Cyber-MAR Vessel Pilot

Impact on the Port and Wider EU Region

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Cyber-MAR Cyber-MAR Range

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Impact on Port Operations (Port Throughput)

Quantify the economic impact of cyber attacks (focus on port disruption)

Broad Aim of Portion of Work:

- Estimating the relative impact cyber attack has on port operations.
- For the cyber scenarios of concern, estimating the consequential level of port disruption (and/or vessel operations) that would stem from that.
- Provide delay information that would be used to inform risk modelling and econometric modelling.

Key Input Sources:

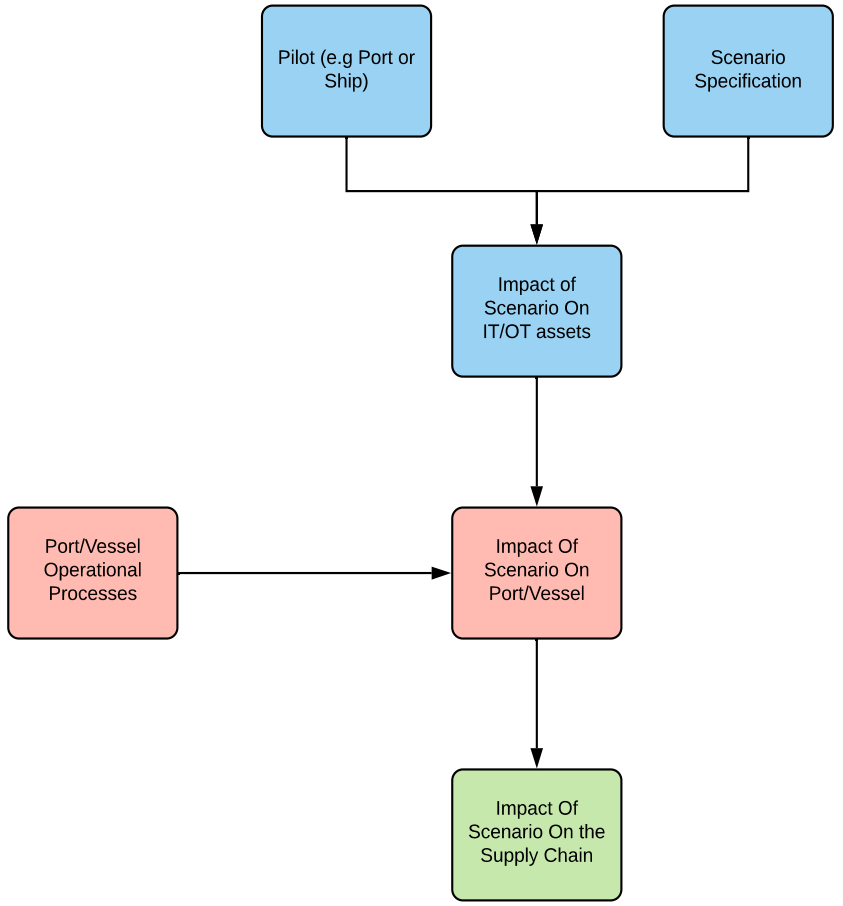
- Port Operational Information and IT/OT asset information
- Port Traffic Information/Statistics
- Cyber Scenario(s) under consideration (which IT/OT assets are made unavailable by the cyber scenario)

Impact on Port Operations (Port Throughput)

In order estimate the level of disruption a certain scenario could have on a maritime port, we can use a combination of expert assessment, historic information (if available) and simulations of port operations.

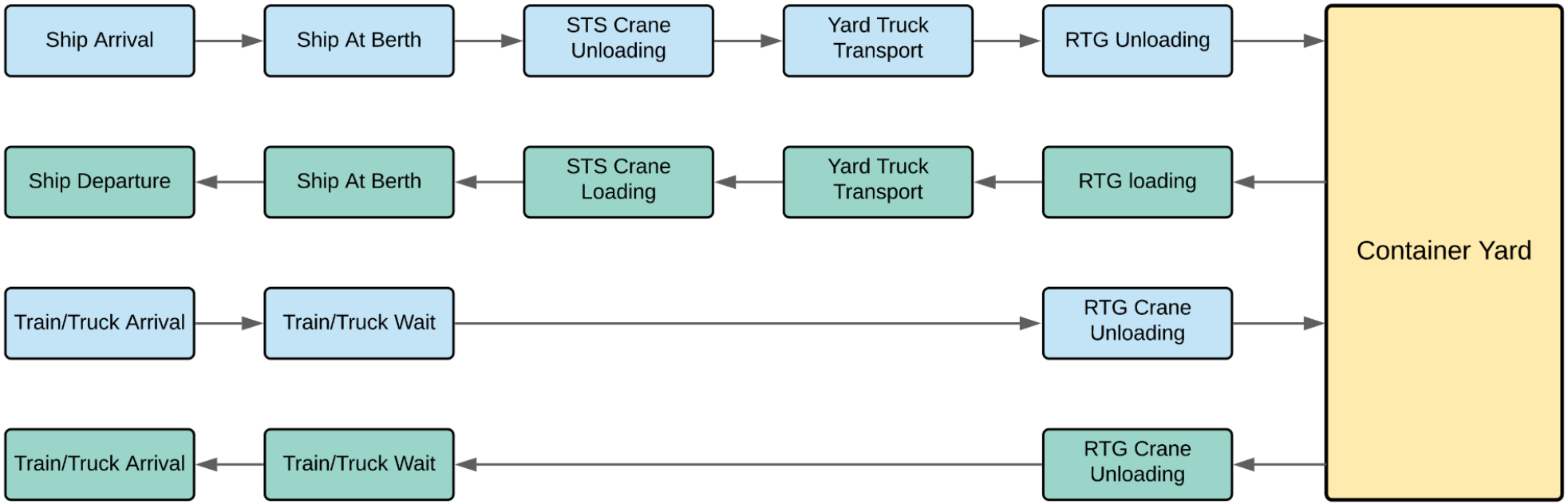
Given a given scenario, expert assessment is used to make informed decisions on the IT/OT assets that would become unavailable (or rendered unusable) should a certain cyber attack be successfully launched on a port or vessel.

Discrete event simulations of port operations then allows the information on the availability of IT/OT assets and the estimated duration the IT/OT assets would be unavailable to be used to estimate the disruption to port operations.



D4.2 - Red
D4.4, D4.5 - Green
Other - Blue

Port Operations (Port Throughput)



Overview of key high level physical port operations

Port Operations (Port Throughput)

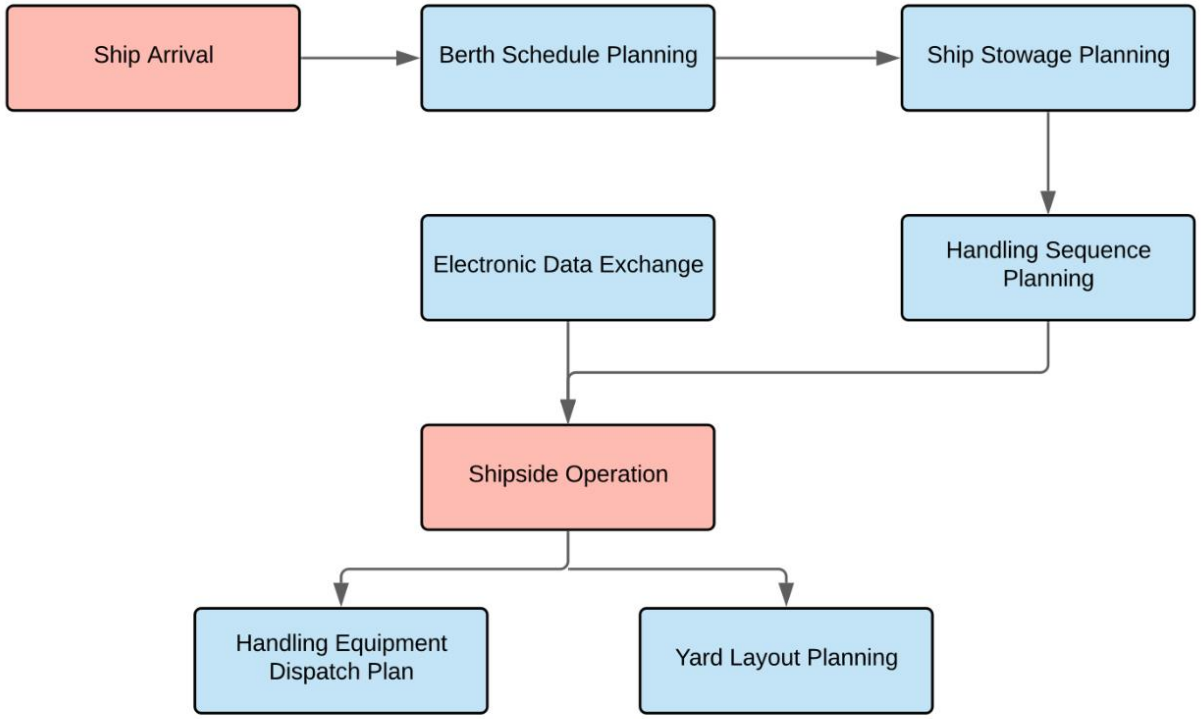


Fig. 2: Maritime Port Container Handling Support Processes

Support processes that rely on IT and OT in port

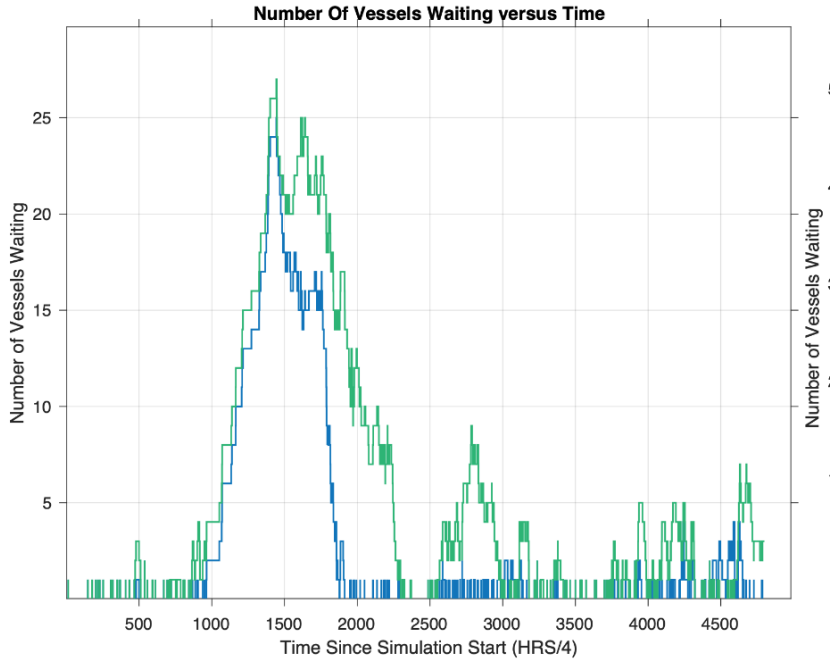
Impact on Port Operations - Normal vs impacted

Key Indicators we will look at to gauge the impact the disruption will have the port are:

- Number of Vessels Waiting to Berth (compare normal with disrupted)
- Ship Turnaround Time (compare normal with disrupted)
- Port Delays (Difference between normal ship turnaround times and the ship turnaround times experienced during periods of delays)

Impact on Port Operations - Normal vs impacted

Vessel Queue Length:

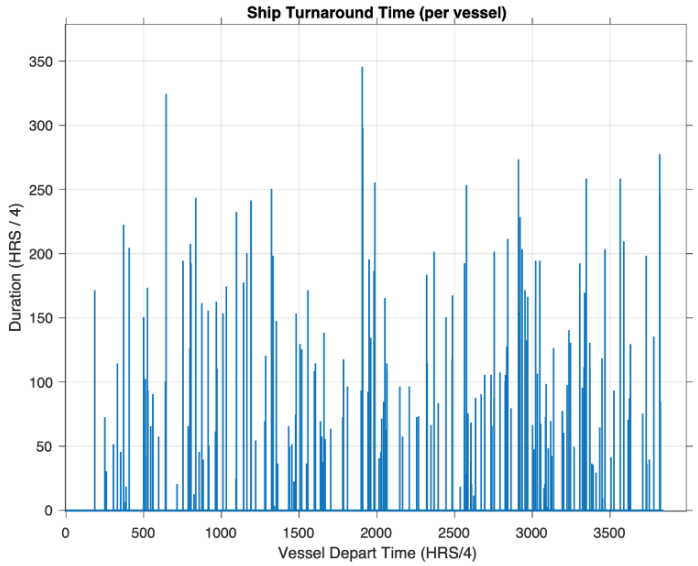


(a) Five days of disruption

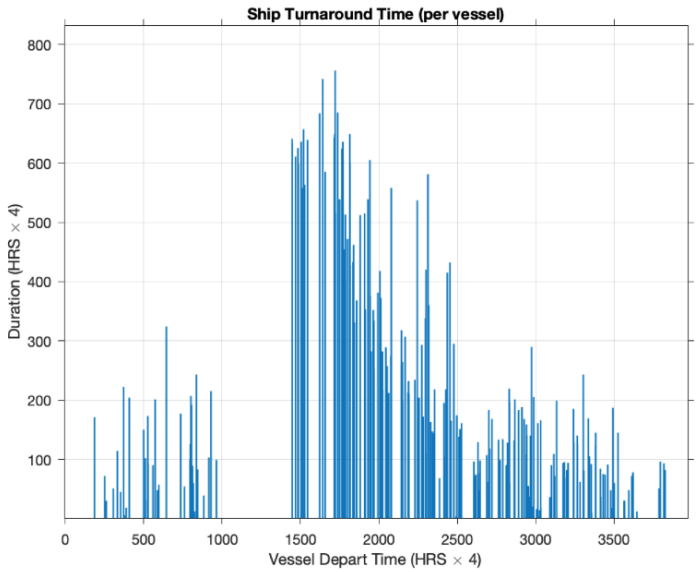
Results from the analysis shows that in the normal case, we expect the number of vessels waiting to enter the port to substantially rise in the case of this considerable disruption. In the central estimate case we would expect the number of vessels in queue to increase by around 25. The analysis shows that it would also take a considerable time to work through this backlog as it is generally not possible to dynamically increase the capacity of a maritime port quickly.

Impact on Port Operations - Normal vs impacted

Ship Turnaround Times:



(a) Service Duration vs Vessel Depart Time



(b) Berth Occupancy = 92%

Similarly ship turnaround times are greatly affected with ship turnaround times rising by up to a factor of 7. After blockage has been resolved, it will take another couple of days for the ship turnaround time to fallback to it's normal range.

Impact on Port Operations – Recovery Time

Days Of Disruption	Description	Number Of Delayed Vessels*	Average Delay	S.D. Delay
3	Low Estimate	43	1.5	0.4
5	Mid Estimate	68	2.4	0.9
7	High Estimate	86	3.5	1.3

Vessels delayed by at least 1 day (Berth Occupancy = 92%)

Days Of Disruption	Description	Number Of Delayed Vessels*	Average Delay	S.D. Delay
3	Low Estimate	90	1.1	1.1
5	Mid Estimate	99	1.9	1.1
7	High Estimate	109	2.9	1.6

Vessels delayed by at least 0.5 day (Berth Occupancy = 92%)

Impact on Port Operations – What it means for Port / Beyond

Due to the fact that one the key tasks of a maritime port is to facilitate the transport of cargo by facilitating the unloading/loading, intra-port transport and storage of that cargo, a key point of concern is how these operations are affecting and how that would in turn affect the ship turn-around time. If ships are delayed (due to the rising ship turn around times or ships not being serviced), then those delays could have wide ranging consequences on both the port itself, and if the disruption is severe enough, possibly also the supply chain.

Impact on the Port and Wider EU Region

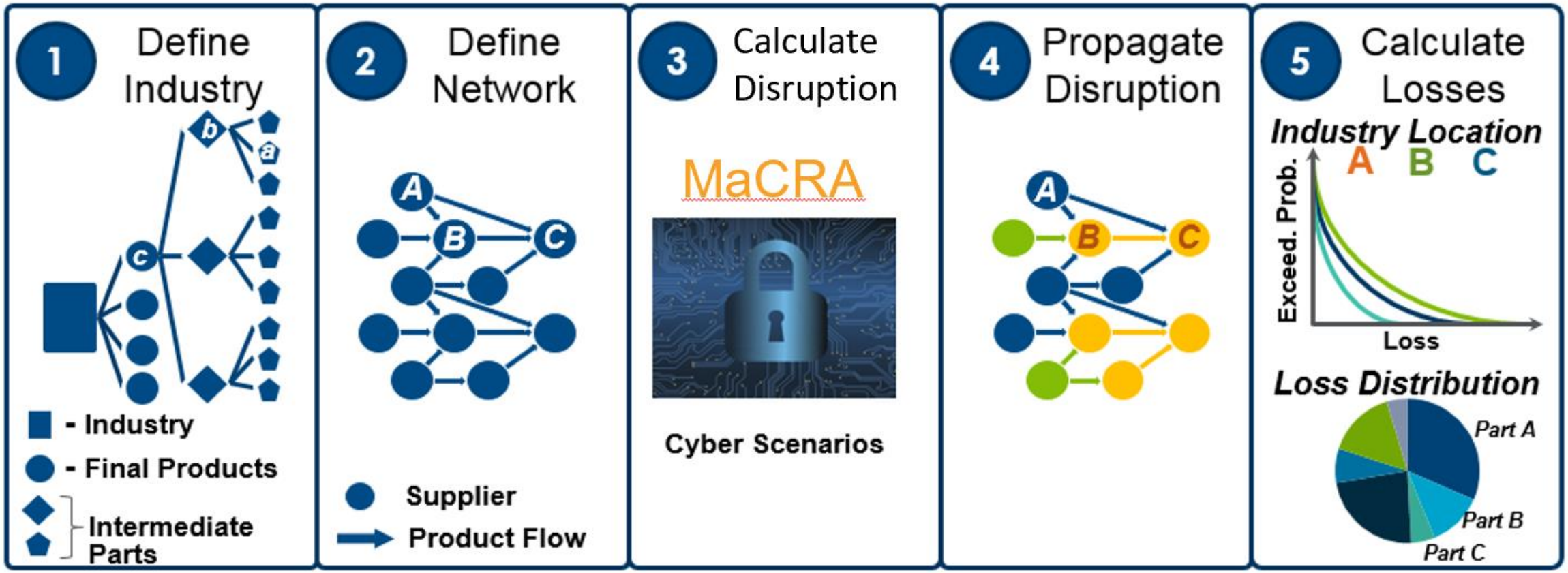
- Wider Econometric Impacts
  - Demonstrate the econometric model
  - Talk through the econometric impact on port and area

Illustrate impact on port throughput

Luis Sousa, AIR

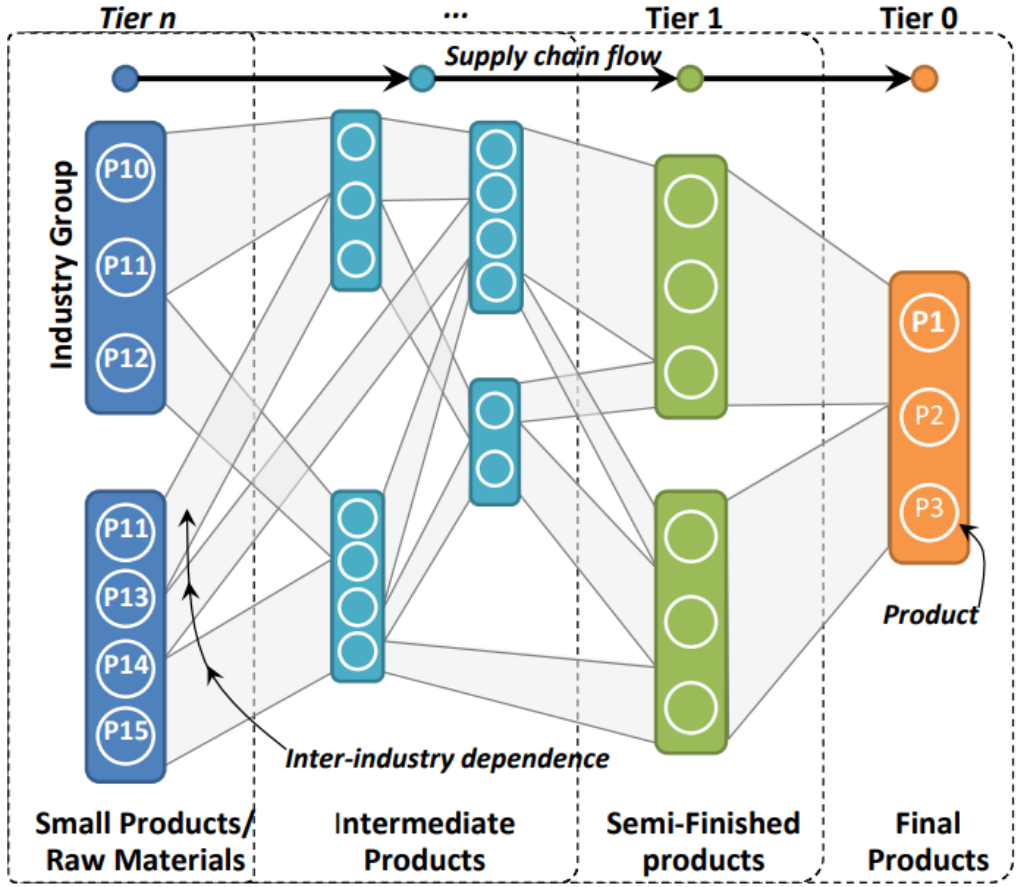
Econometric Modelling Framework

Econometric Model (EM) framework is based on 5 key Modules

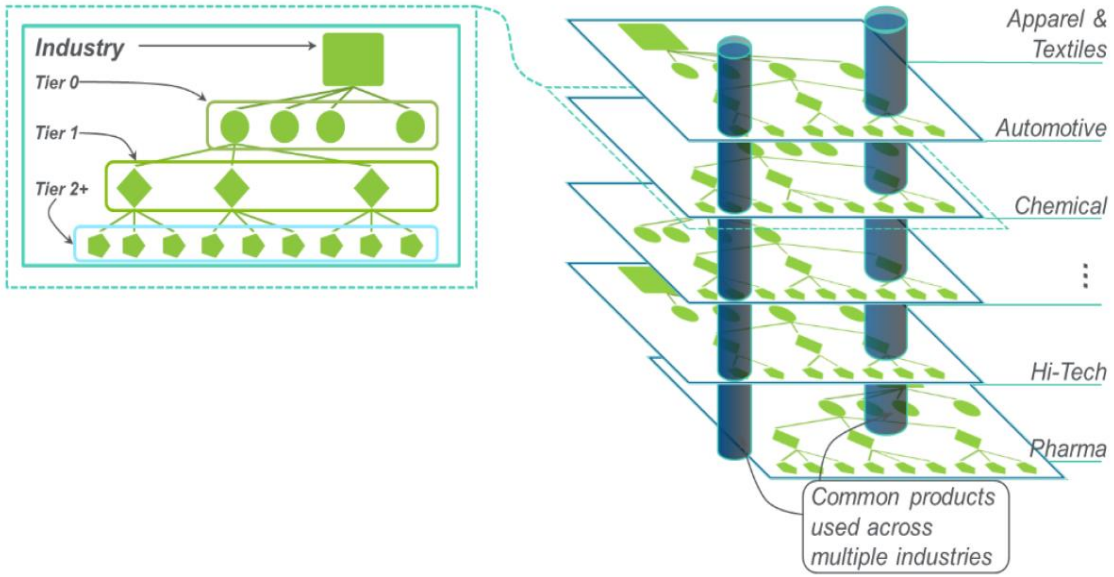


Econometric Modelling Framework

1. Industries and Product Dependency



- Enumerating and interlinking the physical parts (e.g. basic and intermediary products) that are required to construct a final product by a given industry
- Establishing correlations of products across industries



Econometric Modelling Framework

1. Industries and Product Dependency

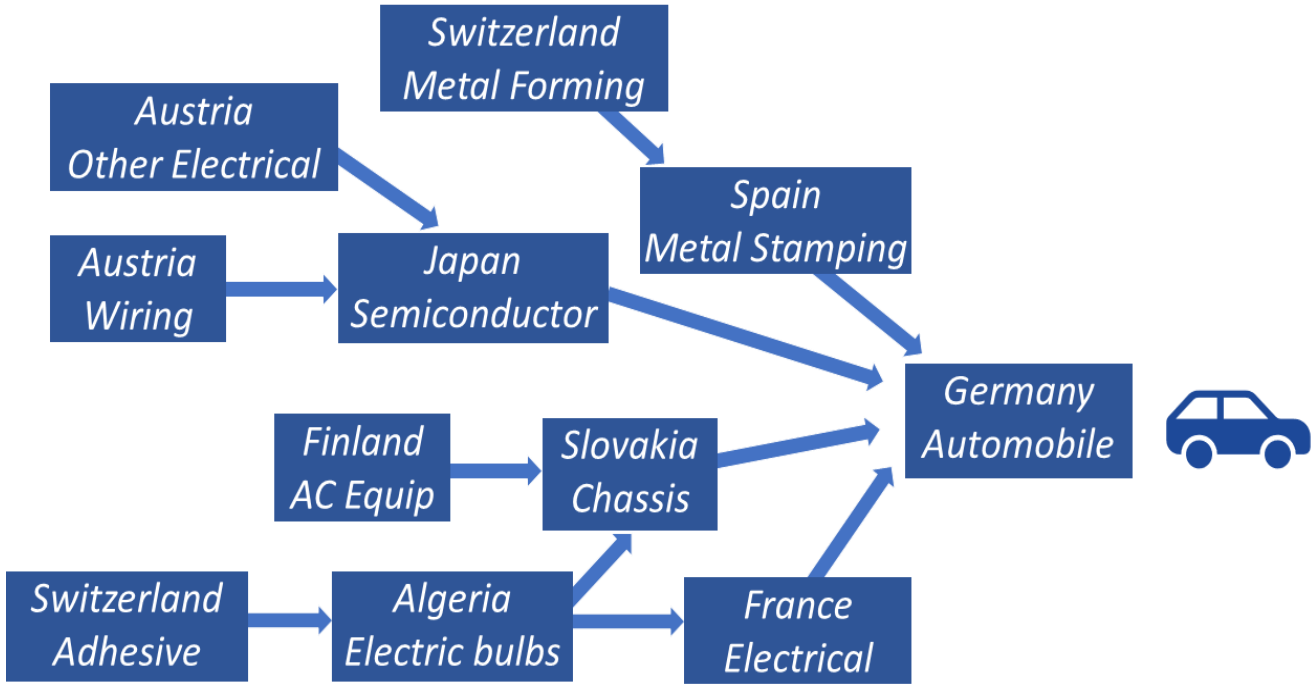
NACE Taxonomy class	Description
1	Crop and animal production hunting and related service activities
2	Forestry and logging
3	Fishing and aquaculture
5	Mining of coal and lignite
6	Extraction of crude petroleum and natural gas
7	Mining of metal ores
8	Other mining and quarrying
9	Mining support service activities
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork except furniture; manufacture of articles of straw and plaiting materials

NACE Taxonomy class	Description
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers, and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing

Econometric Modelling Framework

2. Supply Chain Network Definition

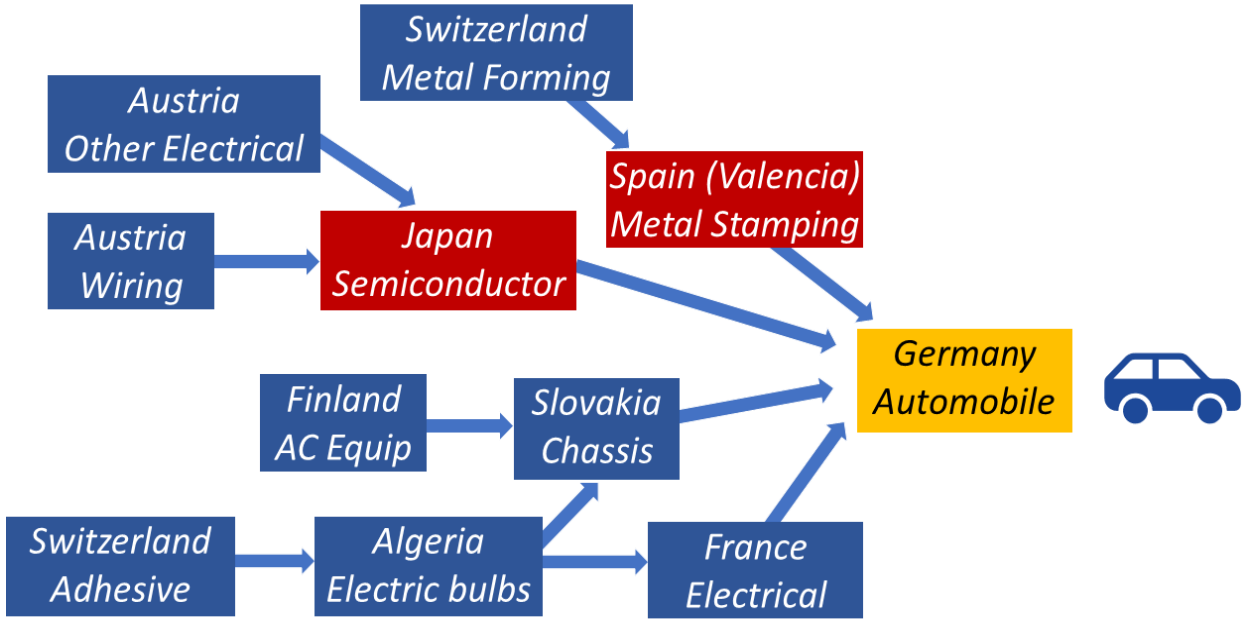
- Combines product dependency models with global trade data to map out global supply chains



Econometric Modelling Framework

4. Disruption Propagation

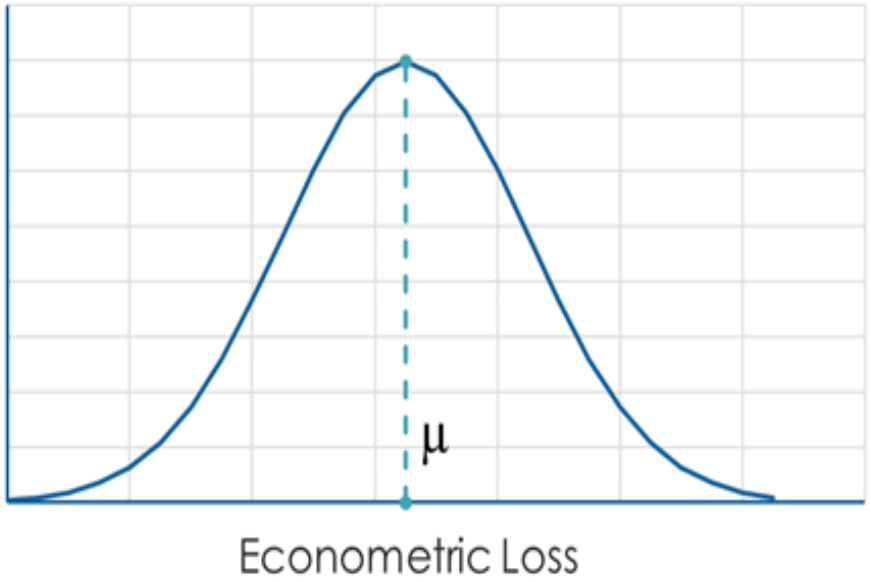
- Once the initial port disruption and its uncertainty are known for each attack scenario (as determined by the MaCRA model) the disruption is propagated through the affected nodes in the network



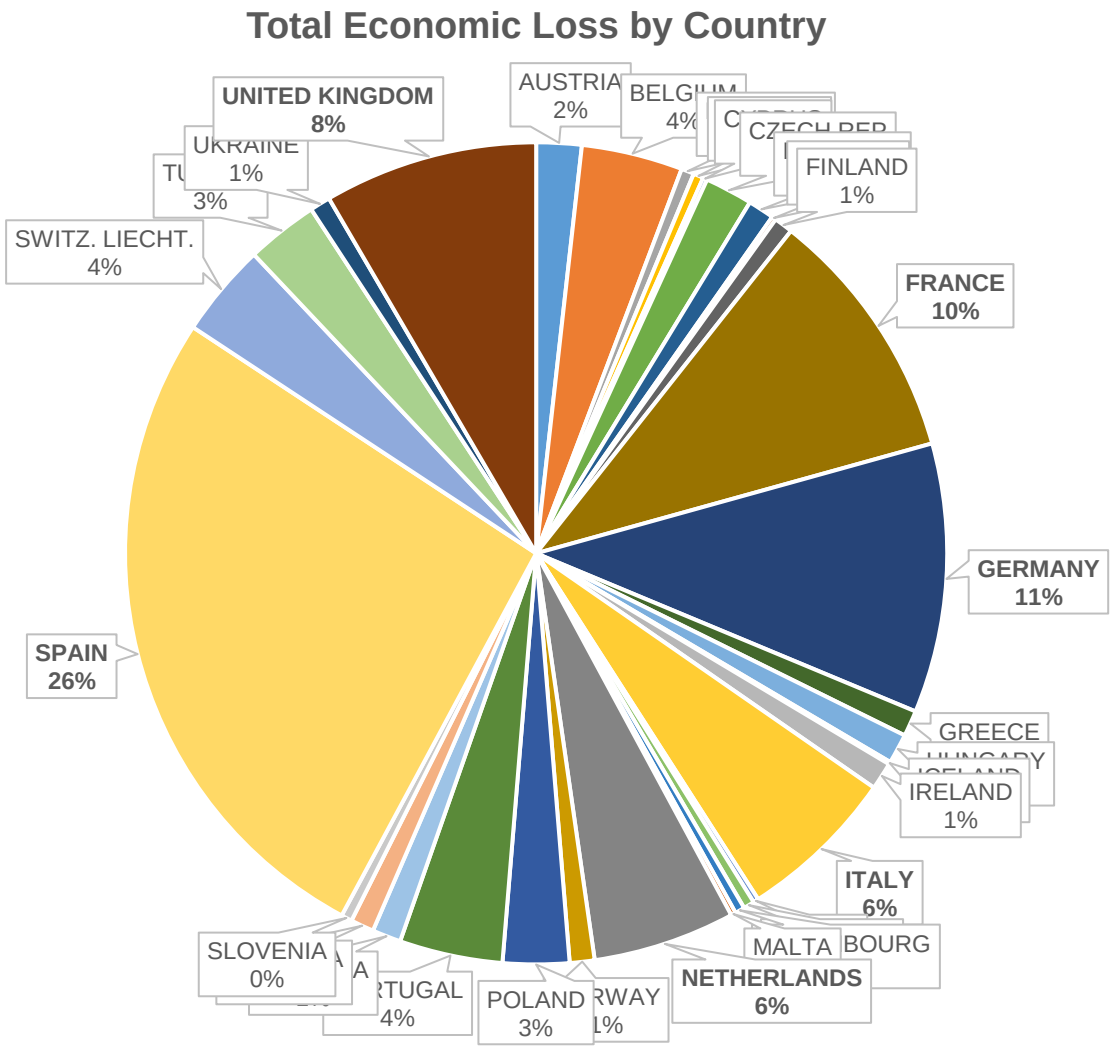
Econometric Modelling Framework

4. Economic Loss Calculation

- Economic losses are determined as a function of the downtime (in days) and daily revenue for the product group / country of interest
- E.g. The total loss in revenue for the automotive industry in Germany as a result of the initial disruption in Port X is Y.



Economic Impact on EU Region

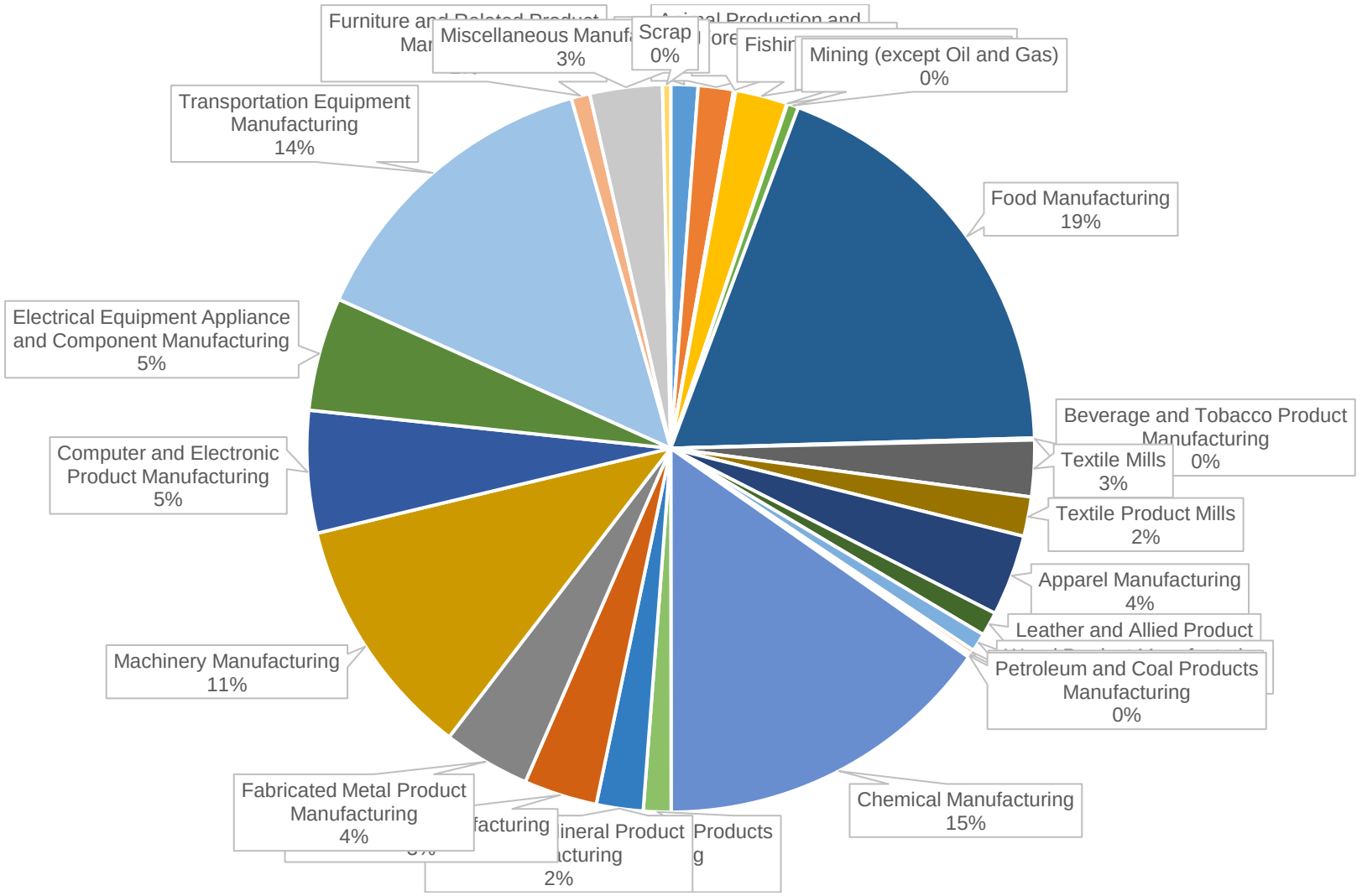


Losses (EUR M)	Initial Port Disruption		
	3 days	5 days	7 days
France	950	1,600	2,200
Germany	1,000	1,700	2,400
Italy	600	1,000	1,400
Netherlands	550	900	1,300
Spain	2,500	4,200	5,900
UK	800	1,300	1,900

Economic Impact on EU Region

Economic Loss by Industry

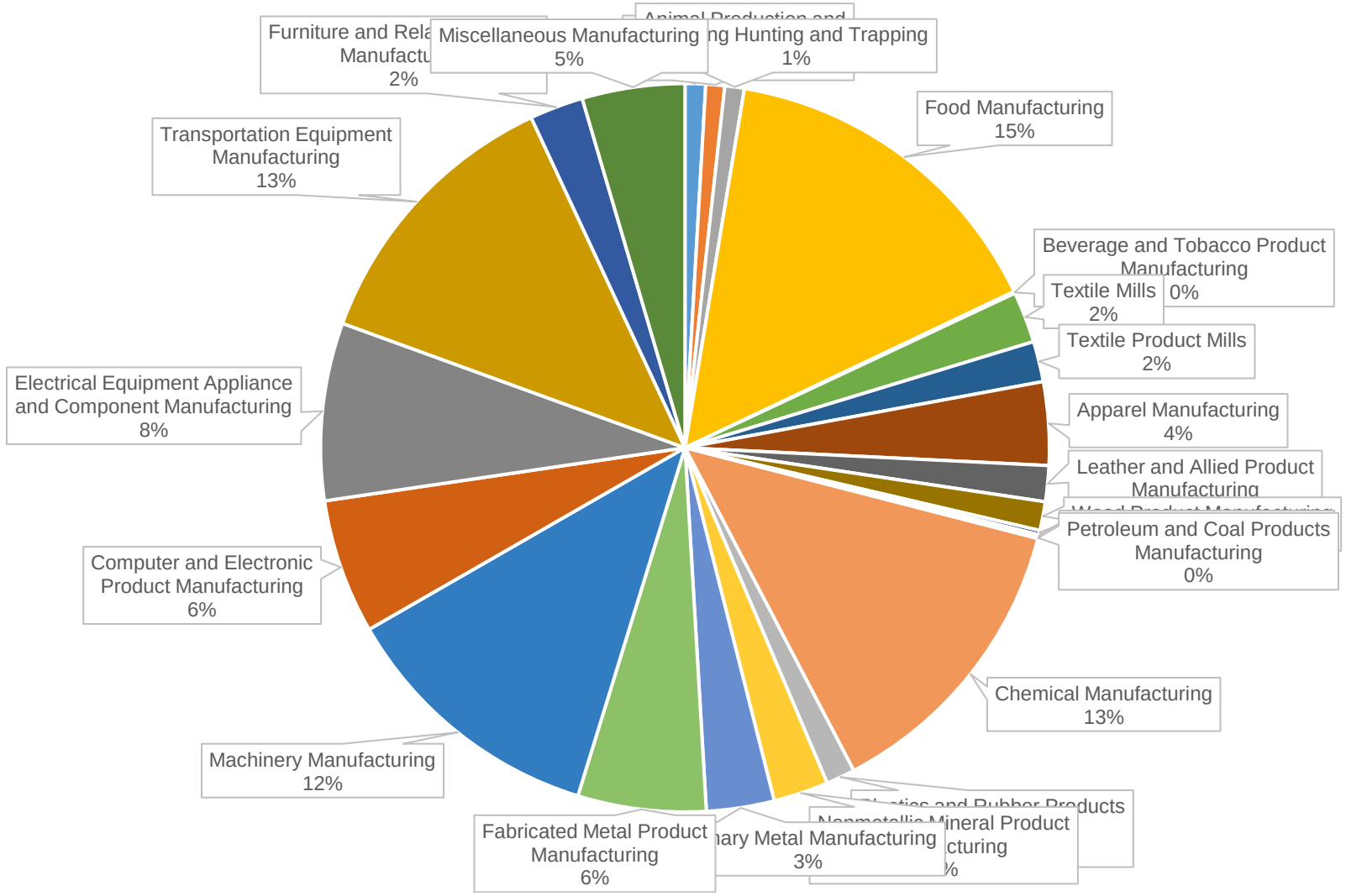
- Spain



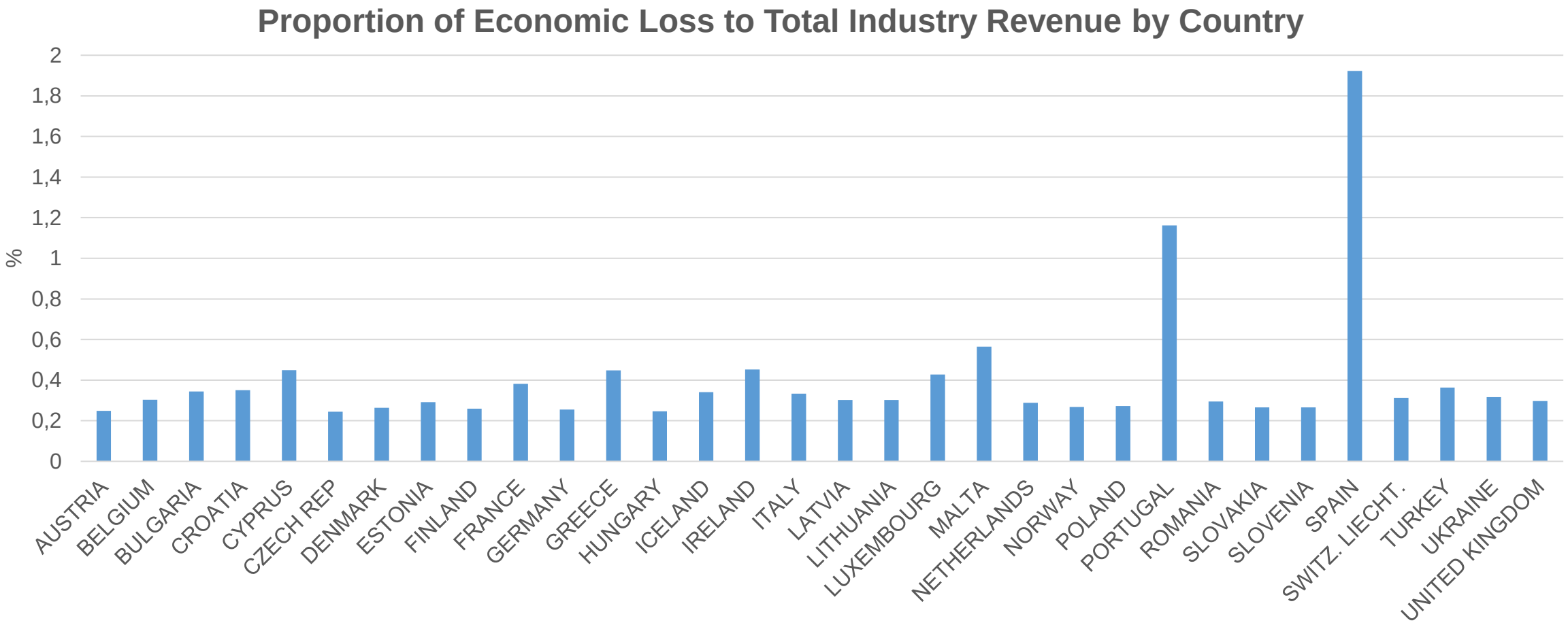
Economic Impact on EU Region

Economic Loss by Industry

- Germany



Economic Impact on EU Region



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