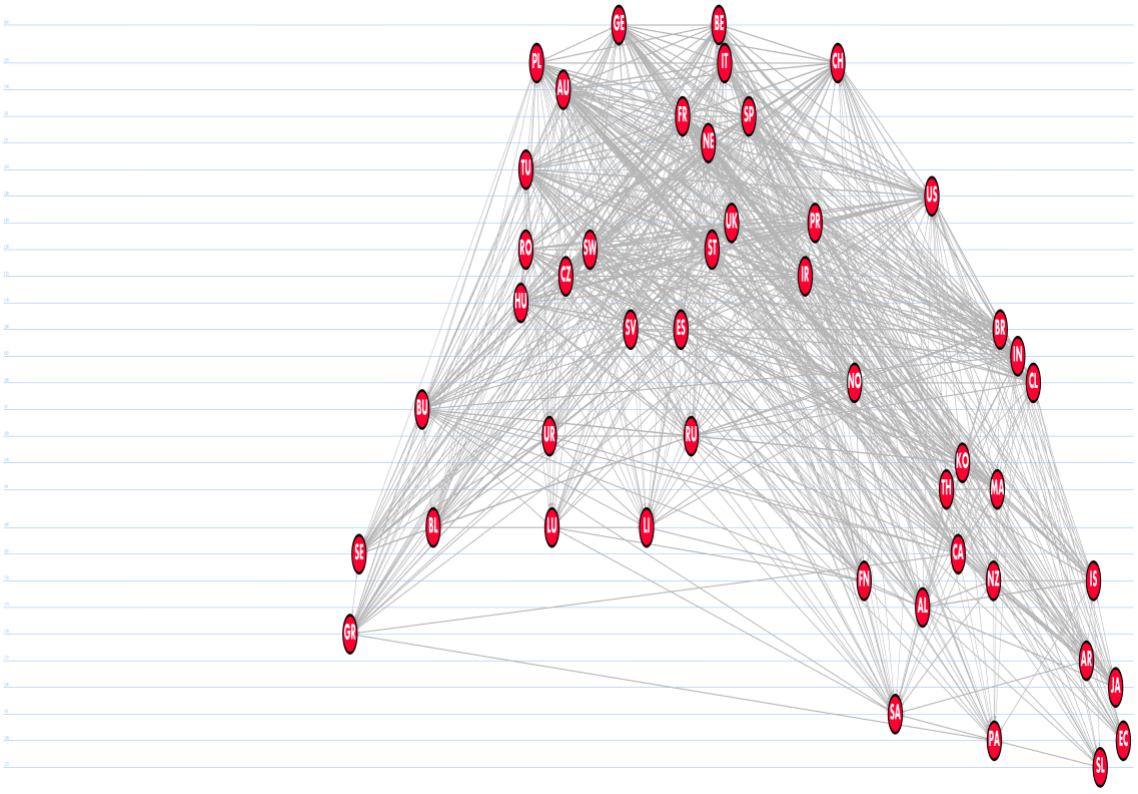
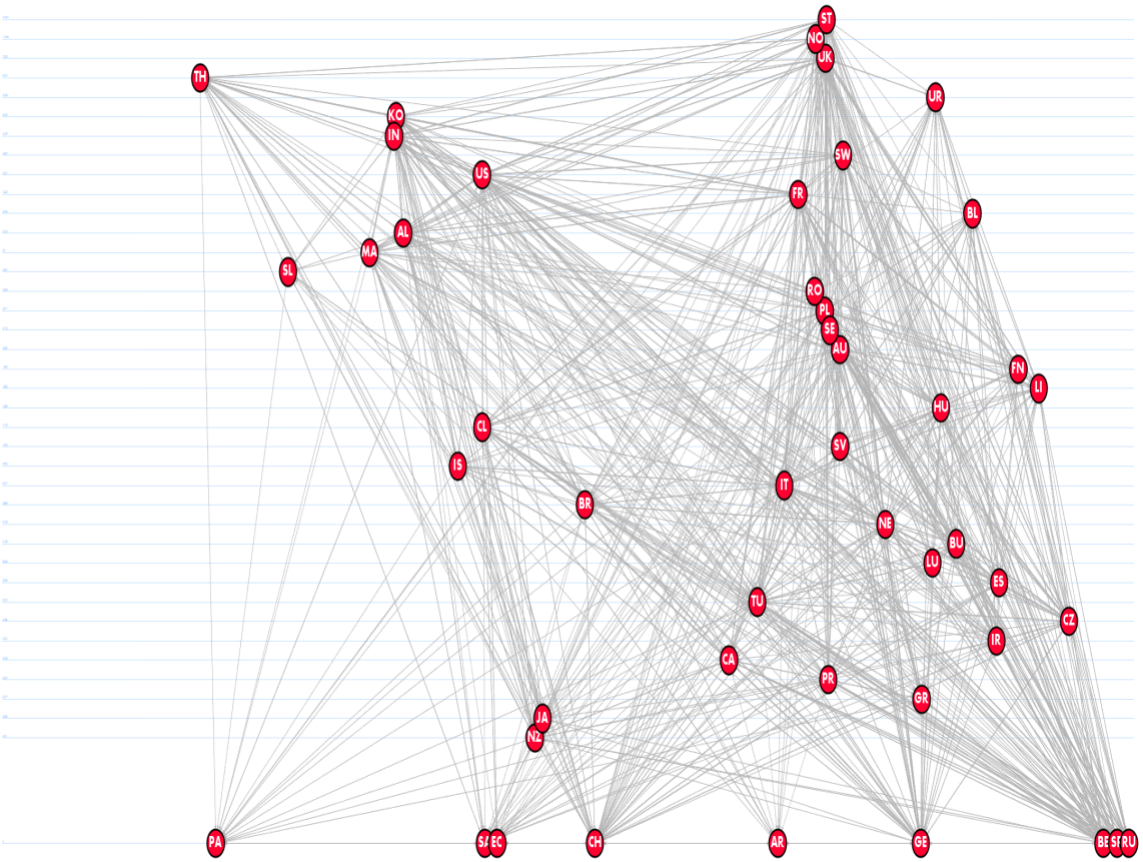


BETWEENNESS VALUED WOOD2015



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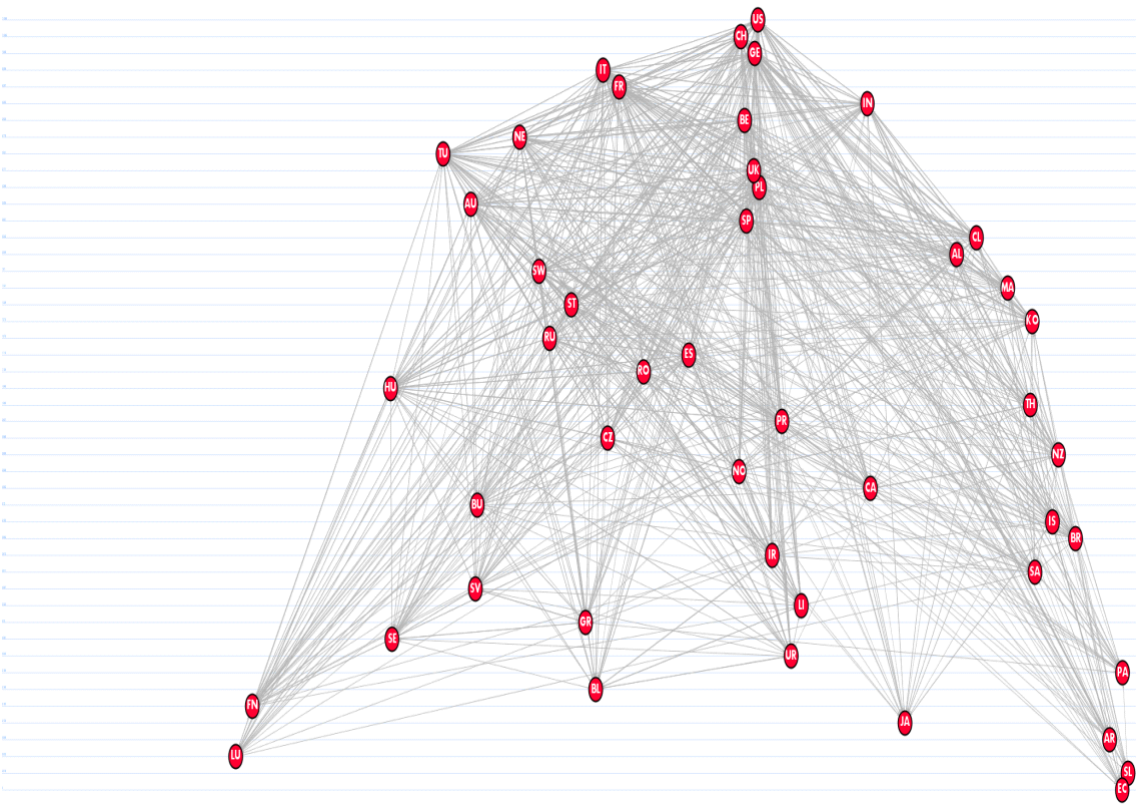

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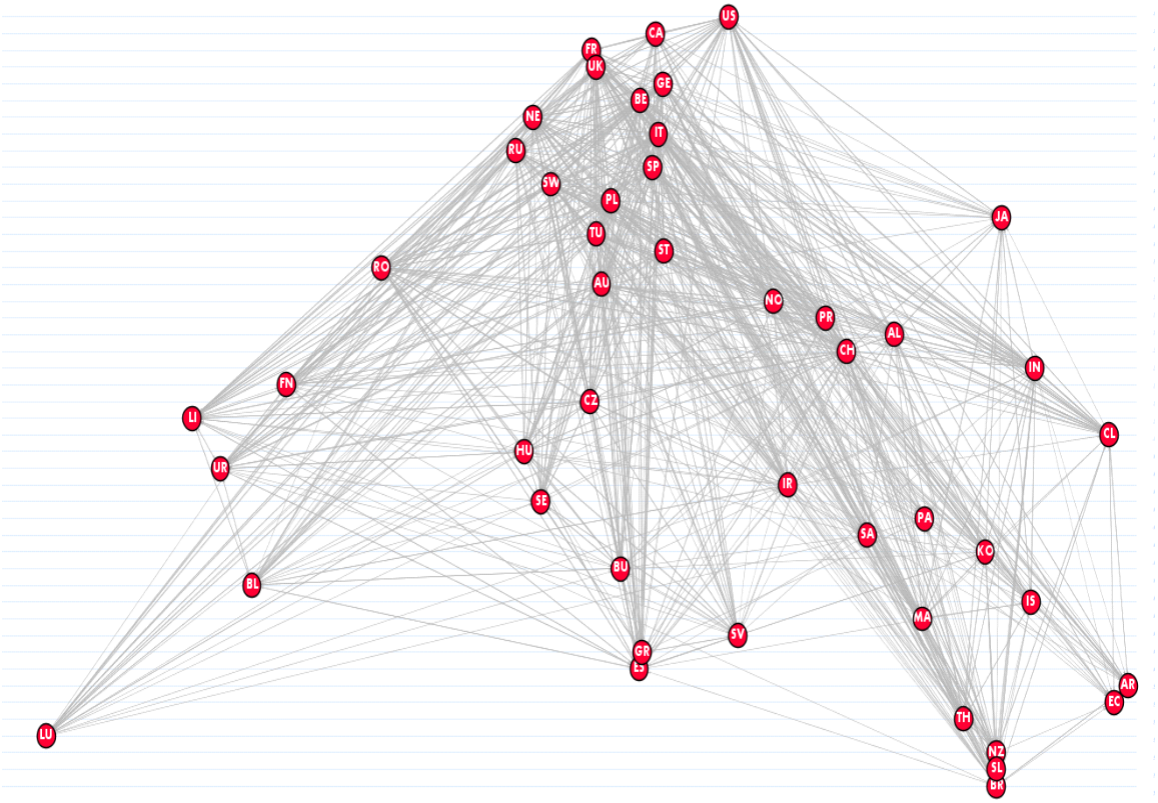

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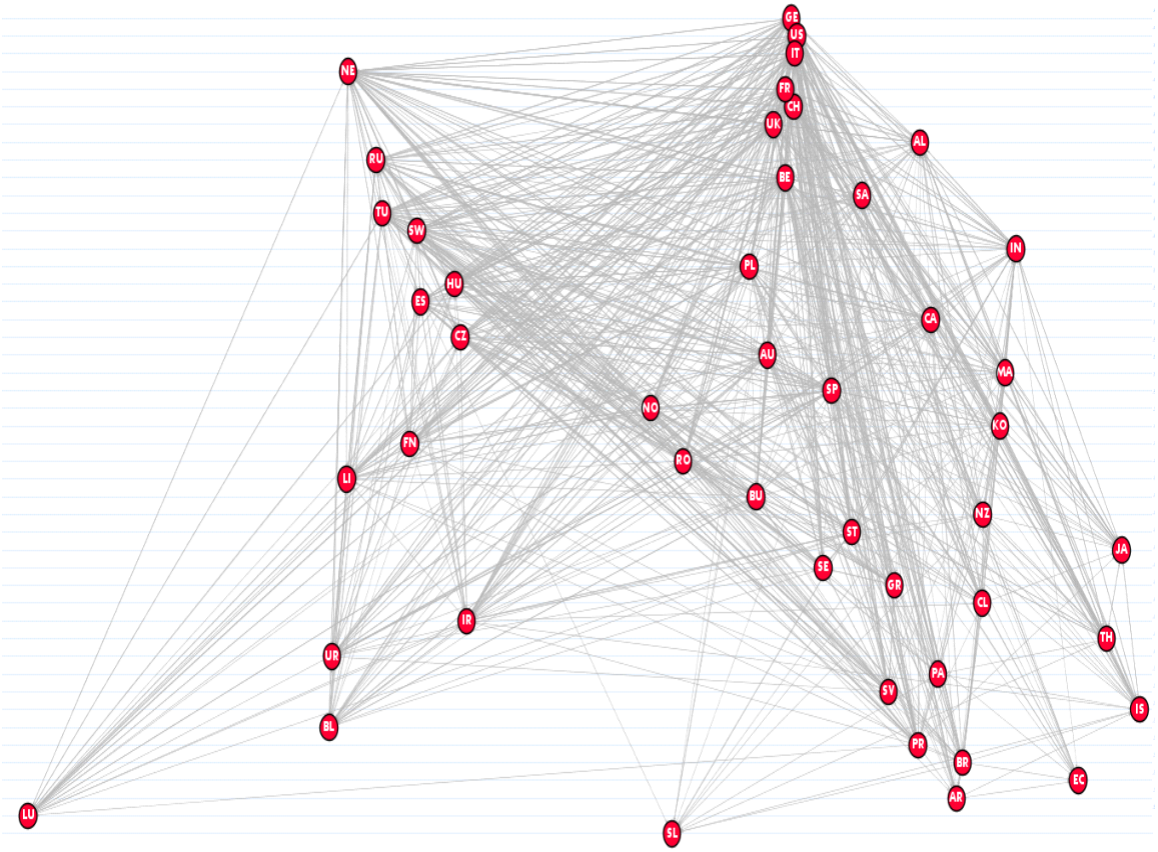
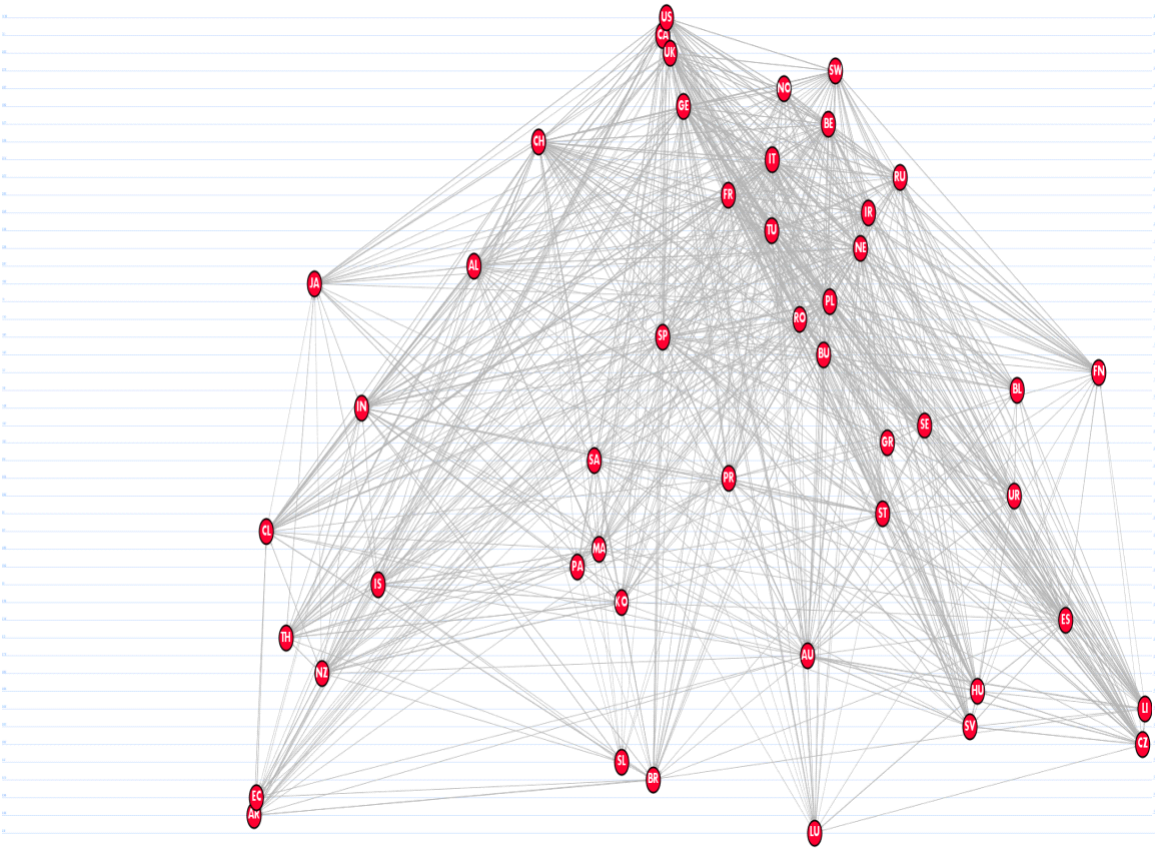


PAGERANK VALUED WOOD2015



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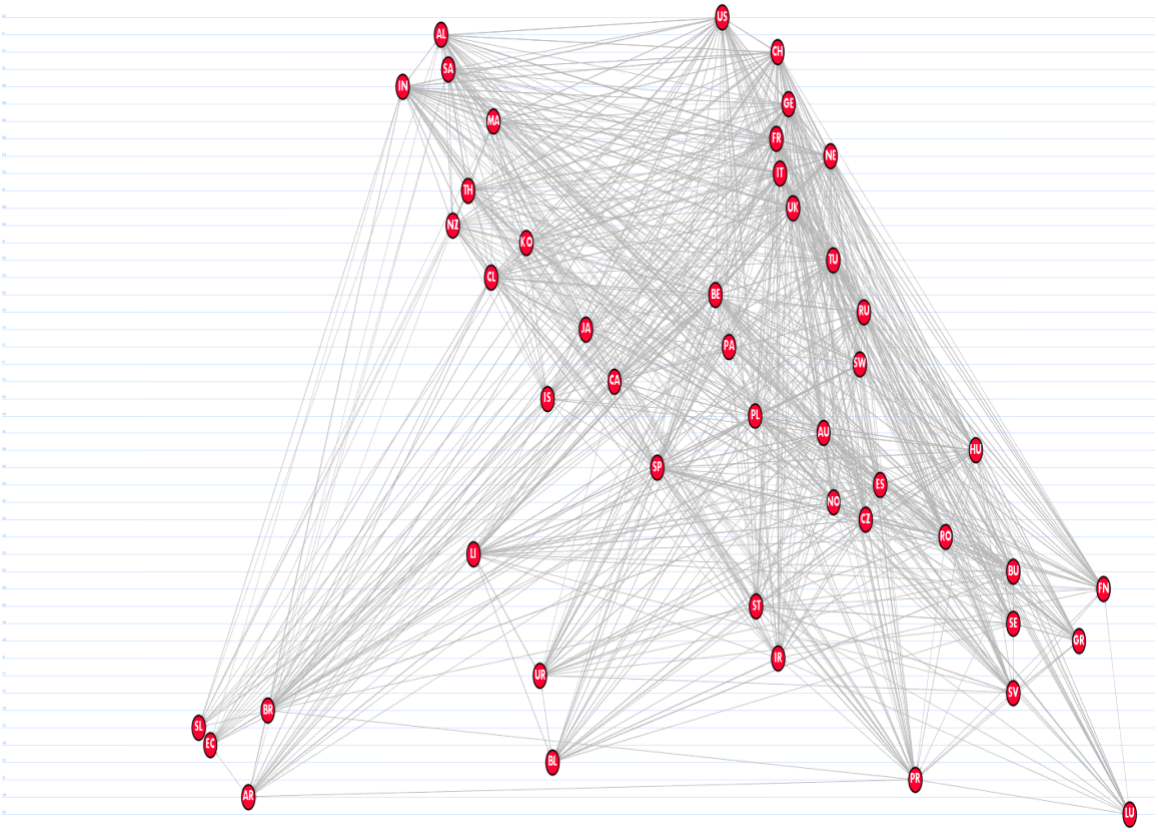

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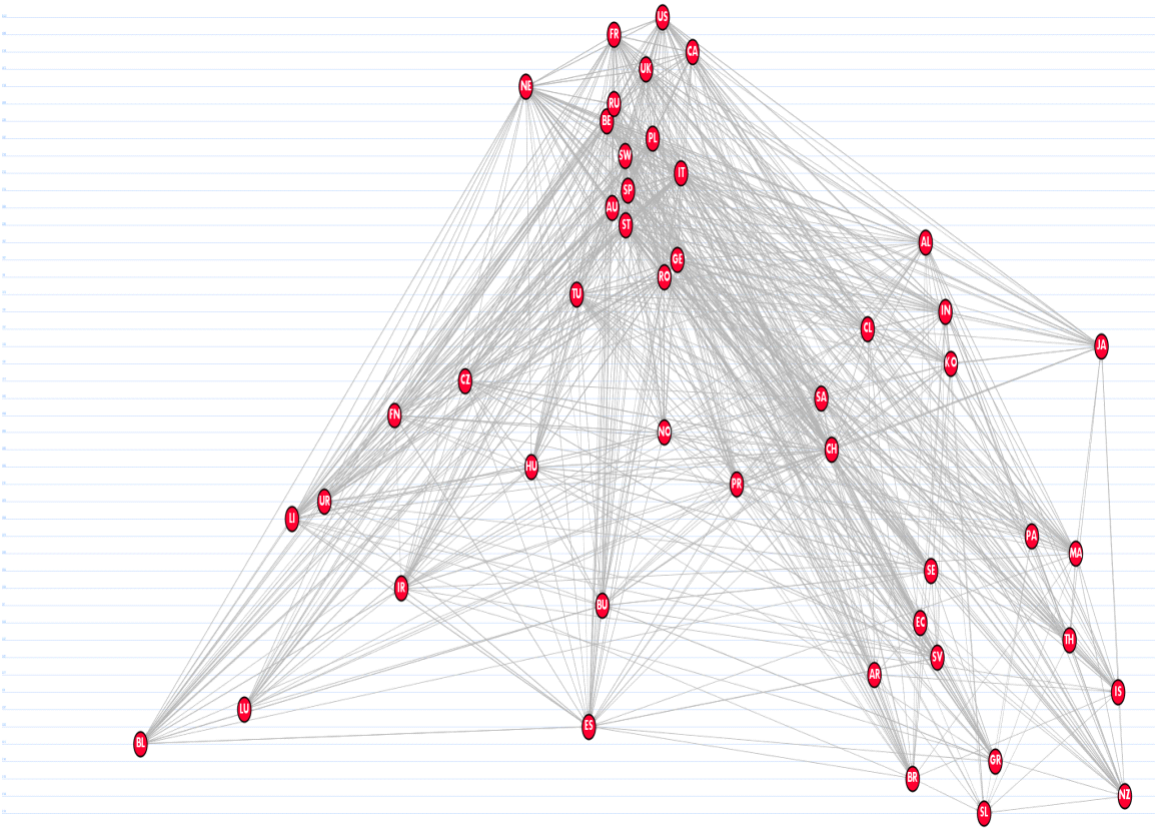

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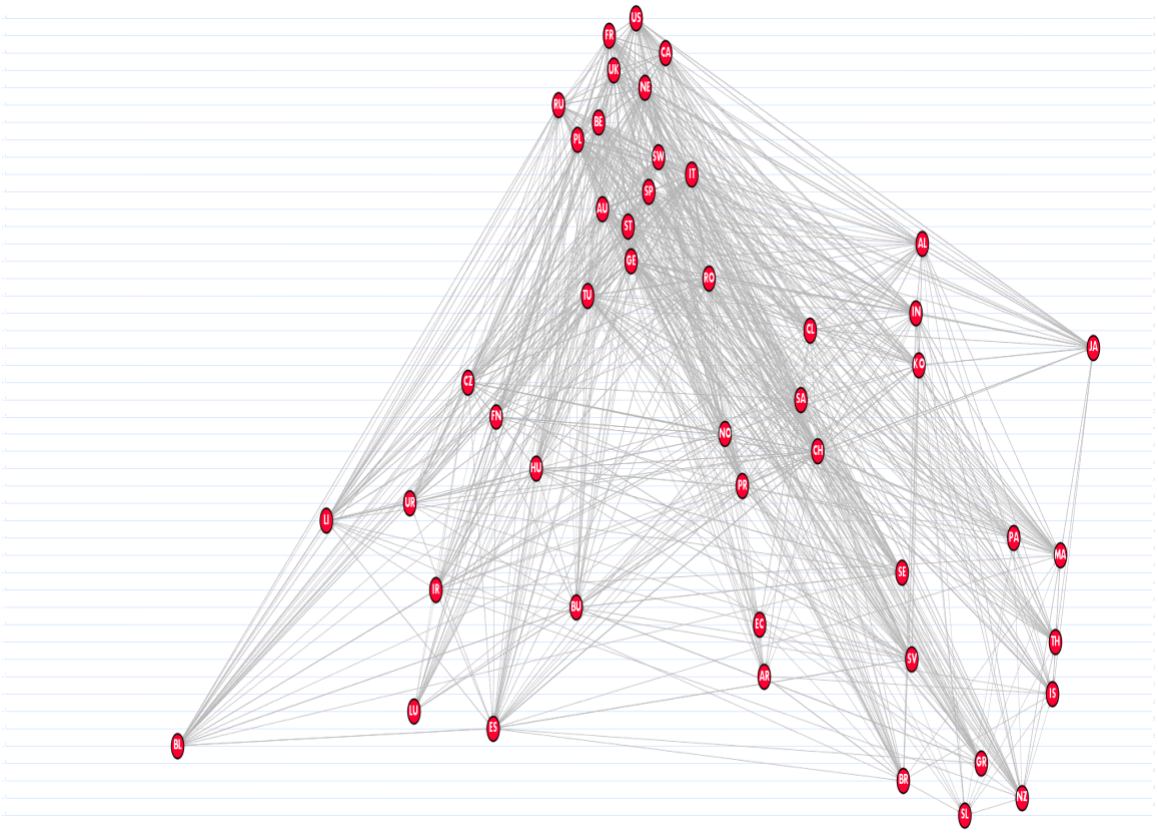
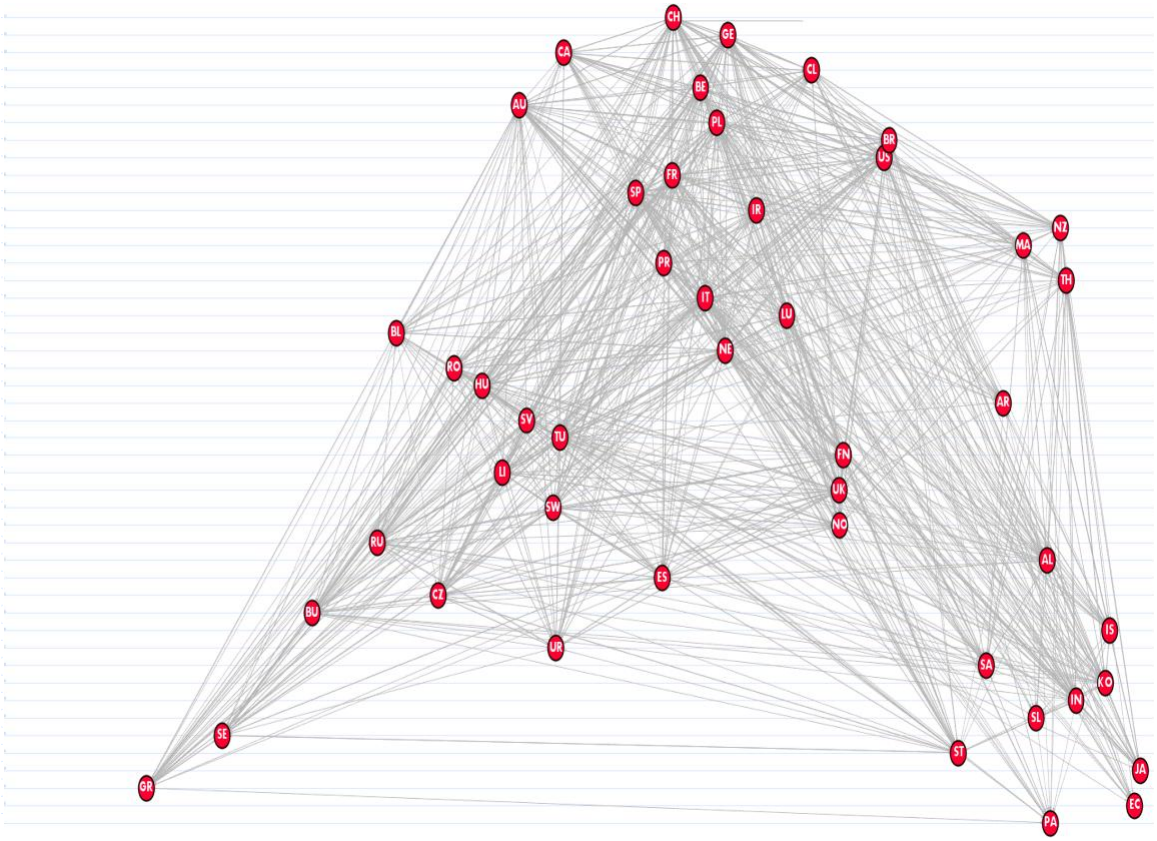


HUB VALUED WOOD2015



HUB BINARY WOOD2015