Bremen, March 2021

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# Measuring global competition in export markets and export sectors

No. 8 WeSIS — Technical papers

Global Dynamics of Social Policy CRC 1342

Gefördert durch DFG Deutsche Forschungsgemeinschaft

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Measuring global competition in export markets and export sectors
SFB 1342 Technical Paper Series, 8
Bremen: SFB 1342, 2021

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Website:
https://www.socialpolicydynamics.de

[DOI https://doi.org/10.26092/elib/1533]
[ISSN 2700-0389]

Gefördert durch die Deutsche Forschungsgemeinschaft (DFG)
Projektnummer 374666841 – SFB 1342

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## 1. Introduction: Competition and the Diffusion of Social Policy

In order to explain the global dynamics of social policy, comparative welfare state research typically distinguishes between domestic factors on the one hand, and transnational linkages on the other. In this Technical Paper, we present two novel datasets that capture trade linkages in a more differentiated way than before. Our new indicators explicitly capture economic competition which has been extensively discussed as a relevant mechanism in the diffusion of public policies but seldom operationalized in the strict sense of "competition". We thereby contribute to overcome the "methodological nationalism" (Adamson 2016, Zürn 1998). The latter is criticized for neglecting the importance of transnational linkages by explaining social policy dynamics only in terms of nationally determined processes that take place in countries independent of each other. However, linkages between nation states influence the spread and design of social policies through direct policy transfers or nationally adapted variants of social policies and programs as the outcome of diffusion processes (Obinger et al. 2013, Mossig/Düpont 2020).

In line with the public policy diffusion literature, the research approach of the CRC 1342 "Global Dynamics of Social Policy" distinguishes between

(a) communication,
(b) political-organizational linkages,
(c) economic linkages,
(d) migration, and
(e) conflicts

as relevant types of linkages with regard to the diffusion of social policies. Diffusion mechanisms (Obinger et al. 2013, Dobbin et al. 2007, Magetti/Gilardi 2016) are

(1) learning,
(2) competition,
(3) imitation, and
(4) coercion.

The new data presented here explicitly operationalizes economic linkages (linkage type c) for better capturing "(2) competition" as the focal mechanism.

## 2. Global Trade Networks and Global Dynamics of Social Policy

The importance of economic globalization accompanied by an increase in trade linkages for the diffusion of social policy rests on the basic assumption that major trading partners influence a country's policy more strongly than less important trading partners. As a result of globalization, countries are increasingly orienting themselves toward each other, less so in terms of social rights but in terms of social spending (Jensen 2011, Schmitt/Starke 2011), although this does not necessarily mean that social policy has fully converged (Jahn 2016).

Both during the first wave of globalization from 1890 to World War I and especially during the second wave of globalization in the period after World War II until the mid-1980s, trade linkages increased rapidly and were the main force driving economic globalization (Mossig/Lischka 2021). Initially, trade was not measured as linkages between countries, though. Instead, public policy studies interpreted a countries' share of trade (imports + exports) as p% of GDP as an indicator of economic openness (Busemeyer 2009). Cameron

(1978) was among the first to show an empirical relationship between public sector expansion and integration into world trade for 18 Western industrialized countries. According to this line of reasoning, open economies with a high share of trade in GDP are particularly vulnerable to external events, such as price developments on the world market. To counteract these external dependencies, the state expands his influence within the domestic sectors of the economy. Smaller economies in particular have a comparatively high trade share in terms of GDP due to the smaller domestic market and a high degree of industrial specialization. The expansion of the welfare state in smaller economies such as the Scandinavian countries or the Netherlands is thus a result of their economic openness. In the literature, such side effects of economic globalization are discussed in the context of the "compensation hypothesis" (Burgoon 2001, Rieger/Leibfried 2003, Genschel 2004).

Later on, with the "efficiency hypothesis" an alternative perspective on globalization effects was proposed. Since the 1980s, globalization and world market integration is less characterized by trade linkages, but countries increasingly become involved in a global competition for foreign direct investments. The competition takes place in terms of offering low-cost location conditions, for example lower social security contributions or taxes (Mossig/Lischka 2021, Düpont et al. 2021). In order to survive in this competition, a dismantling of the welfare state by lowering social standards and social contributions is deemed necessary (Swank 2010) – a process that has been termed as a "race to the bottom" (Kvist 2004).

As highly aggregated indicators, economic openness or world market integration measured by a country's trade share as p% of GDP or foreign investment stocks disregard the varying importance of different partners, though. For example, there is no distinction between important and unimportant trading partners or the specific fields that are contested (Lopéz-Cariboni/Cao 2015). In addition, indirect links through third-party trading partners are ignored. Yet, the structure of the network as well as the position of each individual state in the network determine the scope for action and affect the vulnerability and sensitivity of interstate relations (Glückler/Doreian 2016, Maoz 2011, Mossig/Düpont 2020). Accordingly, dyadic data (Cao/Prakash 2010) and networks of global trade are increasingly used to analyze the diffusion of social policy, e.g. in network diffusion models (Windzio et al forthcoming, Valente 1995).

## 3. Improving the measurement of competition in export networks

In policy diffusion research, trade is inconsistently but mainly linked to competition as the diffusion mechanism (Gilardi 2016) and, as already mentioned, theoretically discussed within the framework of the efficiency or compensation hypothesis. Empirically, however, it is still an open question whether economic competition necessarily triggers a race to the bottom as suggested by the efficiency thesis. Both aligning social policy standards and deliberately exploiting different social standards can be viable policy options for achieving a competitive advantage (Starke/Torsun 2019). Moreover, a strong motivation for trading is to exploit comparative cost advantages which, according to the Ricardo theorem, has a welfare-enhancing effect for both trading partners (Krugman/Obstfeld 2018). Trade linkages therefore do not necessarily belong to the diffusion mechanism of competition per se.

## 3.1 Global economic competition on export-markets

In order to better capture competition between countries, our new indicator "global economic competition on export-markets" (comp_exportmarkets) directly addresses two important questions: (1) Who are the important export competitors of the focal country on common foreign markets? (2) With which countries does the focal country have a less pronounced competitive situation? In contrast to a simple network of trading partners, edges are not formed on the basis of direct trade links between two countries A and B. Instead, the similarity of two countries A and B is defined in terms of the distribution of their exports among the respective export partners. If the trade volumes of A and B are similarly distributed among the sales markets, then there is a high degree of similarity. The weight of the edge between two countries thus reflects that both compete with each other on similar third-party markets. Applying such an operationalization, the competition argument is mapped more precisely and in a more fine-grained way with respect to the sales markets than in a dyadic view of aggregate trade volumes between any two countries.

The newly created indicator is available under the label "comp_exportmarkets" in WeSIS (https://wesis.org/). Utilizing the United Nations Comtrade dataset (https://comtrade.un.org/), our country sample comprises export data from 164 countries (see Appendix A) from 1962 to 2018. Calculations are done on a year-by-year basis. This way, we are able to provide data on the strength of competition in export markets between any two countries for each of the 57 years from 1962 to 2018. We computed the indicator as follows:

1) We set all values to zero on the main diagonal to remove isolated data on reimports.
2) We logarithmize all values, except for the main diagonals and the missing data, which are shown as zero in the basic data. Thus, zeros in the matrix keep the value zero after logarithmization.
3) The logarithmized export volumes of country A to their different sales markets are treated as a 164-dimensional vector, which is calculated for each of the n=164 countries. Whenever a missing value, i.e. a zero, occurs in a vector dimension, we excluded this dimension.
4) Similar vectors indicate that two countries export goods to other countries to a similar degree and meet each other as competitors on these third-party sales markets. As a similarity measure of the country-specific export market vectors, the average Euclidean distances *marketAB* are calculated for two countries A and B respectively with

$$market_{AB} = \frac{\sum_{i=1}^{n} \sqrt{(Log\_EXPORTA_i \; - \; Log\_EXPORTB_i)^2}}{n}$$

where n is the number of vector dimensions with *Log_EXPORTAi* ≠ 0 and *Log_EXPORTBi* ≠ 0.

This is the average Euclidean distance with respect to log exports of countries A and B in all common sales markets.

5) We normalized the distances by dividing with the maximum value of the entire matrix, so that the distances between two countries take values between 0 and 1.
6) We calculate the complement 1 - *marketAB*, so that a low distance, signifying a high degree of competition, is also displayed as a value close to 1 and the network edges are given a correspondingly stronger weight.

## 3.2 Global economic competition in export-sectors

While we just introduced a more fine-grained measure that explicitly captures economic competition on third-party markets, the competition argument can be further disentangled in the empirical operationalization by differentiating exports by product groups (Kim et al. 2020). In the context of the compensation hypothesis, it was pointed out that smaller economies differ from large economies in that smaller countries generally exhibit a higher degree of sectoral specialization in order to be internationally competitive in selected industries. In addition, certain product groups, such as raw materials or agricultural products, are closely tied to their locations or to specific production conditions (e.g., a particular climate). Thus, two countries A and B might have similar countries as their preferred trading partners, but enter the markets there with completely different products. In such a case, one would hardly treat them as "competitors". To better reflect such occurrences, we define an "global economic competition in export sectors" (comp_sector) as an additional indicator and analyse the sectorally subdivided export data of the Comtrade dataset of the United Nations (https://comtrade.un.org/) for the n=164 countries on the SITC 1-digit-level, distinguishing 10 product groups (see Appendix B).

Our methodological approach is similar to that used for competition in markets, except that this time the sectoral differentiated export profiles of a country are used:

1) Logarithmization of the original data. Missing values are still displayed as zero after logarithmization.
2) The logarithmized export volumes of a country A in the respective economic sectors j (j = 1 - 10) are treated as a 10-dimensional vector, which is computed for each of the n=164 countries.
3) Similar vectors indicate that these countries are active to a comparable extent in the economic sectors on the world market and are in competition with each other in these economic sectors. As a similarity measure of the country-specific branch vectors, the average Euclidean distances *sectorAB* are calculated for two countries A and B. As soon as a missing value, i.e. a zero, occurs in a vector dimension, this dimension is excluded:

$$sector_{AB} = \frac{\sum_{j=1}^{n} \sqrt{(Log\_BranchEXPORTA_j - Log\_BranchEXPORTB_j)^2}}{n}$$

   where n is the number of vector dimensions with *Log_BranchEXPORTAj* ≠ 0 and *Log_BranchEXPORTBj* ≠ 0.

This corresponds to the average Euclidean distance with respect to log exports in the respective industries j for two countries A and B.

4) Normalization of the distances by dividing with the maximum value of the entire matrix, so that the distances between two countries take values between 0 and 1.
5) Calculation of the complement 1 - *sectorAB* so that a lower distance, i.e. a high level of competition in sectors, also gets as a large value close to 1 and the network edges are given a correspondingly stronger weight compared to a lower competitive situation, which are then expressed by values close to 0.

## 4. Network representations and distinction from export networks

Below, we plot our indicator of competition in markets (comp_exportmarkets) (Figure 1) and competition in sectors (comp_sector) (Figure 2) as a network in 2017.

Figure 1: Network of global economic competition on export-markets 2017

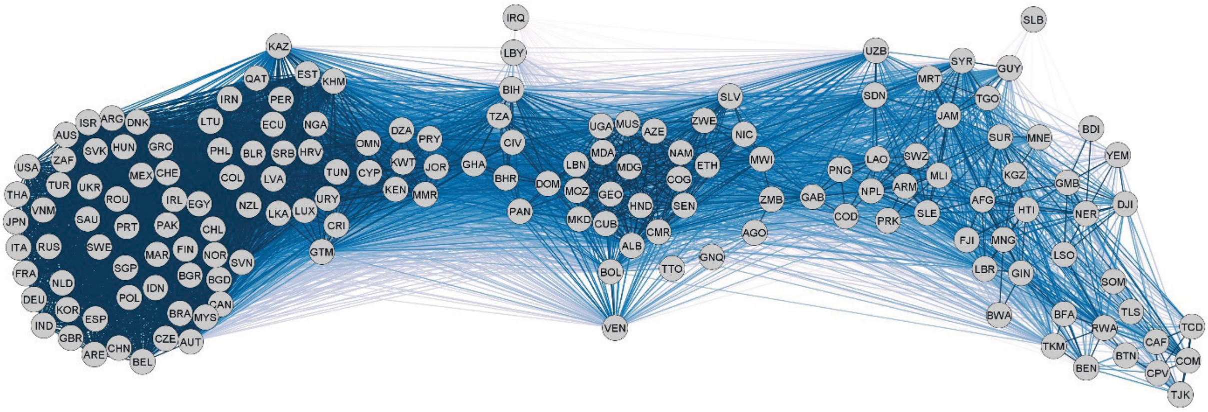
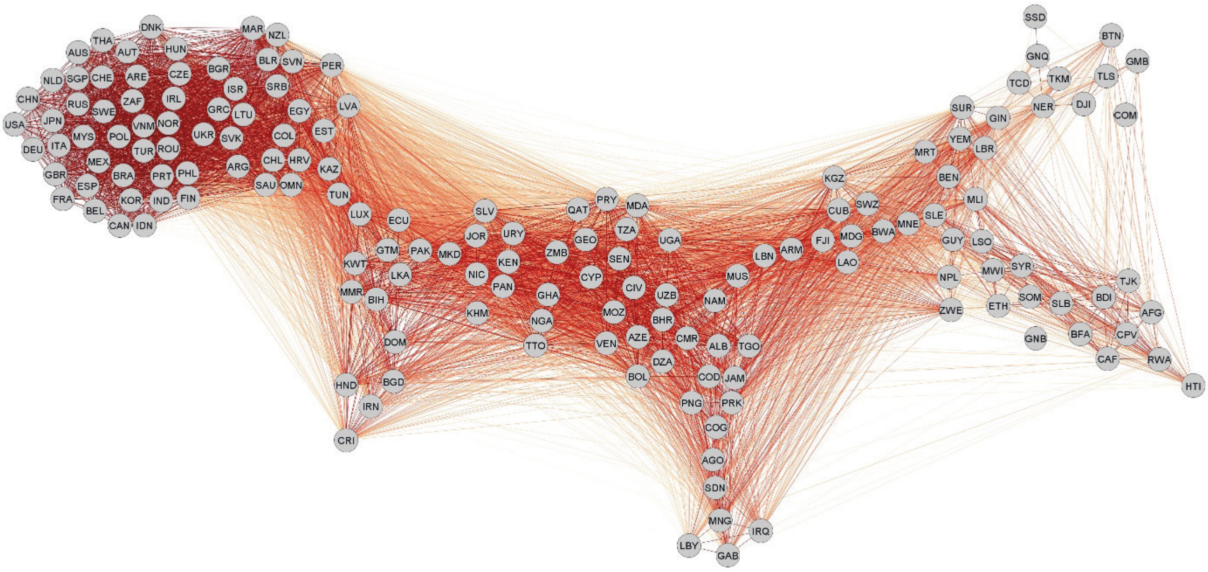


Figure 2: Network of global economic competition in export-sectors 2017



In addition, we compared the newly calculated competition linkages to the conventional export network and calculated correlation coefficients (Table 1) to check whether the three networks differ or how similar they are. For constructing the simple global export network, we logarithmized the export data in order to make it comparable our new measures.

Table 1: Correlation between the three networks (a) exports (log), (b) competition on export markets and (c) competition in export sectors 2017

| | Export network (log) | Competition on export markets | Competition in export-sectors |
|---|---|---|---|
| Export network (log) | 1.000 | 0.290 | 0.169 |
| Competiton on export markets | | 1.000 | 0.867 |
| Competition in export sectors | | | 1.000 |

The correlation coefficients indicate that the newly compiled indicators significantly differ from the simple export network. The correlation between the logarithmized trade data and the new indicator for capturing competition in markets is r = 0.290 and, with regard to competition in economic sectors, only r = 0.169. This indicates that fundamentally different linkages between any two countries describe their competition compared to the simple trade data. On the contrary, the correlation between the two newly formed indicators is comparatively high at r = 0.867.

Nevertheless, we argue that these two forms of competition based on trade relations should not be equated, because significant differences exist for individual countries between the most important competitors in export markets and economic sectors (depending on the national specialization). Table 2 below shows the differences between the respective TOP5 competitors on markets and the TOP5 competitors in economic sectors for three countries as an example. The table shows China, the world's leading exporter in 2017, Norway, which exports oil and natural gas in particular, and Uzbekistan, another commodity-exporting country that was a republic of the former Soviet Union until the early 1990s. Obviously, regional proximity plays a role with regard to competition in markets. Still, as the cases of Norway and Uzbekistan show, the sectoral composition of exports leads to a completely different setup of TOP5 competitors.

Table 2: TOP5-competitors on third-party marktes as well as in economic sectors for China, Norway and Uzbekistan 2017

| | Export | comp_exportmarkets | comp_sector |
|---|---|---|---|
| China | 1 USA (USA)<br>2 Japan (JPN)<br>3 South Korea (KOR)<br>4 Germany (DEU)<br>5 Vietnam (VNM) | 1 USA (USA)<br>2 Germany (DEU)<br>3 India (IND)<br>4 France (FRA)<br>5 Japan (JPN) | 1 Germany (DEU)<br>2 Italia (ITA)<br>3 France (FRA)<br>4 USA (USA)<br>5 United Kingdom (GBR) |
| Norway | 1 Great Britain (GBR)<br>2 Germany (DEU)<br>3 Sweden (SWE)<br>4 Netherlands (NDL)<br>5 France (FRA) | 1 Finland (FIN)<br>2 Ireland (IRL)<br>3 Denmark (DNK)<br>4 Hungaria (HUN)<br>5 Czech Republik (CZE) | 1 United Arab Emirates (ARE)<br>2 Columbia (COL)<br>3 Greece (GRC)<br>4 Finland (FIN)<br>5 South Africa (ZAF) |
| Uzbekistan | 1 China (CHN)<br>2 Russian Fed. (RUS)<br>3 Turkey (TUR)<br>4 Kazachstan (KAZ)<br>5 Kyrgyzstan (KGZ) | 1 Georgia (GEO)<br>2 Moldova (MDA)<br>3 Kyrgyzstan (KGZ)<br>4 Armenia (ARM)<br>5 Albania (ALB) | 1 Bahrain (BHR)<br>2 Cameroon (CMR)<br>3 Pakistan (PAK)<br>4 Slovenia (SLV)<br>5 Cyprus (CYP) |

## 5. Conclusion

While policy diffusion research argued that economic competition is a mechanism for explaining the spread of public policies and social policies in particular, empirical operationalizations just did not catch-up to the theoretical arguments. Instead of using trade flows, or even worse, a country's share of trade as p% of GDP, we propose two new indicators reflecting economic competition more accurately than transnational linkages due to joint trade. For this, we distinguish between competition in markets and competition in economic sectors. Both competition networks based on the newly calculated indicators are hardly correlated with the simple trade matrix. Besides, another key advantage of our procedure is that unreported values that appear as "0" in the trade matrix have a significantly smaller impact on whether or not two countries A and B are linked or compete with each other. In 2017, there were a total of 6635 "0" entries in the original trade data offered by COMTRADE. This amounts to a share of about 24.7% of the possible dyadic relationships. Yet, our indicators are less affected by such non-reported linkages and our procedure offers a feasible and elegant solution to this issue.

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# Appendix

## A Country Sample

| | iso3-code | country | CoW-code | | iso3-code | country | CoW-code | | iso3-code | country | CoW-code |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AFG | Afghanistan | 700 | 56 | GIN | Guinea | 438 | 111 | NOR | Norway | 385 |
| 2 | AGO | Angola | 540 | 57 | GMB | Gambia | 420 | 112 | NPL | Nepal | 790 |
| 3 | ALB | Albania | 339 | 58 | GNB | Guinea-Bissau | 404 | 113 | NZL | New Zealand | 920 |
| 4 | ARE | United Arab Emirates | 696 | 59 | GNQ | Equa. Guinea | 411 | 114 | OMN | Oman | 698 |
| 5 | ARG | Argentina | 160 | 60 | GRC | Greece | 350 | 115 | PAK | Pakistan | 770 |
| 6 | ARM | Armenia | 371 | 61 | GTM | Guatemala | 90 | 116 | PAN | Panama | 95 |
| 7 | AUS | Australia | 900 | 62 | GUY | Guyana | 110 | 117 | PER | Peru | 135 |
| 8 | AUT | Austria | 305 | 63 | HND | Honduras | 91 | 118 | PHL | Philippines | 840 |
| 9 | AZE | Azerbaijan | 373 | 64 | HRV | Croatia | 344 | 119 | PNG | Pap. New Guinea | 910 |
| 10 | BDI | Burundi | 516 | 65 | HTI | Haiti | 41 | 120 | POL | Poland | 290 |
| 11 | BEL | Belgium | 211 | 66 | HUN | Hungary | 310 | 121 | PRK | North Korea | 731 |
| 12 | BEN | Benin | 434 | 67 | IDN | Indonesia | 850 | 122 | PRT | Portugal | 235 |
| 13 | BFA | Burkina Faso | 439 | 68 | IND | India | 750 | 123 | PRY | Paraguay | 150 |
| 14 | BGD | Bangladesh | 771 | 69 | IRL | Ireland | 205 | 124 | QAT | Qatar | 694 |
| 15 | BGR | Bulgaria | 355 | 70 | IRN | Iran | 630 | 125 | ROU | Romania | 360 |
| 16 | BHR | Bahrain | 692 | 71 | IRQ | Iraq | 645 | 126 | RUS | Russia | 365 |
| 17 | BIH | Bosnia & Herzegovina | NA | 72 | ISR | Israel | 666 | 127 | RWA | Rwanda | 517 |
| 18 | BLR | Belarus | 370 | 73 | ITA | Italy | 325 | 128 | SAU | Saudi Arabia | 670 |
| 19 | BOL | Bolivia | 145 | 74 | JAM | Jamaica | 51 | 129 | SDN | Sudan | 625 |
| 20 | BRA | Brazil | 140 | 75 | JOR | Jordan | 663 | 130 | SEN | Senegal | 433 |
| 21 | BTN | Bhutan | 760 | 76 | JPN | Japan | 740 | 131 | SGP | Singapore | 830 |
| 22 | BWA | Botswana | 571 | 77 | KAZ | Kazakhstan | 705 | 132 | SLB | Solomon Islands | 940 |
| 23 | CAF | Cen. African Republic | 482 | 78 | KEN | Kenya | 501 | 133 | SLE | Sierra Leone | 451 |
| 24 | CAN | Canada | 20 | 79 | KGZ | Kyrgyzstan | 703 | 134 | SLV | El Salvador | 92 |
| 25 | CHE | Switzerland | 225 | 80 | KHM | Cambodia | 811 | 135 | SOM | Somalia | 520 |
| 26 | CHL | Chile | 155 | 81 | KOR | South Korea | 732 | 136 | SRB | Serbia | 345 |
| 27 | CHN | China | 710 | 82 | KWT | Kuwait | 690 | 137 | SSD | South Sudan | 626 |
| 28 | CIV | Ivory Coast | 437 | 83 | LAO | Laos | 812 | 138 | SUR | Suriname | 115 |
| 29 | CMR | Cameroon | 471 | 84 | LBN | Lebanon | 660 | 139 | SVK | Slovakia | 317 |
| 30 | COD | Dem. Rep. Congo | 490 | 85 | LBR | Liberia | 450 | 140 | SVN | Slovenia | 349 |
| 31 | COG | Congo | 484 | 86 | LBY | Libya | 620 | 141 | SWE | Sweden | 380 |
| 32 | COL | Colombia | 100 | 87 | LKA | Sri Lanka | 780 | 142 | SWZ | Swaziland | 572 |
| 33 | COM | Comoros | 581 | 88 | LSO | Lesotho | 570 | 143 | SYR | Syria | 652 |
| 34 | CPV | Cape Verde | 402 | 89 | LTU | Lithuania | 368 | 144 | TCD | Chad | 483 |
| 35 | CRI | Costa Rica | 94 | 90 | LUX | Luxembourg | 212 | 145 | TGO | Togo | 461 |
| 36 | CUB | Cuba | 40 | 91 | LVA | Latvia | 367 | 146 | THA | Thailand | 800 |
| 37 | CYP | Cyprus | 352 | 92 | MAR | Morocco | 600 | 147 | TJK | Tajikistan | 702 |
| 38 | CZE | Czech Republic | 316 | 93 | MDA | Moldova | 359 | 148 | TKM | Turkmenistan | 701 |
| 39 | DEU | Germany | 255 | 94 | MDG | Madagascar | 580 | 149 | TLS | Timor-Leste | NA |
| 40 | DJI | Djibouti | 522 | 95 | MEX | Mexico | 70 | 150 | TTO | Trinidad&Tobago | 52 |
| 41 | DNK | Denmark | 390 | 96 | MKD | No. Macedonia | NA | 151 | TUN | Tunisia | 616 |
| 42 | DOM | Dominican Republic | 42 | 97 | MLI | Mali | 432 | 152 | TUR | Turkey | 640 |
| 43 | DZA | Algeria | 615 | 98 | MMR | Myanmar | 775 | 153 | TZA | Tanzania | 510 |
| 44 | ECU | Ecuador | 130 | 99 | MNE | Montenegro | NA | 154 | UGA | Uganda | 500 |
| 45 | EGY | Egypt | 651 | 100 | MNG | Mongolia | 712 | 155 | UKR | Ukraine | 369 |
| 46 | ESP | Spain | 230 | 101 | MOZ | Mozambique | 541 | 156 | URY | Uruguay | 165 |
| 47 | EST | Estonia | 366 | 102 | MRT | Mauritania | 435 | 157 | USA | United States of America | 2 |
| 48 | ETH | Ethiopia | 530 | 103 | MUS | Mauritius | 590 | | | | |
| 49 | FIN | Finland | 375 | 104 | MWI | Malawi | 553 | 158 | UZB | Uzbekistan | 704 |
| 50 | FJI | Fiji | 950 | 105 | MYS | Malaysia | 820 | 159 | VEN | Venezuela | 101 |
| 51 | FRA | France | 220 | 106 | NAM | Namibia | 565 | 160 | VNM | Vietnam | 816 |
| 52 | GAB | Gabon | 481 | 107 | NER | Niger | 436 | 161 | YEM | Yemen | 679 |
| 53 | GBR | United Kingdom | 200 | 108 | NGA | Nigeria | 475 | 162 | ZAF | South Africa | 560 |
| 54 | GEO | Georgia | 372 | 109 | NIC | Nicaragua | 93 | 163 | ZMB | Zambia | 551 |
| 55 | GHA | Ghana | 452 | 110 | NLD | Netherlands | 210 | 164 | ZWE | Zimbabwe | 552 |

## B Comtrade 1-digit SITC

| Commodity Code | Commodity Label |
|---|---|
| 0 | Food and live animals |
| 1 | Beverages and tobacco |
| 2 | Crude materials, inedible, except fuels |
| 3 | Mineral fuels, lubricants and related materials |
| 4 | Animal and vegetable oils and fats |
| 5 | Chemicals |
| 6 | Manufact goods classified chiefly by material |
| 7 | Machinery and transport equipment |
| 8 | Miscellaneous manufactured articles |
| 9 | Commod. & transacts. Not class. Accord. To kind |

# C Python Script „comp_exportmarkets"

```
import numpy as np
from scipy import spatial
import pandas as pd

country_list = []

country_to_id = {}
id_to_country = {}

country_matrices_input = {}

# load country information
for i, l in enumerate( open("../data/countries/country_sample_ivo.csv").readlines()[1:] ):
    country_id = l.split(";")[0]

    country_to_id[ country_id ] = i
    id_to_country[ i ] = country_id

# load country trade data
for line in open("../data/comtrade_dyadic_total_exports_sum_20200709_FaB.csv").readlines()[1:]:
    country_a, country_b, year, _, value = line.strip().replace('"',"").split(",")

    year = int(year)

    if not ( country_a in country_to_id ):
        continue
    if not ( country_b in country_to_id ):
        continue

    country_a_number = country_to_id[ country_a ]
    country_b_number = country_to_id[ country_b ]

    if not (year in country_matrices_input ):
        country_matrices_input[ year ] = np.zeros( (164, 164) )

    country_matrices_input[ year ][ country_a_number ][ country_b_number ] = value

# impute zeros
for year,matrix_per_year in country_matrices_input.items():

    if year != 2017:
        continue

    gesamthandel = float( np.sum( matrix_per_year ) )

    matrix_per_year_original = np.array( matrix_per_year, copy=True )

    for x in range(164):
        for y in range(164):
            matrix_per_year[x][y] = np.log( matrix_per_year[x][y] )

country_matrices_output = {}
for year,matrix_per_year in country_matrices_input.items():
    country_matrices_output[ year ] = np.zeros( (164, 164) )

# compute values
for year,matrix_per_year in country_matrices_input.items():
    if year != 2017:
        continue

    for x in range(164):
        for y in range(164):
            x_as_vector = matrix_per_year[x][:]
            y_as_vector = matrix_per_year[y][:]

            relevant_dimensions = []

            for i in range(164):
                if i == x:
                    continue
                if i == y:
                    continue

                if x_as_vector[i] > -np.inf and y_as_vector[i] > -np.inf:
```

```
                    relevant_dimensions.append( i )

            relevant_x_as_vector = x_as_vector[ relevant_dimensions ]
            relevant_y_as_vector = y_as_vector[ relevant_dimensions ]

                  distance_between_countries = spatial.distance.euclidean( relevant_x_as_vector,
relevant_y_as_vector )
            distance_between_countries /= float( len( relevant_dimensions ) )

            country_matrices_output[ year ][ x ][ y ] = distance_between_countries

    column_names = []
    for c in range(164):
        column_names.append( id_to_country[ c ] )

    country_matrices_output[ year ] = country_matrices_output[ year ] / np.max( country_matrices_
output[ year ] )
    country_matrices_output[ year ] = np.subtract( 1.0, country_matrices_output[ year ] )

     df = pd.DataFrame(data=country_matrices_output[ year ], index=column_names, columns=column_
names)

   #np.savetxt( "output/export_" + str(year) + '.csv', country_matrices_output[year], delimiter=',',
fmt='%f')
    df.to_csv( "output/export_" + str(year) + '.csv' )
```

# D Python Script „comp_sector“

```
import numpy as np
from scipy import spatial
import pandas as pd

country_list = []

country_to_id = {}
id_to_country = {}

country_matrices_input = {}
country_matrices_output = {}

# load country information
for i, l in enumerate( open("../data/countries/country_sample_ivo.csv").readlines()[1:] ):
    country_id = l.split(";")[0]

    country_to_id[ country_id ] = i
    id_to_country[ i ] = country_id

# load country trade data
for line in open("../data/comtrade_commodity_exports_sum_20200709_FaB.csv").readlines()[1:]:
    line_parts = line.strip().replace('"',"").split(",")

    year = int(line_parts[1])

    country_a = line_parts[0]

    if not ( country_a in country_to_id ):
        continue

    trade_data = line_parts[2:]

    country_a_number = country_to_id[ country_a ]

    if not (year in country_matrices_input ):
        country_matrices_input[ year ] = np.zeros( (164, 10) )

    country_matrices_input[ year ][ country_a_number ] = trade_data

# impute zeros
for year,matrix_per_year in country_matrices_input.items():

    if year != 2017:
        continue

    gesamthandel = float( np.sum( matrix_per_year ) )

    matrix_per_year_original = np.array( matrix_per_year, copy=True )

    for x in range(164):
        for y in range(10):
            matrix_per_year[x][y] = np.log( matrix_per_year[x][y] )

country_matrices_output = {}
for year,matrix_per_year in country_matrices_input.items():
    country_matrices_output[ year ] = np.zeros( (164, 164) )

# compute values
for year,matrix_per_year in country_matrices_input.items():
    if year != 2017:
        continue

    for x in range(164):
        for y in range(164):
            x_as_vector = matrix_per_year[x][:]
            y_as_vector = matrix_per_year[y][:]

            relevant_dimensions = []

            for i in range(10):
                if x_as_vector[i] > -np.inf and y_as_vector[i] > -np.inf:
                    relevant_dimensions.append( i )
                else:
                    print( i )
```

```
            relevant_x_as_vector = x_as_vector[ relevant_dimensions ]
            relevant_y_as_vector = y_as_vector[ relevant_dimensions ]

             #country_matrices_output[ year ][ x ][ y ] = spatial.distance.euclidean( matrix_per_
year[x][:] , matrix_per_year[y][:])

                  distance_between_countries = spatial.distance.euclidean( relevant_x_as_vector,
relevant_y_as_vector )
            distance_between_countries /= float( len( relevant_dimensions ) )

            country_matrices_output[ year ][ x ][ y ] = distance_between_countries

    column_names = []
    for c in range(164):
        column_names.append( id_to_country[ c ] )

    country_matrices_output[ year ] = country_matrices_output[ year ] / np.max( country_matrices_
output[ year ] )

    country_matrices_output[ year ] = np.subtract( 1.0, country_matrices_output[ year ] )

     df = pd.DataFrame(data=country_matrices_output[ year ], index=column_names, columns=column_
names)

   #np.savetxt( "output/export_" + str(year) + '.csv', country_matrices_output[year], delimiter=',',
fmt='%f')
    df.to_csv( "output/trade_" + str(year) + '.csv' )
```