Appendix A.0. Pseudo Code

```
 sel_p <- 10 #leading partners number

### Regions ####
#Importations
[Function_raw.R]
row_regions_diff_Imp(path2, sel_p)→
[Functions_2.R]
extract_regions_diff_Imp(file_name, path1)-> nn_reg <-extract_reg_n(file_name, path1, sel_p)
return(nn_reg)
[Functions_1.R]
extract_reg_n<-test_upload_data1(file_name, path, sel_p)
[Functions_2.R]
← max_imp_regions(t_temp, sel_p) #order the Importations table by decreasing
← window_regions_Imp(t_e, sel_p)# extract the sel_p elements except element one ->world
← window_extract_Unspecified(t_window) # eliminate the "Unspecified" elements
#←miss_regions_Imp(t_window)missMDA by method Kfold and imputePCA
[Functions_2.R]
n_East_Asia_Pacific ←network(t_window, loop=T) # Each country table into Network with loops
[Function_raw.R]
n← Networks(n_East_Asia_Pacific,…) # Joint the 160 countries and regions into Multi-Network
[Functions_3.R]
#Modeling analysis
← fit_n1 <-modeling_edges(n_r_Imp)
   n_mod_Tar_r_cov <-modeling_covariate(n_r_Tar)
   n_mod_Tar_r_names <-modeling_names(n_r_Tar)
   n_mod_Tar_r_e <-modeling_residuals(fit_n1)
   n_mod_Tar_r_g <-mod_goodness(fit_n1)
#Comparative Modeling Edges-analysis
←comparative_mod(n_mod_Imp_r_e, n_mod_Tar_r_e, sel_p)
← Compare_Dist_Degrees_sel_p (net_r_Imp, net_r_Tar, sel_p, path2)
[main.R]
#Plotting each network in comparative  by 10 Region-Partners Imp and Tariff
n_r_Imp ← row_regiones_diff_Imp(path2)
#plot(n_r_Imp, displaylabels=F)
#Plotting Multi-ERG Importations by Degree Analysis
net_r_Imp<- graph_analysis_n_Imp(n_r_Imp, path2)
net <- net_r_Imp #object_net_igraph
#Graph Cumulative Freq vs Degree, and Multi-ERG Importations by Diameter/Edges Analysis
graph_analysis_2(net_r_Imp, file_name, path2, sel_p)#_1.png & _2.png
#Multi-ERG Importations by Hub and Authorities  Analyses
graph_analysis_3(net_r_Imp, file_name, path2) #_3_1 & 3_2.png
#Distances Multi-ERGM Network Analyses
graph_analysis_4(net_r_Imp, file_name, path2) #_4.png
#Distances Multi-ERGM Network Analyses
graph_analysis_5(net_r_Imp, file_name, path2) #_5_1, _5_2 & 5_3.png
#K-core decomposition Analysis
graph_analysis_6_0(net_r_Imp, file_name, path2) #_7_1.png
#Cliques&Cocitation Analyses, Dendrograms, Clustering Analyses
graph_analysis_6_1(net_r_Imp, file_name, path2) #_7_2, _8_1, _8_2, _9-_12.png
#Tariffs
```

```
[main.R]
n_r_Tar = row_regiones_Tar(sel_p)
[Function_raw.R]
row_regiones_Tar →
[Functions_1.R]
extract_reg_t<-test_upload_data1(file_name, path, sel_p)
← max_tariff_regions(t_temp, sel_p) #order the Tariffs table by decreasing
← window_regions_tariff(t_e, sel_p) # extract the sel_p elements except element one ->world
← window_extract_Unspecified(t_window) # eliminate the "Unspecified" elements
#←miss_regions_Imp(t_window)missMDA by method Kfold and imputePCA
[Functions_2.R]
n_East_Asia_Pacific <- network(t_window, loop=T) # Each country table into Network with loops
[Function_raw.R]
n<- Networks(n_East_Asia_Pacific,…) # Joint the 160 countries and regions into Multi-Network

### Countries####
 #Importations
[main.R]
n_c_Imp <- row_countries_diff_Imp(path2, sel_p)
net_c_Imp = graph_analysis_c_Imp(n_c_Imp, path2)
net <- net_c_Imp#object_net_igraph
graph_analysis_2_c(net_c_Imp, file_name, path2)#_1.png & _2.png
graph_analysis_3(net_c_Imp, file_name, path2)
#Tariffs
n_c_Tar = row_countries_Tar( sel_p)
net_c_Tar = graph_analysis_c_Tar(n_c_Tar, path2)
net <- net_c_Tar#object_net_igraph
graph_analysis_2_c(net_c_Tar, file_name, path2)
```

Appendix A.1. Pseudo Code by Functions

```
[Functions_2.R]
# Fundamental Parameter Multi-ERGM Network Analyses
←graph_analysis_2{
#Density
  #Method 1: Calculating density
  #vertices count
  vcount(net)
  #edges count
  ecount(net)
  edge_density(net, loops=F)
  #Method 2: Calculating density
  ecount(net)/(vcount(net)*vcount(net)-1)

  #Reciprocity
  # Method1: Calculating reciprocity
  reciprocity(net)
  # Mutual, asymmetric, and null node pairs
  dyad_census(net)
  # Method2: Calculating reciprocity
  2*dyad_census(net)$mut/ecount(net)

  #Transitivity
```

```
  transitivity(net, type="global") # net is treated as an undirected network
  transitivity(as_undirected(net, mode="collapse")) # same as above
  t <-transitivity(net, type="local")
  triad_census(net) # for directed networks

  #Diameters
  diameter(net, directed=F, weights=NA)
  diameter(net, directed=F)
  diam <- get_diameter(net, directed=T)
  diam
  as.vector(diam)
#Node_Degrees
  deg <- degree(net, mode="all")
  deg
  plot(net, vertex.size=deg*3)
  hist(deg, breaks=1:vcount(net)-1, main="Histogram of node degree")
#Degree (number of ties)
  # which.max(d)
  # which(d==1)
  d <- degree(net, mode="in")
  d_in <-centr_degree(net, mode="in", normalized=T)
  d_in

  # Closeness (centrality based on distance to others in the graph)
  #Inverse of the node's average geodesic distance to others in the network.
  c <- closeness(net, mode="all", weights=NA)
  c_clo <- centr_clo(net, mode="all", normalized=T)

  #Eigenvector (centrality proportional to the sum of connection centralities)
  #Values of the first eigenvector of the graph matrix.
  c_e <- eigen_centrality(net, directed=T, weights=NA)
  centr_eigen(net, directed=T, normalized=T)

  #Betweenness (centrality based on a broker position connecting others)
  #Number of geodesics that pass through the node or the edge.
  b <- betweenness(net, directed=T, weights=NA)
  edge_betweenness(net, directed=T, weights=NA)
  centr_betw(net, directed=T, normalized=T)
}
[Functions_2.R]
miss_regions_Imp(t_window)#missMDA by method Kfold and imputePCA
{
  library(missMDA)
  names(t_window)<-NULL
  nb <- estim_ncpPCA(t_window[3], method.cv = "Kfold", verbose = FALSE)
  nb$ncp #2
  #plot(0:5, nb$criterion, xlab = "nb dim", ylab = "MSEP")
  res.comp <- imputePCA(t_window[3], ncp = nb$ncp) # iterativePCA algorithm
  res.comp$completeObs
  t_window[3]<-res.comp$completeObs
  colnames(t_window)<-c("ID","Country","Import")
```

```
  return(t_window)
}
[Functions_2.R]
# by Mutual(cliques&Cocitation), k-core, clustering
graph_analysis_6_1{
  #Matrix, which.max(co)
  #length(co), rownames(co)
  co <- cocitation(net)
  #as.undirected mutual, collapse, each
  net.sym <- as.undirected(net, mode= "mutual",
                           edge.attr.comb=list(weight="sum", "ignore"))
  #list, length(cli)
  cliques(net.sym) # list of cliques
  cli <- sapply(cliques(net.sym), length) # clique sizes
  #max(unlist(cli))
  #names(unlist(cli))
  largest_cliques(net.sym) # cliques with max number of nodes
}
```

Appendix B.0. Density distributions and leading partners selection

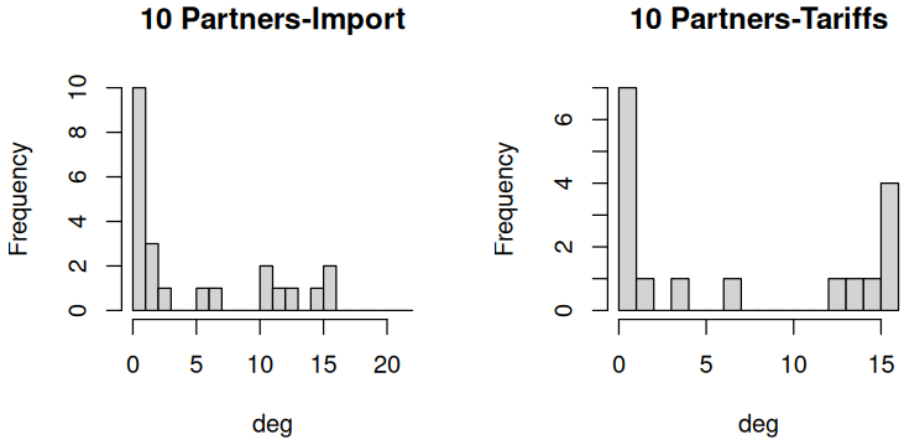

Figure B.1. Comparing density distributions; both have asymmetric distributions with the maximum frequency on degree=1, followed by frequencies on degree=16; both have *10 leading partners* by layer.

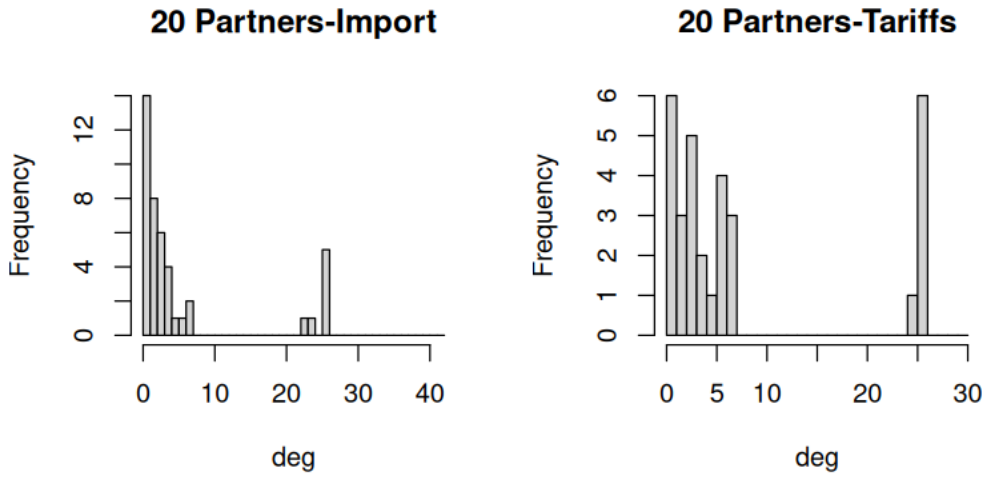

Figure B.2. Comparing density distributions; both have asymmetric distributions with the maximum frequency on degree=1, followed by frequencies on degree=26; both have 2*0 leading partners* by layer.

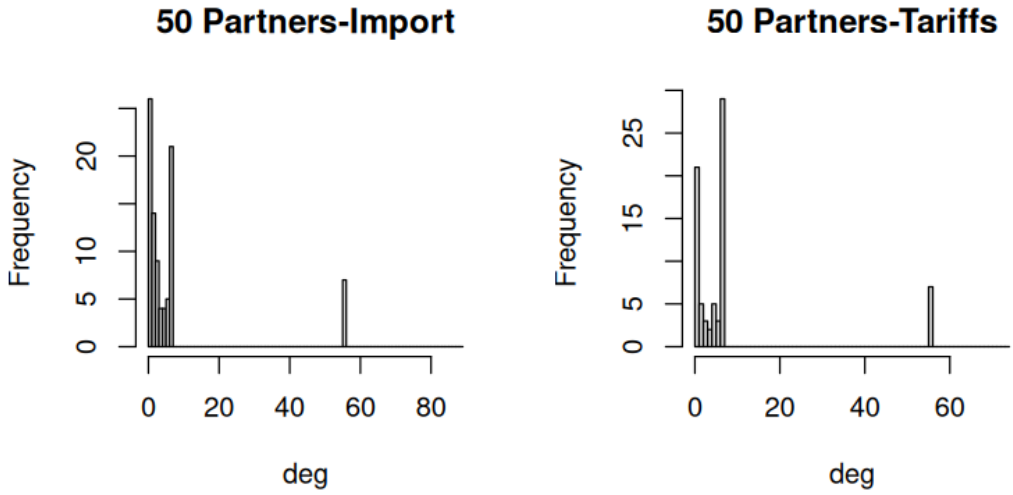

Figure B.3. Comparing density distributions, both have asymmetric distributions, with the maximum frequency on values less than 10 degrees, followed by a frequency of 56 degrees and *50 leading partners* by layer.

Table B.1 Multi-ERGMs: Sensitive-Model-Specifications

sel_p value	**Formula = n ~ edges**
Importations → 10	Network attributes: vertices = 64 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10 Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.0990 0.1403 0 -14.96 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 723.6 on 522 degrees of freedom Residual Deviance: 360.0 on 521 degrees of freedom AIC: 362 BIC: 366.3 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :7.610 1st Qu.:7.860 Median :7.950 Mean :8.033 3rd Qu.:8.215 Max. :8.520 $`Pearson residuals` edges Min. :-0.20405 1st Qu.:-0.07180 Median : 0.01871 Mean :-0.01132 3rd Qu.: 0.05033 Max. : 0.14905
Tariffs → 10	Network attributes: vertices = 63 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10 Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.0794 0.1417 0 -14.67 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 698.7 on 504 degrees of freedom Residual Deviance: 351.6 on 503 degrees of freedom AIC: 353.6 BIC: 357.8 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :7.470 1st Qu.:7.915 Median :8.000 Mean :7.989 3rd Qu.:8.170 Max. :8.280 $`Pearson residuals` edges Min. :-0.100259 1st Qu.:-0.063873 Median : 0.000000 Mean : 0.006603 3rd Qu.: 0.033604 Max. : 0.207015
Importations → 20	Network attributes: vertices = 133 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10

	Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.89037 0.09153 0 -31.58 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 3318.8 on 2394 degrees of freedom Residual Deviance: 987.2 on 2393 degrees of freedom AIC: 989.2 BIC: 995 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :17.38 1st Qu.:17.71 Median :17.83 Mean :17.87 3rd Qu.:17.92 Max. :18.62 $`Pearson residuals` edges Min. :-0.15444 1st Qu.: 0.02005 Median : 0.03932 Mean : 0.03010 3rd Qu.: 0.06485 Max. : 0.15601
Tariffs → 20	Network attributes: vertices = 133 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10 Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.89037 0.09153 0 -31.58 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 3318.8 on 2394 degrees of freedom Residual Deviance: 987.2 on 2393 degrees of freedom AIC: 989.2 BIC: 995 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :17.76 1st Qu.:18.11 Median :18.20 Mean :18.23 3rd Qu.:18.39 Max. :18.64 $`Pearson residuals` edges Min. :-0.16328 1st Qu.:-0.09834 Median :-0.04310 Mean :-0.05685 3rd Qu.:-0.02651 Max. : 0.05812
Importations → 50	Network attributes: vertices = 343 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10 Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -3.87120 0.05512 0 -70.23 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 22824 on 16464 degrees of freedom

	Residual Deviance: 3280 on 16463 degrees of freedom AIC: 3282 BIC: 3290 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :47.76 1st Qu.:48.00 Median :48.08 Mean :48.20 3rd Qu.:48.23 Max. :49.12 $`Pearson residuals` edges Min. :-1.682e-01 1st Qu.:-3.039e-02 Median :-1.285e-02 Mean :-2.837e-02 3rd Qu.: 6.722e-05 Max. : 4.314e-02
Tariffs → 50	Network attributes: vertices = 343 array.max: 128 MCMC.scale: 1 MCMC.effectiveSize.damp: 10 Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -3.87120 0.05512 0 -70.23 <1e-04 *** --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 22824 on 16464 degrees of freedom Residual Deviance: 3280 on 16463 degrees of freedom AIC: 3282 BIC: 3290 (Smaller is better. MC Std. Err. = 0) $`Fitted values` edges Min. :46.86 1st Qu.:47.26 Median :48.12 Mean :48.23 3rd Qu.:49.02 Max. :50.10 $`Pearson residuals` edges Min. :-0.29612 1st Qu.:-0.15399 Median :-0.01746 Mean :-0.03447 3rd Qu.: 0.11542 Max. : 0.14943

Appendix B.1 Convergence of Models and Pearson Residual Distributions

 # sel_p = 10-leading-partners

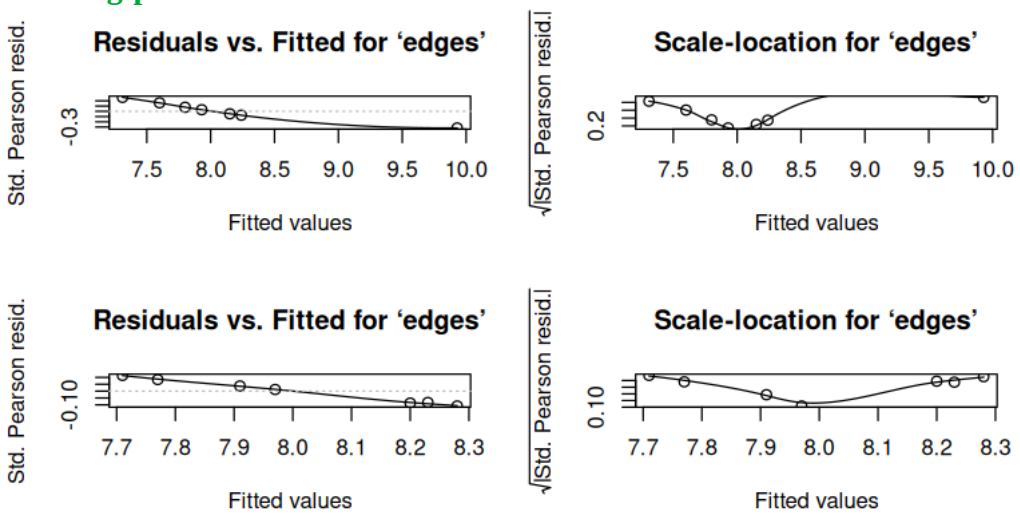

Figure B.4 Comparison of convergence of the models: the upper graph shows the fitted edge values from Multi-ERGM RPI, and the lower graph shows the fitted edge values from Multi-ERGM RPT in *the 10 leading partners* by layer. Both models converge at 8 (see Table B.1 for more details).

 # sel_p = 20-leading-partners

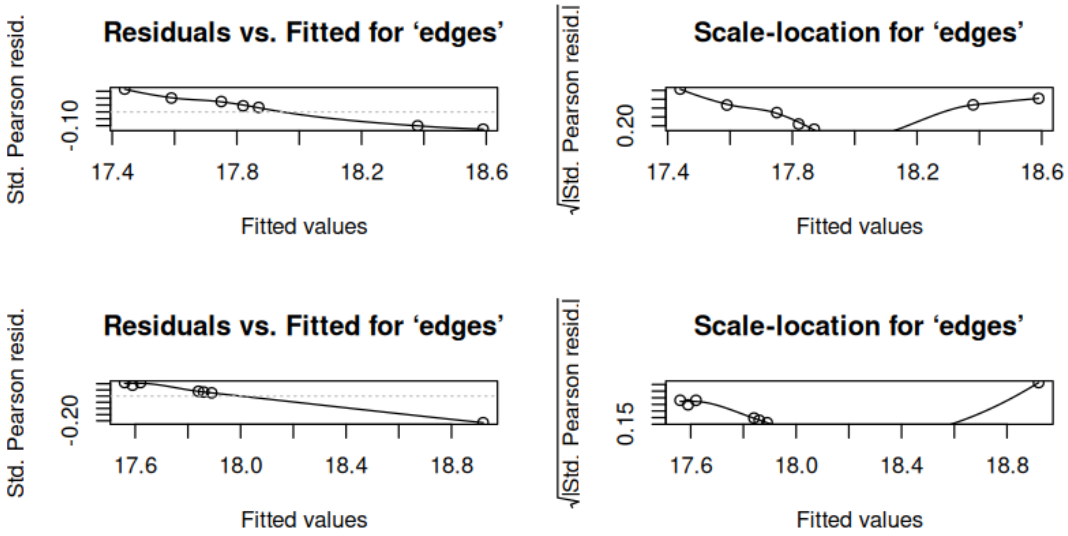

Figure B.5 Comparison of convergence of the models: the upper graph shows the fitted edge values from Multi-ERGM RPI, and the lower graph shows the fitted edge values from Multi-ERGM RPT in *the 20 leading partners* by layer. Both models converge at 18 (see Table B.1 for more details).

 # sel_p = 50-leading-partners

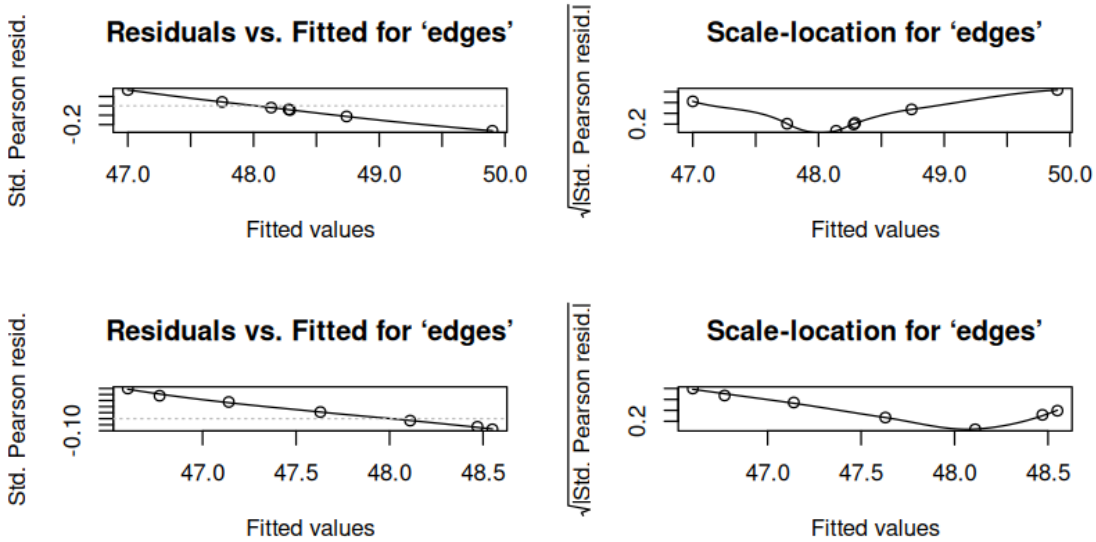

Figure B.6 Comparison of convergence of the models: the upper graph shows the fitted edge values from Multi-ERGM RPI, and the lower graph shows the fitted edge values from Multi-ERGM RPT in *the 50 leading partners* by layer. Both models converge at 48 (see Table B.1 for more details).

Table B.2. Multi-ERGMs Covariance-Model-Parameters

p_sel=10	**Formula = n ~ edges + nodecov(".NetworkName")**
Importations	Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.060412 0.316312 0 -6.514 <1e-04 *** nodecov..NetworkName -0.004757 0.035090 0 -0.136 0.892 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 723.6 on 522 degrees of freedom Residual Deviance: 360.0 on 520 degrees of freedom AIC: 364 BIC: 372.5 (Smaller is better. MC Std. Err. = 0)

Tariffs	Maximum Likelihood Results: Estimate Std. Error MCMC % z value Pr(>|z|) edges -2.079e+00 3.169e-01 0 -6.561 <1e-04 *** nodecov..NetworkName 1.416e-16 3.543e-02 0 0.000 1 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Null Deviance: 698.7 on 504 degrees of freedom Residual Deviance: 351.6 on 502 degrees of freedom AIC: 355.6 BIC: 364.1 (Smaller is better. MC Std. Err. = 0)

Appendix B.3. Relation of the Models by vertex.names

 # Formula = n~edges+ nodefactor("vertex.names")

 # Multi-ERGM RPI

Maximum Likelihood Results:

```
                                          Estimate Std. Error MCMC % z value Pr(>|z|)
edges                                     -3.662508   2.144725      0  -1.708
0.0877
nodefactor.vertex.names.Canada             0.007135   1.502319      0   0.005
0.9962
nodefactor.vertex.names.China              0.043021   1.147250      0   0.037
0.9701
nodefactor.vertex.names.East Asia & Pacific  0.922427   1.119893      0   0.824
0.4101
nodefactor.vertex.names.Europe & Central Asia  0.922427   1.119893      0   0.824
0.4101
nodefactor.vertex.names.France             0.398116   1.500388      0   0.265
0.7907
nodefactor.vertex.names.Germany            0.122771   1.245745      0   0.099
0.9215
nodefactor.vertex.names.India             -0.058576   1.304855      0  -0.045
0.9642
nodefactor.vertex.names.Italy              0.398116   1.500388      0   0.265
0.7907
nodefactor.vertex.names.Japan              0.268233   1.497432      0   0.179
0.8578
nodefactor.vertex.names.Korea, Rep.        0.128459   1.326917      0   0.097
0.9229
nodefactor.vertex.names.Latin America & Caribbean  2.285095   1.202875      0   1.900
0.0575 .
nodefactor.vertex.names.Mexico             0.007135   1.502319      0   0.005
0.9962
nodefactor.vertex.names.Middle East & North Africa  1.303674   1.127170      0   1.157
0.2474
nodefactor.vertex.names.Netherlands        0.398116   1.500388      0   0.265
0.7907
nodefactor.vertex.names.North America      1.049428   1.125465      0   0.932
0.3511
nodefactor.vertex.names.Other Asia, nes    0.268233   1.497432      0   0.179
0.8578
nodefactor.vertex.names.Saudi Arabia      -0.149482   1.494677      0  -0.100
0.9203
nodefactor.vertex.names.South Africa      -0.006787   1.500842      0  -0.005
0.9964
nodefactor.vertex.names.South Asia         1.660781   1.132134      0   1.467
0.1424
```

```
nodefactor.vertex.names.Sub-Saharan Africa          1.504454   1.136185      0   1.324
0.1855
nodefactor.vertex.names.United Arab Emirates       -0.080979   1.304114      0  -0.062
0.9505
nodefactor.vertex.names.United States               0.051622   1.159111      0   0.045
0.9645
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

     Null Deviance: 723.6  on 522  degrees of freedom
 Residual Deviance: 323.6  on 499  degrees of freedom

AIC: 369.6  BIC: 467.5  (Smaller is better. MC Std. Err. = 0)
```

 # Multi-ERGM RPT

```
Maximum Likelihood Results:
                                          Estimate Std. Error MCMC % z value Pr(>|z|)
edges                                   -3.678e+00  2.077e+00      0  -1.771
0.0766
nodefactor.vertex.names.China            9.420e-02  1.115e+00      0   0.084
0.9327
nodefactor.vertex.names.East Asia & Pacific         9.499e-01  1.086e+00      0   0.875
0.3816
nodefactor.vertex.names.Europe & Central Asia       9.499e-01  1.086e+00      0   0.875
0.3816
nodefactor.vertex.names.Germany          2.210e-01  1.470e+00      0   0.150
0.8804
nodefactor.vertex.names.India            1.727e-01  1.271e+00      0   0.136
0.8919
nodefactor.vertex.names.Japan            1.307e-01  1.466e+00      0   0.089
0.9289
nodefactor.vertex.names.Latin America & Caribbean   1.168e+00  1.098e+00      0   1.063
0.2877
nodefactor.vertex.names.Middle East & North Africa  1.036e+00  1.091e+00      0   0.950
0.3423
nodefactor.vertex.names.North America               9.499e-01  1.086e+00      0   0.875
0.3816
nodefactor.vertex.names.South Africa     1.033e-01  1.466e+00      0   0.070
0.9439
nodefactor.vertex.names.South Asia       9.499e-01  1.086e+00      0   0.875
0.3816
nodefactor.vertex.names.Spain            2.210e-01  1.470e+00      0   0.150
0.8804
nodefactor.vertex.names.Sub-Saharan Africa          1.313e+00  1.107e+00      0   1.186
0.2357
nodefactor.vertex.names.Turkey           2.475e-01  1.469e+00      0   0.168
0.8662
nodefactor.vertex.names.United Kingdom             -2.756e-15  1.464e+00      0   0.000
1.0000
nodefactor.vertex.names.United States    1.425e-01  1.159e+00      0   0.123
0.9021
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

     Null Deviance: 698.7  on 504  degrees of freedom
 Residual Deviance: 337.2  on 487  degrees of freedom

AIC: 371.2  BIC: 443  (Smaller is better. MC Std. Err. = 0)
```

Appendix B.4 Relation of the Goodness-of-fit Models

#Tables of Goodness-of-fit

Table B.4 Multi-ERGMs Goodness-of-fit for in-degree

Importations

```
Goodness-of-fit for in-degree

          obs min  mean max MC p-value
idegree0   57   0  0.02   1       0.00
idegree1    0   0  0.31   3       1.00
idegree2    0   0  1.43   5       0.54
idegree3    0   0  3.37   8       0.04
idegree4    0   1  5.94  11       0.00
idegree5    0   3  8.91  19       0.00
idegree6    0   3 10.33  19       0.00
idegree7    0   3 10.34  18       0.00
idegree8    6   3  8.59  16       0.42
idegree9    1   2  6.22  11       0.00
idegree10   0   0  4.19  10       0.02
idegree11   0   0  2.25   7       0.20
idegree12   0   0  1.14   4       0.66
idegree13   0   0  0.54   3       1.00
idegree14   0   0  0.28   3       1.00
idegree15   0   0  0.06   1       1.00
idegree16   0   0  0.04   1       1.00
idegree17   0   0  0.02   1       1.00
idegree18   0   0  0.01   1       1.00
idegree20   0   0  0.01   1       1.00

Goodness-of-fit for out-degree

          obs min  mean max MC p-value
odegree0    7   0  0.05   1       0.00
odegree1   57   0  0.49   3       0.00
odegree2    0   0  1.28   5       0.42
odegree3    0   0  3.39   9       0.02
odegree4    0   1  6.39  13       0.00
odegree5    0   2  8.42  16       0.00
odegree6    0   4 10.34  19       0.00
odegree7    0   4 10.01  17       0.00
odegree8    0   1  8.52  15       0.00
odegree9    0   2  6.27  12       0.00
odegree10   0   0  4.36  11       0.02
odegree11   0   0  2.34   7       0.12
odegree12   0   0  1.16   4       0.64
odegree13   0   0  0.62   3       1.00
odegree14   0   0  0.21   2       1.00
odegree15   0   0  0.09   1       1.00
odegree16   0   0  0.04   1       1.00
odegree17   0   0  0.01   1       1.00
odegree18   0   0  0.01   1       1.00

Goodness-of-fit for edgewise shared partner

          obs min   mean max MC p-value
esp.OTP0   57 180 209.57 236        0.0
esp.OTP1    0 113 153.63 181        0.0
esp.OTP2    0  27  55.37  80        0.0
esp.OTP3    0   3  13.02  28        0.0
esp.OTP4    0   0   2.31  13        0.3
```

	esp.OTP5 0 0 0.26 3 1.0 esp.OTP6 0 0 0.02 1 1.0 Goodness-of-fit for minimum geodesic distance obs min mean max MC p-value 1 57 385 434.18 481 0 2 0 1581 1860.42 2102 0 3 0 1383 1616.55 1788 0 4 0 20 115.03 236 0 5 0 0 1.41 13 1 Inf 3975 0 4.41 63 0 Goodness-of-fit for model statistics obs min mean max MC p-value 57.00 385.00 434.18 481.00 0.00
Tariffs	Goodness-of-fit for in-degree obs min mean max MC p-value idegree0 56 0 0.02 1 0.00 idegree1 0 0 0.22 2 1.00 idegree2 0 0 1.26 5 0.44 idegree3 0 0 3.11 7 0.06 idegree4 0 2 5.80 13 0.00 idegree5 0 2 8.32 16 0.00 idegree6 0 4 9.92 21 0.00 idegree7 0 4 9.96 21 0.00 idegree8 7 3 8.50 16 0.76 idegree9 0 2 6.73 15 0.00 idegree10 0 0 4.11 9 0.04 idegree11 0 0 2.75 8 0.02 idegree12 0 0 1.43 4 0.50 idegree13 0 0 0.53 3 1.00 idegree14 0 0 0.22 2 1.00 idegree15 0 0 0.07 1 1.00 idegree16 0 0 0.02 1 1.00 idegree17 0 0 0.03 1 1.00 Goodness-of-fit for out-degree obs min mean max MC p-value odegree0 7 0 0.04 1 0.00 odegree1 56 0 0.23 2 0.00 odegree2 0 0 1.46 5 0.40 odegree3 0 0 2.87 7 0.04 odegree4 0 1 5.39 12 0.00 odegree5 0 4 8.48 13 0.00 odegree6 0 5 10.41 18 0.00 odegree7 0 5 9.96 16 0.00 odegree8 0 2 8.34 15 0.00 odegree9 0 2 6.65 12 0.00 odegree10 0 0 4.21 10 0.02 odegree11 0 0 2.62 9 0.14 odegree12 0 0 1.37 7 0.48 odegree13 0 0 0.58 3 1.00 odegree14 0 0 0.25 2 1.00 odegree15 0 0 0.09 1 1.00 odegree16 0 0 0.04 1 1.00

```
odegree18   0   0  0.01   1       1.00

Goodness-of-fit for edgewise shared partner

          obs min   mean max MC p-value
esp.OTP0   56 178 204.18 229       0.00
esp.OTP1    0 114 155.52 191       0.00
esp.OTP2    0  28  57.78 106       0.00
esp.OTP3    0   4  14.79  32       0.00
esp.OTP4    0   0   2.41   8       0.36
esp.OTP5    0   0   0.31   3       1.00
esp.OTP6    0   0   0.04   1       1.00
esp.OTP7    0   0   0.01   1       1.00

Goodness-of-fit for minimum geodesic distance

      obs  min    mean  max MC p-value
1      56  379  435.04  491          0
2       0 1530 1850.67 2121          0
3       0 1264 1522.26 1730          0
4       0   11   93.41  274          0
5       0    0    0.90   14          1
Inf  3850    0    3.72   62          0

Goodness-of-fit for model statistics

        obs         min        mean         max MC p-value
      56.00      379.00      435.04      491.00        0.00
```

#Figures of Goodness-of-fit

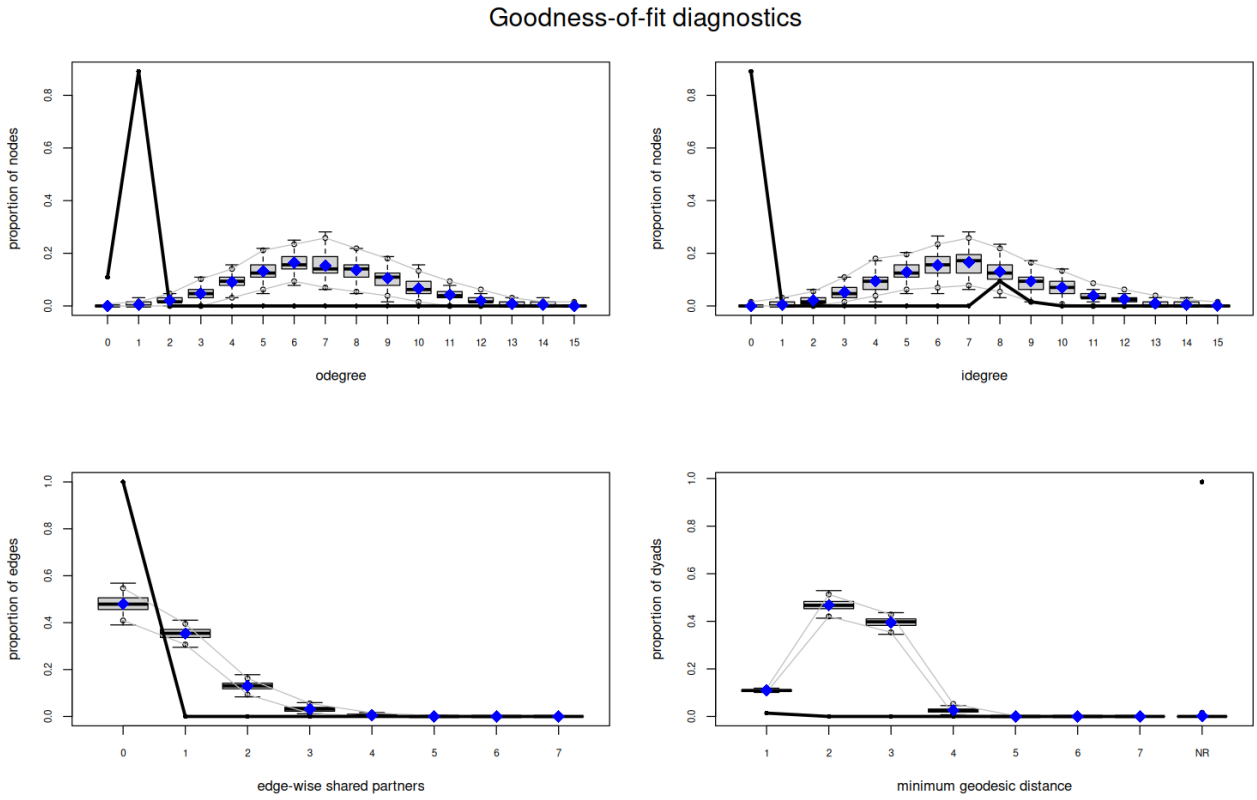

Figure B.7 Goodness-of-fit for model statistics of Multi-ERGM RPI, the upper graph shows the proportion of nodes vs out-degree and proportion of nodes vs in-degree; and the lower graph shows the proportion of edges vs edge-wise shared partners and proportion of dyads vs minimum geodesic distance.

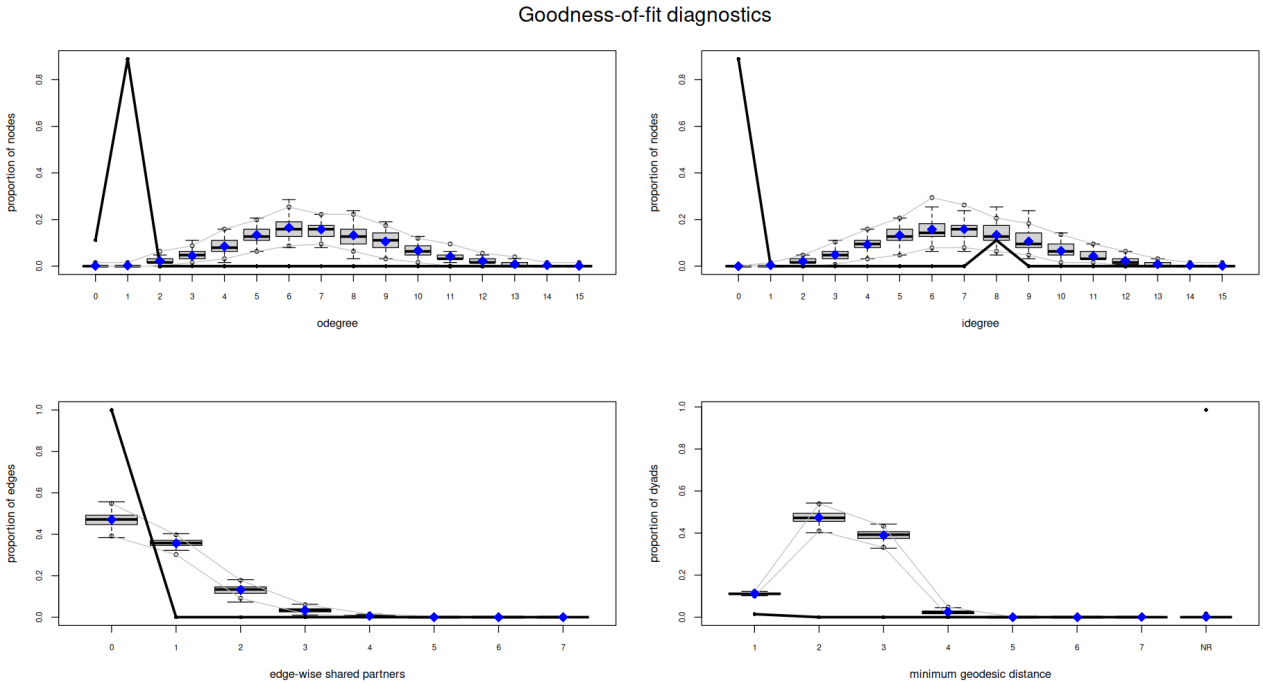

Figure B.8 Goodness-of-fit for model statistics of Multi-ERGM RPT, the upper graph shows the proportion of nodes vs out-degree and proportion of nodes vs in-degree; and the lower graph shows the proportion of edges vs edge-wise shared partners and proportion of dyads vs minimum geodesic distance.

Appendix C. Saturated Figures

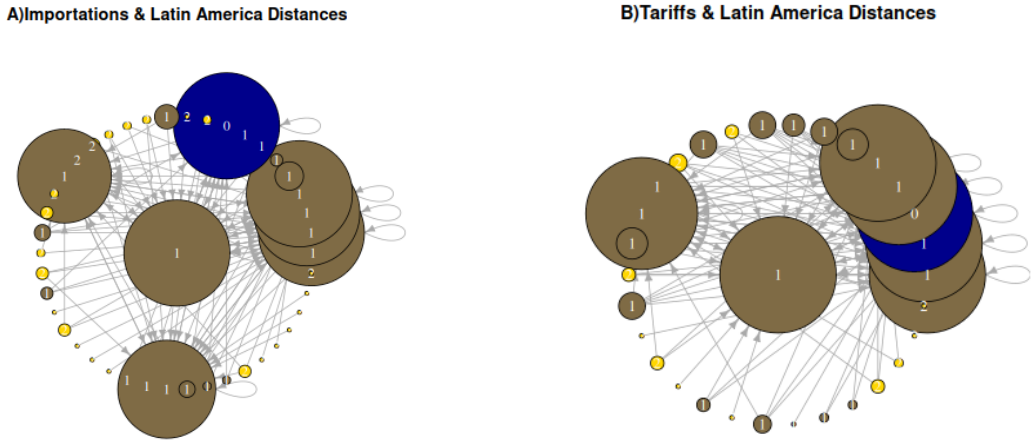

Figure C.1. Comparison of the network's distances and the visual analyses of the networks. Both have *20 leading partners* by layer; the graphs are saturated, making it impossible to follow the arrow connections, as the node shapes overlap and their labels as well.

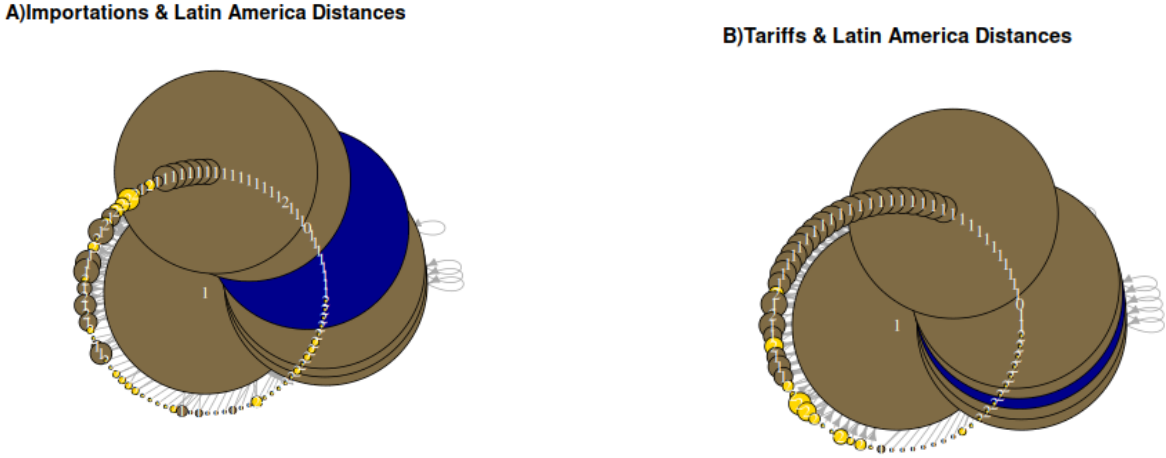

Figure C.2. Comparison of the network's distances and the visual analyses of the networks. Both have 5*0 leading partners* by layer; the graphs are saturated, with the nodes' shapes overlapping and their labels as well.

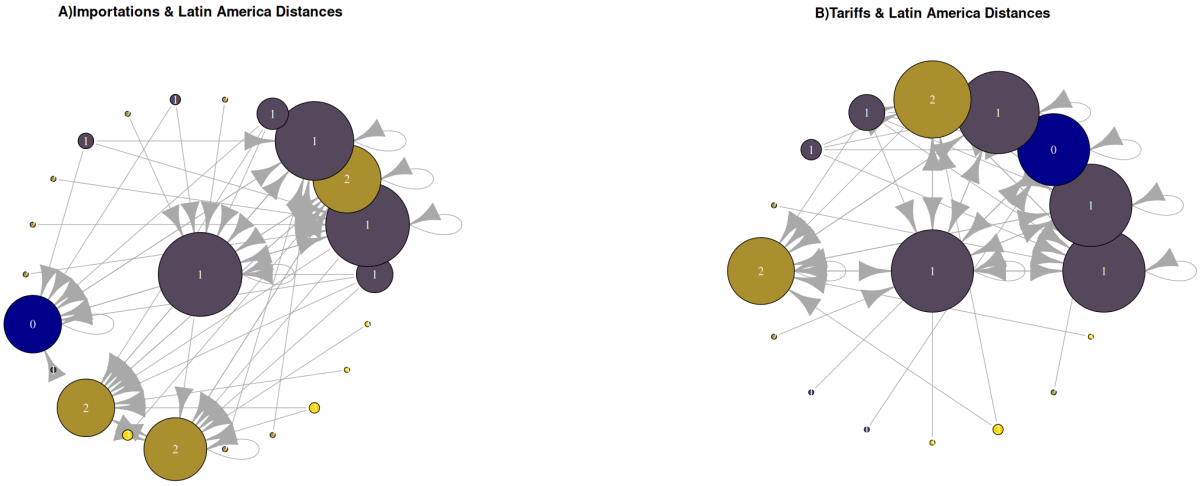

Figure C.3. Comparison of the network's distances and the visual analyses of the networks. Both have 1*0 leading partners* by layer; the graphs look neat and polished. It is easy to decode them.

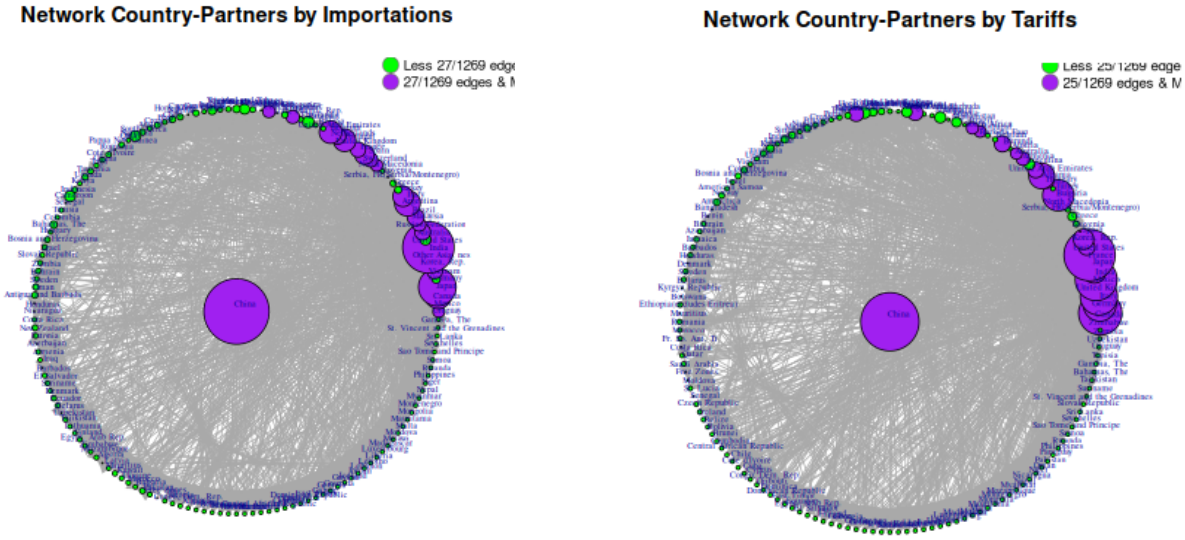

Figure C.4. Comparison of the density edges by countries and the visual analyses of the networks. Both have *10 leading partners*; both graphs appear saturated, with node shapes overlapping and their labels as well. It is impossible to follow the connections of the arrows and hard to decode them at a glance.

Appendix D.0. Network lists

#Importations, sel_p=10

```
networklist
$`East Asia & Pacific`
+ 15/63 edges from 968044d (vertex names):
 [1] East Asia & Pacific       ->East Asia & Pacific
 [2] China                     ->East Asia & Pacific
 [3] East Asia & Pacific       ->Europe & Central Asia
 [4] Europe & Central Asia     ->East Asia & Pacific
 [5] East Asia & Pacific       ->Middle East & North Africa
 [6] Middle East & North Africa->East Asia & Pacific
 [7] East Asia & Pacific       ->North America
 [8] North America             ->East Asia & Pacific
 [9] United States             ->East Asia & Pacific
[10] Other Asia, nes           ->East Asia & Pacific
+ ... omitted several edges

$China
+ 7/63 edges from 968044d (vertex names):
[1] China->East Asia & Pacific        China->Europe & Central Asia
[3] China->Middle East & North Africa China->North America
[5] China->Latin America & Caribbean  China->South Asia
[7] China->Sub-Saharan Africa

$`Europe & Central Asia`
+ 15/63 edges from 968044d (vertex names):
 [1] Europe & Central Asia->East Asia & Pacific
 [2] East Asia & Pacific  ->Europe & Central Asia
 [3] China                ->Europe & Central Asia
 [4] Europe & Central Asia->Europe & Central Asia
 [5] Europe & Central Asia->Middle East & North Africa
 [6] Europe & Central Asia->North America
 [7] North America        ->Europe & Central Asia
 [8] United States        ->Europe & Central Asia
 [9] Germany              ->Europe & Central Asia
[10] Netherlands          ->Europe & Central Asia
+ ... omitted several edges

$`Middle East & North Africa`
+ 12/63 edges from 968044d (vertex names):
 [1] Middle East & North Africa->East Asia & Pacific
 [2] East Asia & Pacific       ->Middle East & North Africa
 [3] China                     ->Middle East & North Africa
 [4] Europe & Central Asia     ->Middle East & North Africa
 [5] Middle East & North Africa->Middle East & North Africa
 [6] North America             ->Middle East & North Africa
 [7] United States             ->Middle East & North Africa
 [8] Middle East & North Africa->South Asia
 [9] South Asia                ->Middle East & North Africa
[10] India                     ->Middle East & North Africa
+ ... omitted several edges

$`North America`
+ 14/63 edges from 968044d (vertex names):
 [1] North America            ->East Asia & Pacific
 [2] East Asia & Pacific      ->North America
 [3] China                    ->North America
 [4] North America            ->Europe & Central Asia
 [5] Europe & Central Asia    ->North America
 [6] North America            ->Middle East & North Africa
```

```
 [7] North America            ->North America
 [8] United States            ->North America
 [9] Germany                  ->North America
[10] North America            ->Latin America & Caribbean
+ ... omitted several edges

$`United States`
+ 6/63 edges from 968044d (vertex names):
[1] United States->East Asia & Pacific        United States->Europe & Central Asia
[3] United States->Middle East & North Africa United States->North America
[5] United States->Latin America & Caribbean  United States->South Asia

$`Other Asia, nes`
+ 1/63 edge from 968044d (vertex names):
[1] Other Asia, nes->East Asia & Pacific

$`Korea, Rep.`
+ 2/63 edges from 968044d (vertex names):
[1] Korea, Rep.->East Asia & Pacific       Korea, Rep.->Latin America & Caribbean

$Japan
+ 1/63 edge from 968044d (vertex names):
[1] Japan->East Asia & Pacific

$Germany
+ 3/63 edges from 968044d (vertex names):
[1] Germany->Europe & Central Asia     Germany->North America
[3] Germany->Latin America & Caribbean

$Netherlands
+ 1/63 edge from 968044d (vertex names):
[1] Netherlands->Europe & Central Asia

$France
+ 1/63 edge from 968044d (vertex names):
[1] France->Europe & Central Asia

$Italy
+ 1/63 edge from 968044d (vertex names):
[1] Italy->Europe & Central Asia

$`Latin America & Caribbean`
+ 10/63 edges from 968044d (vertex names):
 [1] East Asia & Pacific      ->Latin America & Caribbean
 [2] China                    ->Latin America & Caribbean
 [3] Europe & Central Asia    ->Latin America & Caribbean
 [4] Latin America & Caribbean->North America
 [5] North America            ->Latin America & Caribbean
 [6] United States            ->Latin America & Caribbean
 [7] Korea, Rep.              ->Latin America & Caribbean
 [8] Germany                  ->Latin America & Caribbean
 [9] Latin America & Caribbean->Latin America & Caribbean
[10] Brazil                   ->Latin America & Caribbean

$Brazil
+ 1/63 edge from 968044d (vertex names):
[1] Brazil->Latin America & Caribbean

$`South Asia`
+ 11/63 edges from 968044d (vertex names):
```

```
 [1] East Asia & Pacific       ->South Asia
 [2] China                     ->South Asia
 [3] Europe & Central Asia     ->South Asia
 [4] South Asia                ->Middle East & North Africa
 [5] Middle East & North Africa->South Asia
 [6] North America             ->South Asia
 [7] United States             ->South Asia
 [8] South Asia                ->Sub-Saharan Africa
 [9] Sub-Saharan Africa        ->South Asia
[10] United Arab Emirates      ->South Asia
+ ... omitted several edges

$India
+ 2/63 edges from 968044d (vertex names):
[1] India->Middle East & North Africa India->Sub-Saharan Africa

$`Sub-Saharan Africa`
+ 11/63 edges from 968044d (vertex names):
 [1] East Asia & Pacific       ->Sub-Saharan Africa
 [2] China                     ->Sub-Saharan Africa
 [3] Europe & Central Asia     ->Sub-Saharan Africa
 [4] Sub-Saharan Africa        ->Middle East & North Africa
 [5] Middle East & North Africa->Sub-Saharan Africa
 [6] Sub-Saharan Africa        ->South Asia
 [7] South Asia                ->Sub-Saharan Africa
 [8] India                     ->Sub-Saharan Africa
 [9] Sub-Saharan Africa        ->Sub-Saharan Africa
[10] United Arab Emirates      ->Sub-Saharan Africa
+ ... omitted several edges

$Mexico
+ 1/63 edge from 968044d (vertex names):
[1] Mexico->North America

$Canada
+ 1/63 edge from 968044d (vertex names):
[1] Canada->North America

$`United Arab Emirates`
+ 2/63 edges from 968044d (vertex names):
[1] United Arab Emirates->South Asia         United Arab Emirates->Sub-Saharan Africa

$`Saudi Arabia`
+ 1/63 edge from 968044d (vertex names):
[1] Saudi Arabia->South Asia

$`South Africa`
+ 1/63 edge from 968044d (vertex names):
[1] South Africa->Sub-Saharan Africa
```

#Tariffs, sel_p=10

```
> networklist
$`Europe & Central Asia`
+ 15/63 edges from f1b1e39 (vertex names):
 [1] Europe & Central Asia     ->Europe & Central Asia
 [2] Europe & Central Asia     ->East Asia & Pacific
 [3] East Asia & Pacific       ->Europe & Central Asia
 [4] Europe & Central Asia     ->North America
 [5] North America             ->Europe & Central Asia
 [6] Europe & Central Asia     ->Latin America & Caribbean
```

```
 [7] Latin America & Caribbean ->Europe & Central Asia
 [8] Europe & Central Asia     ->South Asia
 [9] South Asia                ->Europe & Central Asia
[10] Europe & Central Asia     ->Middle East & North Africa
+ ... omitted several edges

$`East Asia & Pacific`
+ 15/63 edges from f1b1e39 (vertex names):
 [1] East Asia & Pacific       ->Europe & Central Asia
 [2] Europe & Central Asia     ->East Asia & Pacific
 [3] East Asia & Pacific       ->East Asia & Pacific
 [4] East Asia & Pacific       ->North America
 [5] North America             ->East Asia & Pacific
 [6] East Asia & Pacific       ->Latin America & Caribbean
 [7] Latin America & Caribbean ->East Asia & Pacific
 [8] East Asia & Pacific       ->South Asia
 [9] South Asia                ->East Asia & Pacific
[10] East Asia & Pacific       ->Middle East & North Africa
+ ... omitted several edges

$`North America`
+ 15/63 edges from f1b1e39 (vertex names):
 [1] North America             ->Europe & Central Asia
 [2] Europe & Central Asia     ->North America
 [3] North America             ->East Asia & Pacific
 [4] East Asia & Pacific       ->North America
 [5] North America             ->North America
 [6] North America             ->Latin America & Caribbean
 [7] Latin America & Caribbean ->North America
 [8] North America             ->South Asia
 [9] South Asia                ->North America
[10] North America             ->Middle East & North Africa
+ ... omitted several edges

$`Latin America & Caribbean`
+ 13/63 edges from f1b1e39 (vertex names):
 [1] Latin America & Caribbean->Europe & Central Asia
 [2] Europe & Central Asia    ->Latin America & Caribbean
 [3] Latin America & Caribbean->East Asia & Pacific
 [4] East Asia & Pacific      ->Latin America & Caribbean
 [5] Latin America & Caribbean->North America
 [6] North America            ->Latin America & Caribbean
 [7] Latin America & Caribbean->Latin America & Caribbean
 [8] Latin America & Caribbean->South Asia
 [9] South Asia               ->Latin America & Caribbean
[10] China                    ->Latin America & Caribbean
+ ... omitted several edges

$`South Asia`
+ 15/63 edges from f1b1e39 (vertex names):
 [1] South Asia                ->Europe & Central Asia
 [2] Europe & Central Asia     ->South Asia
 [3] South Asia                ->East Asia & Pacific
 [4] East Asia & Pacific       ->South Asia
 [5] South Asia                ->North America
 [6] North America             ->South Asia
 [7] South Asia                ->Latin America & Caribbean
 [8] Latin America & Caribbean ->South Asia
 [9] South Asia                ->South Asia
[10] South Asia                ->Middle East & North Africa
```

```
+ ... omitted several edges

$`Middle East & North Africa`
+ 14/63 edges from f1b1e39 (vertex names):
 [1] Middle East & North Africa->Europe & Central Asia
 [2] Europe & Central Asia     ->Middle East & North Africa
 [3] Middle East & North Africa->East Asia & Pacific
 [4] East Asia & Pacific       ->Middle East & North Africa
 [5] Middle East & North Africa->North America
 [6] North America             ->Middle East & North Africa
 [7] Middle East & North Africa->South Asia
 [8] South Asia                ->Middle East & North Africa
 [9] Middle East & North Africa->Middle East & North Africa
[10] China                     ->Middle East & North Africa
+ ... omitted several edges

$China
+ 7/63 edges from f1b1e39 (vertex names):
[1] China->Europe & Central Asia      China->East Asia & Pacific
[3] China->North America              China->Latin America & Caribbean
[5] China->South Asia                 China->Middle East & North Africa
[7] China->Sub-Saharan Africa

$`United States`
+ 4/63 edges from f1b1e39 (vertex names):
[1] United States->East Asia & Pacific        United States->Latin America & Caribbean
[3] United States->South Asia                 United States->Middle East & North Africa

$Japan
+ 1/63 edge from f1b1e39 (vertex names):
[1] Japan->East Asia & Pacific

$`Sub-Saharan Africa`
+ 12/63 edges from f1b1e39 (vertex names):
 [1] Sub-Saharan Africa        ->Europe & Central Asia
 [2] Europe & Central Asia     ->Sub-Saharan Africa
 [3] East Asia & Pacific       ->Sub-Saharan Africa
 [4] Sub-Saharan Africa        ->North America
 [5] North America             ->Sub-Saharan Africa
 [6] Sub-Saharan Africa        ->South Asia
 [7] South Asia                ->Sub-Saharan Africa
 [8] Middle East & North Africa->Sub-Saharan Africa
 [9] China                     ->Sub-Saharan Africa
[10] Sub-Saharan Africa        ->Sub-Saharan Africa
+ ... omitted several edges

$`United Kingdom`
+ 1/63 edge from f1b1e39 (vertex names):
[1] United Kingdom->Europe & Central Asia

$Germany
+ 1/63 edge from f1b1e39 (vertex names):
[1] Germany->Latin America & Caribbean

$Spain
+ 1/63 edge from f1b1e39 (vertex names):
[1] Spain->Latin America & Caribbean

$Turkey
+ 1/63 edge from f1b1e39 (vertex names):
```

```
[1] Turkey->Middle East & North Africa

$India
+ 2/63 edges from f1b1e39 (vertex names):
[1] India->Middle East & North Africa India->Sub-Saharan Africa

$Canada
+ 1/63 edge from f1b1e39 (vertex names):
[1] Canada->North America

$`South Africa`
+ 1/63 edge from f1b1e39 (vertex names):
[1] South Africa->Sub-Saharan Africa
```

Appendix D.1. Fundamental Parameter Multi-ERGM Network Analyses

#Importations, sel_p=10

```
vsize <- degree(net_r, mode="all")
```

```
       East Asia & Pacific                     China      Europe & Central Asia
                        16                         7                         16
Middle East & North Africa             North America             United States
                        13                        15                         6
           Other Asia, nes                Korea, Rep.                     Japan
                         1                         2                         1
                   Germany                Netherlands                    France
                         3                         1                         1
                     Italy  Latin America & Caribbean                    Brazil
                         1                        11                         1
                South Asia                     India         Sub-Saharan Africa
                        11                         2                        12
                    Mexico                    Canada       United Arab Emirates
                         1                         1                         2
             Saudi Arabia               South Africa
                         1                         1
```

```
centr_betw(net, directed=T, normalized=T)
#The first element correspond to the betweeness centrality name in this case the maximum
betweeness is the maximum value of 39.0
```

```
  East Asia & Pacific                     China      Europe & Central Asia
                 39.0                       0.0                       22.0
Middle East & North Africa             North America             United States
                 26.0                      23.5                       0.0
           Other Asia, nes                Korea, Rep.                     Japan
                  0.0                       0.0                        0.0
                   Germany                Netherlands                    France
                  0.0                       0.0                        0.0
                     Italy  Latin America & Caribbean                    Brazil
                  0.0                       6.5                        0.0
                South Asia                     India         Sub-Saharan Africa
                 10.0                       0.0                        9.0
                    Mexico                    Canada       United Arab Emirates
                  0.0                       0.0                        0.0
             Saudi Arabia               South Africa
                  0.0                       0.0
```

```
closeness(net, mode="all", weights=NA)
```

```
       East Asia & Pacific                     China      Europe & Central Asia
                0.03030303                0.02702703                0.03125000
Middle East & North Africa             North America             United States
                0.02702703                0.02857143                0.02564103
           Other Asia, nes                Korea, Rep.                     Japan
                0.01851852                0.01960784                0.01851852
                   Germany                Netherlands                    France
```

```
0.02127660                0.01886792                0.01886792
     Italy  Latin America & Caribbean                    Brazil
0.01886792                0.02500000                0.01639344
South Asia                     India        Sub-Saharan Africa
0.02777778                0.01818182                0.02564103
    Mexico                    Canada      United Arab Emirates
0.01785714                0.01785714                0.01851852
Saudi Arabia              South Africa
0.01754386                0.01666667
```

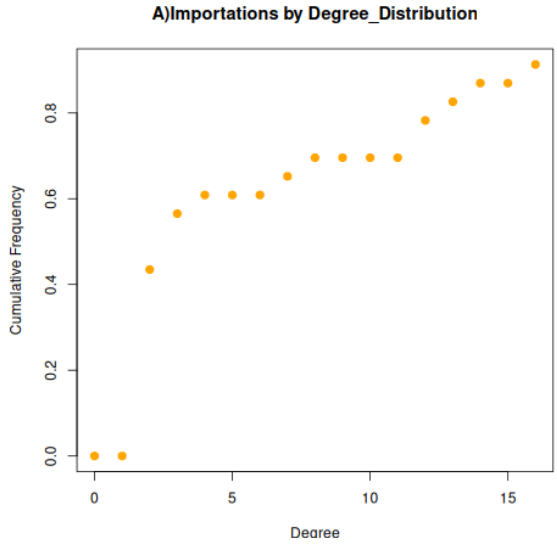

Figure D.1 Multi-ERGM RPI shows a cumulative frequency of ties and degree analysis in Region-Partner by Importations analysis in 2022.

#Tariff, sel_p=10

```
vsize
     Europe & Central Asia        East Asia & Pacific              North America
                        16                         16                         16
 Latin America & Caribbean               South Asia Middle East & North Africa
                        14                         16                         15
                     China              United States                      Japan
                         7                          4                          1
        Sub-Saharan Africa             United Kingdom                    Germany
                        13                          1                          1
                     Spain                     Turkey                      India
                         1                          1                          2
                    Canada               South Africa
                         1                          1
centr_betw(net, directed=T, normalized=T)
#The first element correspond to the betweeness centrality name in this case the maximum
betweeness is the maximum value of 12.5
     Europe & Central Asia        East Asia & Pacific              North America
                 10.285714                   8.976190                  10.285714
 Latin America & Caribbean               South Asia Middle East & North Africa
                 12.500000                   5.119048                   9.904762
                     China              United States                      Japan
                  0.000000                   0.000000                   0.000000
        Sub-Saharan Africa             United Kingdom                    Germany
                  7.928571                   0.000000                   0.000000
                     Spain                     Turkey                      India
                  0.000000                   0.000000                   0.000000
                    Canada               South Africa
                  0.000000                   0.000000
closeness(net, mode="all", weights=NA)
     Europe & Central Asia        East Asia & Pacific              North America
```

```
                0.04166667                 0.04347826                 0.04166667
Latin America & Caribbean                South Asia Middle East & North Africa
                0.03703704                 0.04166667                 0.04000000
                     China              United States                      Japan
                0.04000000                 0.03225806                 0.02631579
        Sub-Saharan Africa             United Kingdom                    Germany
                0.03846154                 0.02564103                 0.02380952
                     Spain                     Turkey                      India
                0.02380952                 0.02500000                 0.02631579
                    Canada               South Africa
        0.02564103                 0.02439024
```

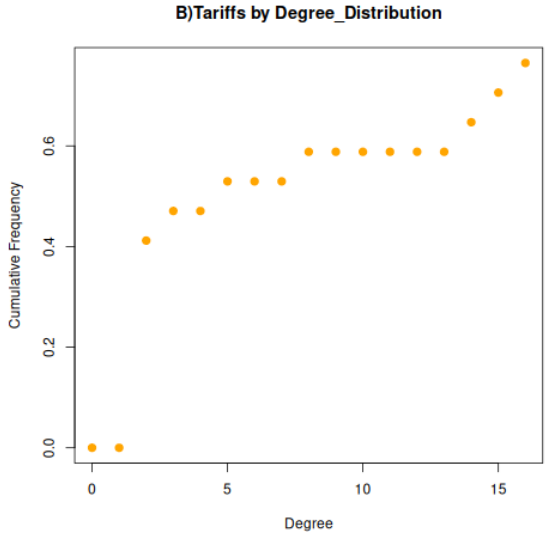

Figure D.2 Multi-ERGM RPT shows a cumulative frequency of ties and degree analysis in Region-Partner by Importations analysis in 2022.