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Where are those robots? Towards Europe's Robot Geography

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Dominant narrative of robotisation

- Takes as face value what technologically is possible
- Focuses on quantitative side of employment effects
- Compares the skill needs of current jobs with the (future) skills of robots
- Assessments based on aggregated figures

Estimates with high degree of uncertainty

(replacement of humans' by robots for 14-50% of jobs, transformation of 25-60% of jobs)

Current deployment of industrial robots

- Economic growth (+1 robot/1,000 workers = 0.5% growth of GDP per person employed(Dauth et al., 2017)
- Productivity gains (annually by 0.36% (Graetz and Michaels, 2018)
- Influenced by developmental stage, position in international division of labour, wage and employment structures, sectoral composition of economies.

Where are those robots?

Which countries have access to economic benefits?

What drives or hinders robotisation?

Robotisation divides

Narrow definition: fault lines between countries and regions that have high industrial robot penetration and those that have low adoption rate by putting these differences in economic, industrial and geographic context

- Driven by **price/wages competition** between robots and humans
- Influenced by **employment structure**
- Across **sectoral structure** (specialisation vs. diversification)

Data and methodology

- **International Federation of Robotics** (IFR) data for robot stock (by country, year, industries), and **EU KLEMS** data for employment
- The "**unspecified**" category is treated as robots that are not belonging to manufacturing or automotive industries (86% and 44% of robots are deployed in manufacturing and automotive industries).
- Because of different denominator (persons employed) robot density values in this study differ from IFR measures, though the **orders of magnitude** are similar.

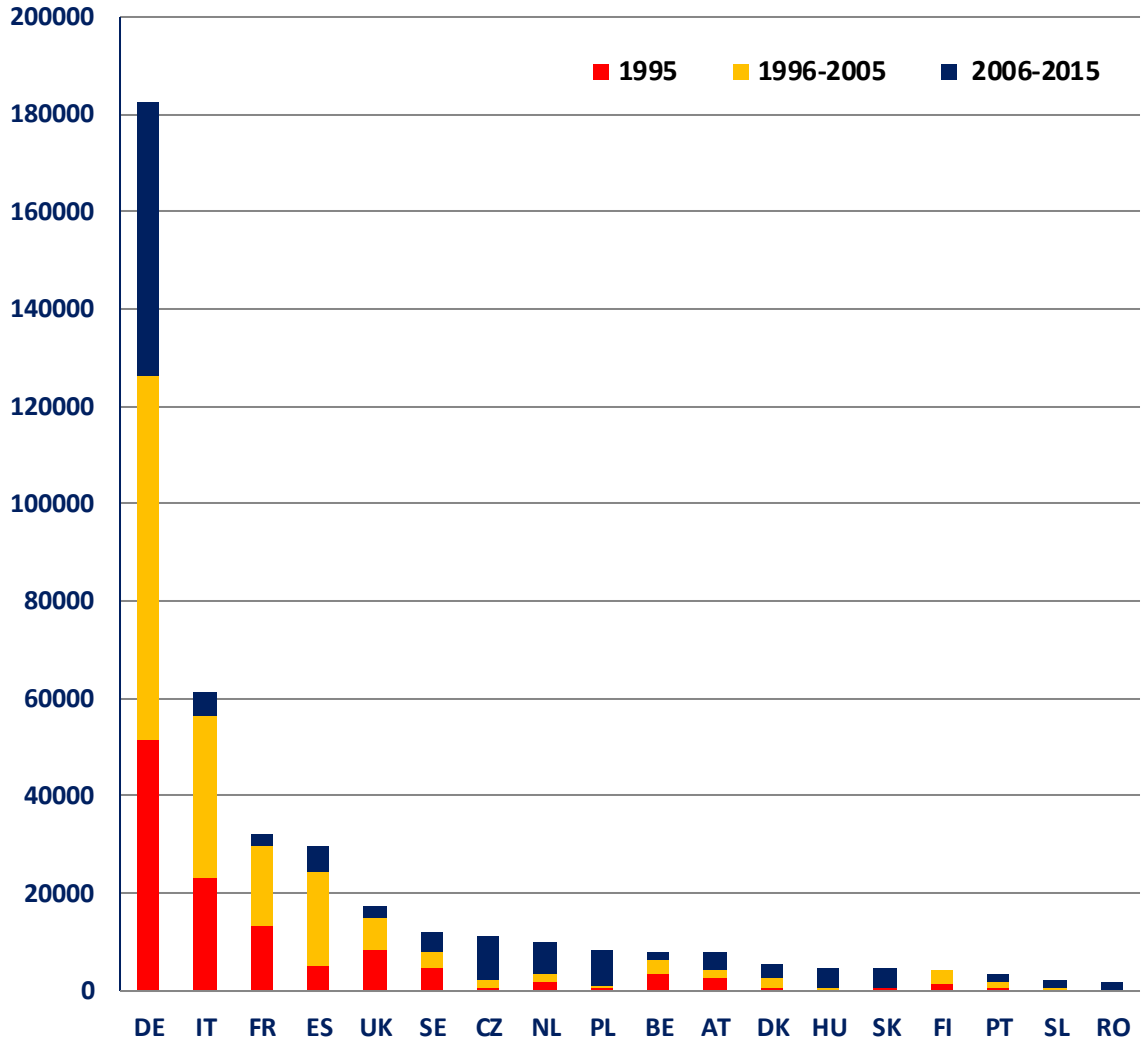
Robot density and robot deployment index values should be interpreted primarily by looking at the orders of magnitude!

Diffusion waves of robots in Europe (1995-2015)

- **1996-2005:** catching up of large economies with Germany
- **2006-2015**: entering a new group of countries (Central and Eastern Europe)

The time-space adoption pattern of robots follows the model of expansion diffusion

Figure 1. **Timer-space diffusion waves in the adoption of industrial robots in Europe, 1995-2015**
(number of industrial robots installed)



Source: author's calculation based on data of International Federation of Robotics

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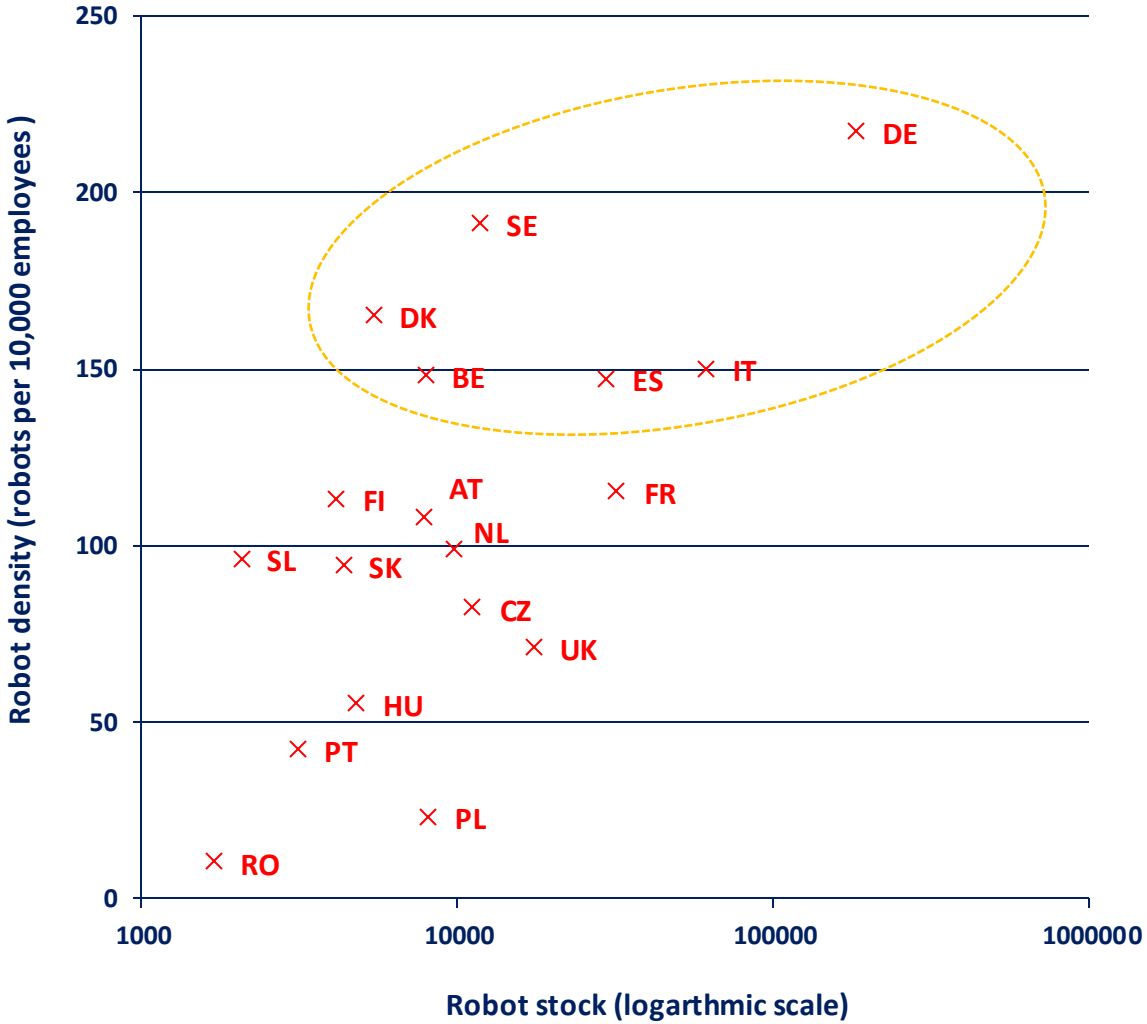
Territorial distribution of robots in Europe

- **Germany**: 183,000 robots (45%)
- **Large economies** (IT, FR, ES): 123,000 (30%)
- **Other old member states** (AT, BE, DK, FI, NL, UK, SE, PT): 68,000 (17%)
- **Central and Eastern Europe** (CZ, HU, PL, SK, SL, RO): 32,000 (8%)

Concentration in large economies with high robot density

Figure 2. **Robot stock and robot density in Europe, selected countries, 2015** (robot density: number of industrial robots per 10,000 employees in manufacturing)



Source: author's calculation based on data of International Federation of Robotics and EU KLEMS

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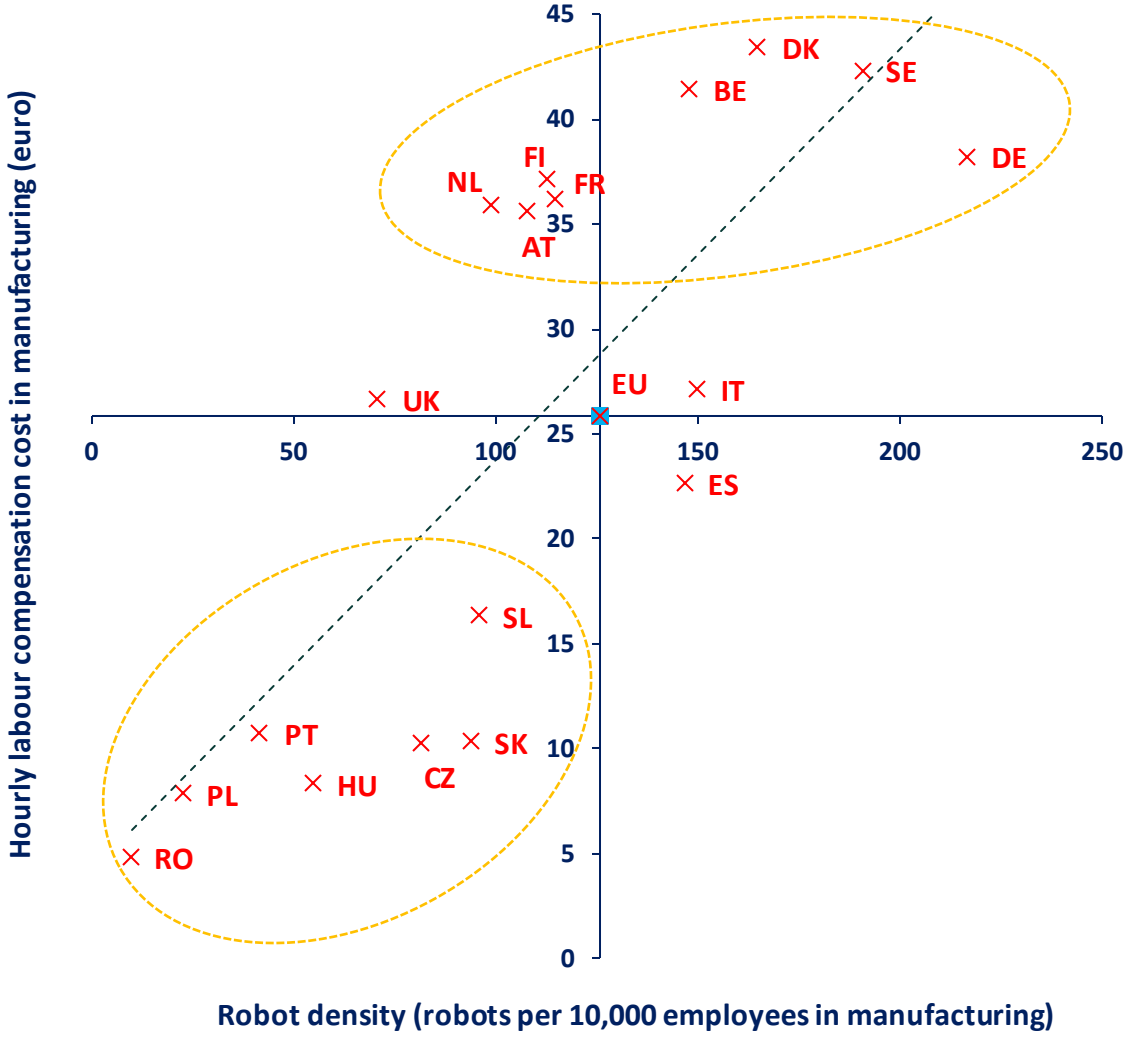
Robotisation divide driven by price/wage competition

- A production factor with falling prices (robots) substitutes other factors with high prices (human labour)
- **Robots' payback period** (time of return in investments in robots) is shorter in high wages than in low wages countries

High wages are coupled with high robot densities, low wages are associated with low densities

WEST – EAST DIVIDE

Figure 3. **Robot densities and labour compensation costs in Europe, selected countries, 2015**



Source: author's calculation based on data of International Federation of Robotics, EU KLEMS, and EUROSTAT (2019) Labour cost levels by NACE Rev. 2 activity, [lc_lci_lev], last update: 13-05-2019.

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Robotisation divide influenced by employment structure

- When availability of a certain production factor becomes difficult, it will be substituted by other factors
- Shrinking availability of a labour force in manufacturing vs. large labour pool

Shrinking labour force available boosts, while abundance of labour pool hinders robot deployment

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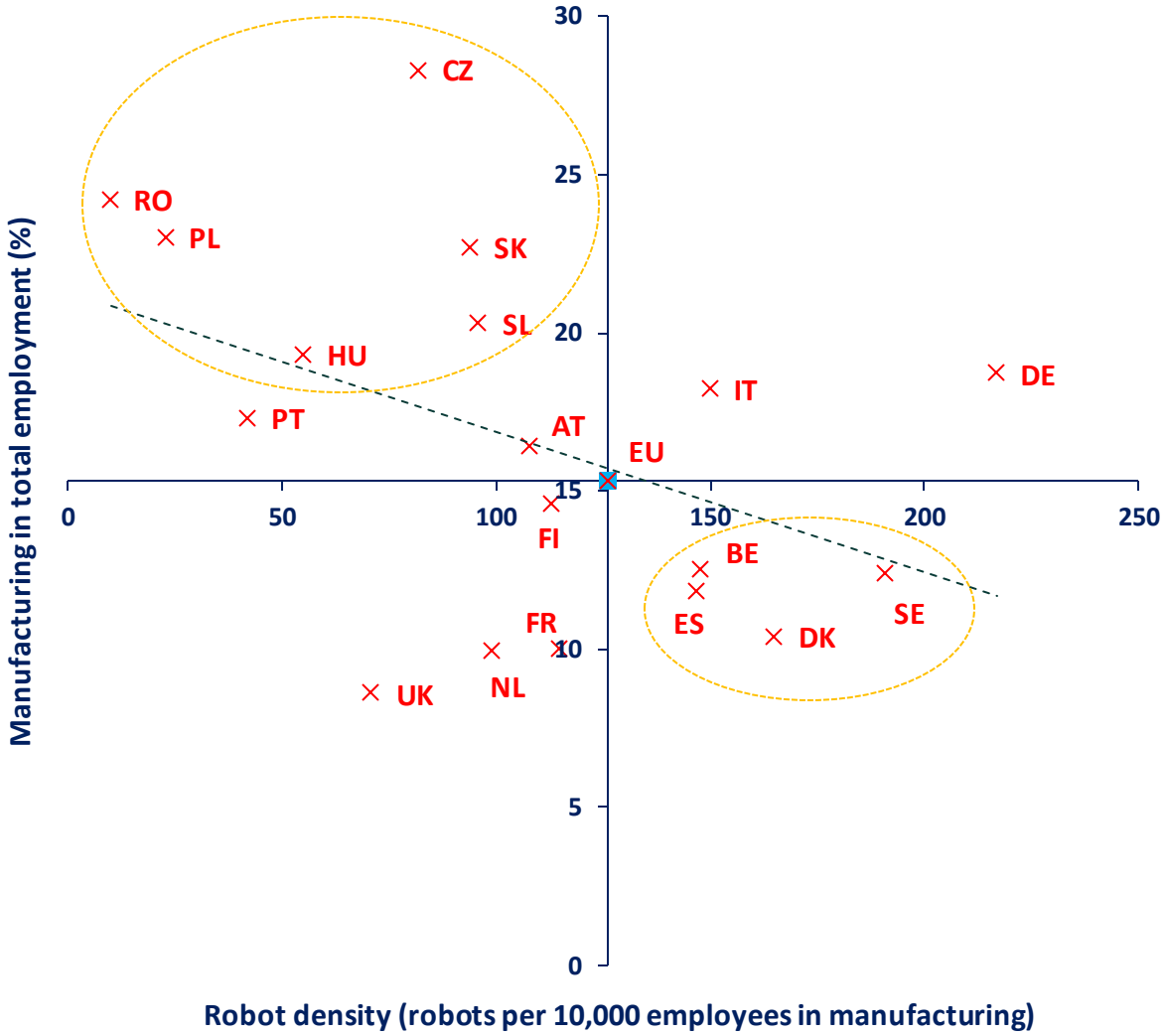
Figure 4. **Robot densities in manufacturing and manufacturing in total employment in Europe, selected countries, 2015**



Source: author's calculation based on data of International Federation of Robotics and EU KLEMS

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Who lead the race for automated production?

- **Robot density** takes into account the different size of manufacturing sector, but neglects the role of manufacturing in total employment.
- **Robot Deployment Index (RDI)**: robot density of a given country to robot density in Europe divided by manufacturing in total employment of a given country to manufacturing employment in Europe.

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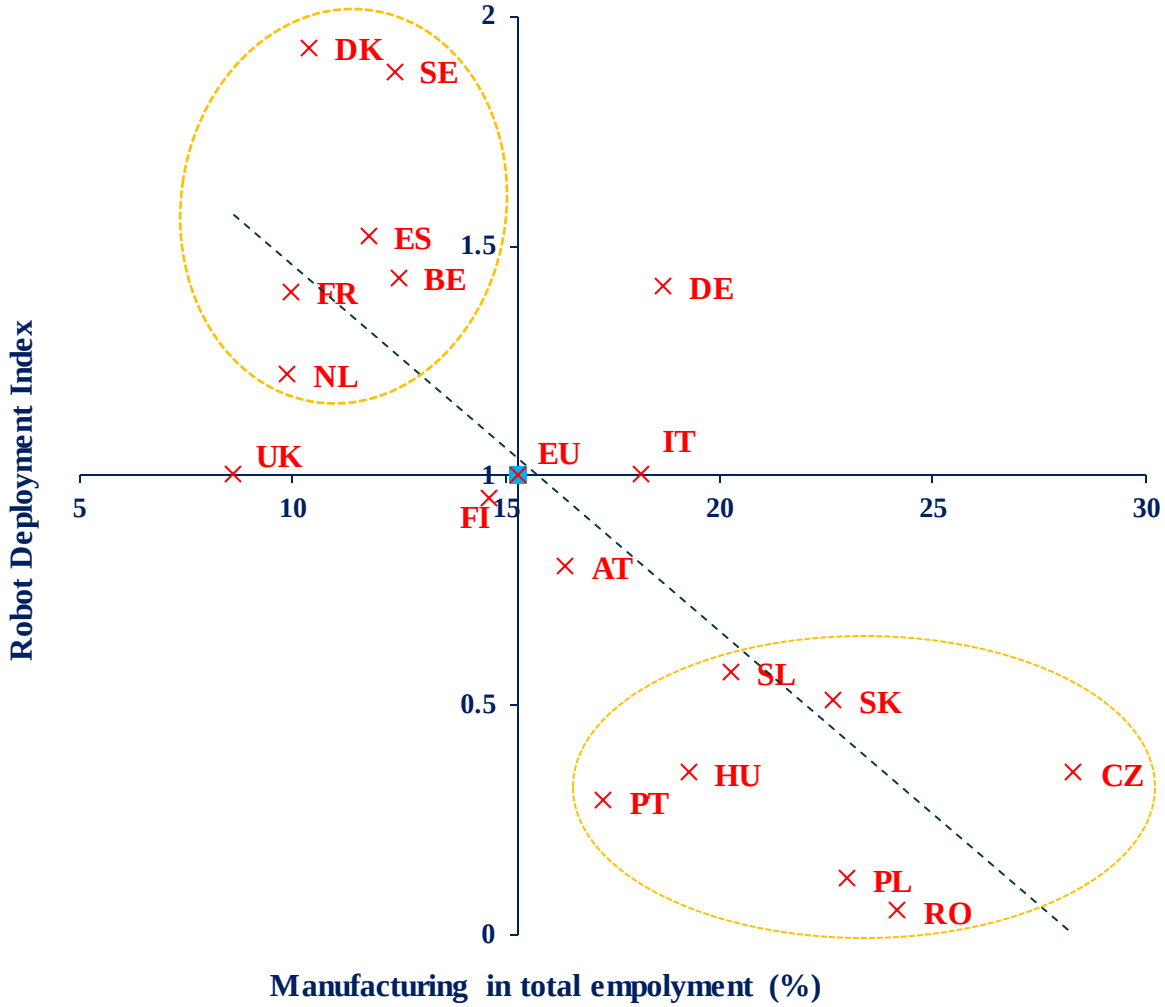
Figure 5. **Robot Deployment Index and manufacturing in total employment in Europe, selected countries, 2015** (RDI: robot density of a given country to robot density in Europe divided by manufacturing in total employment of a given country to manufacturing employment in Europe)



Source: author's calculation based on data of International Federation of Robotics and EU KLEMS

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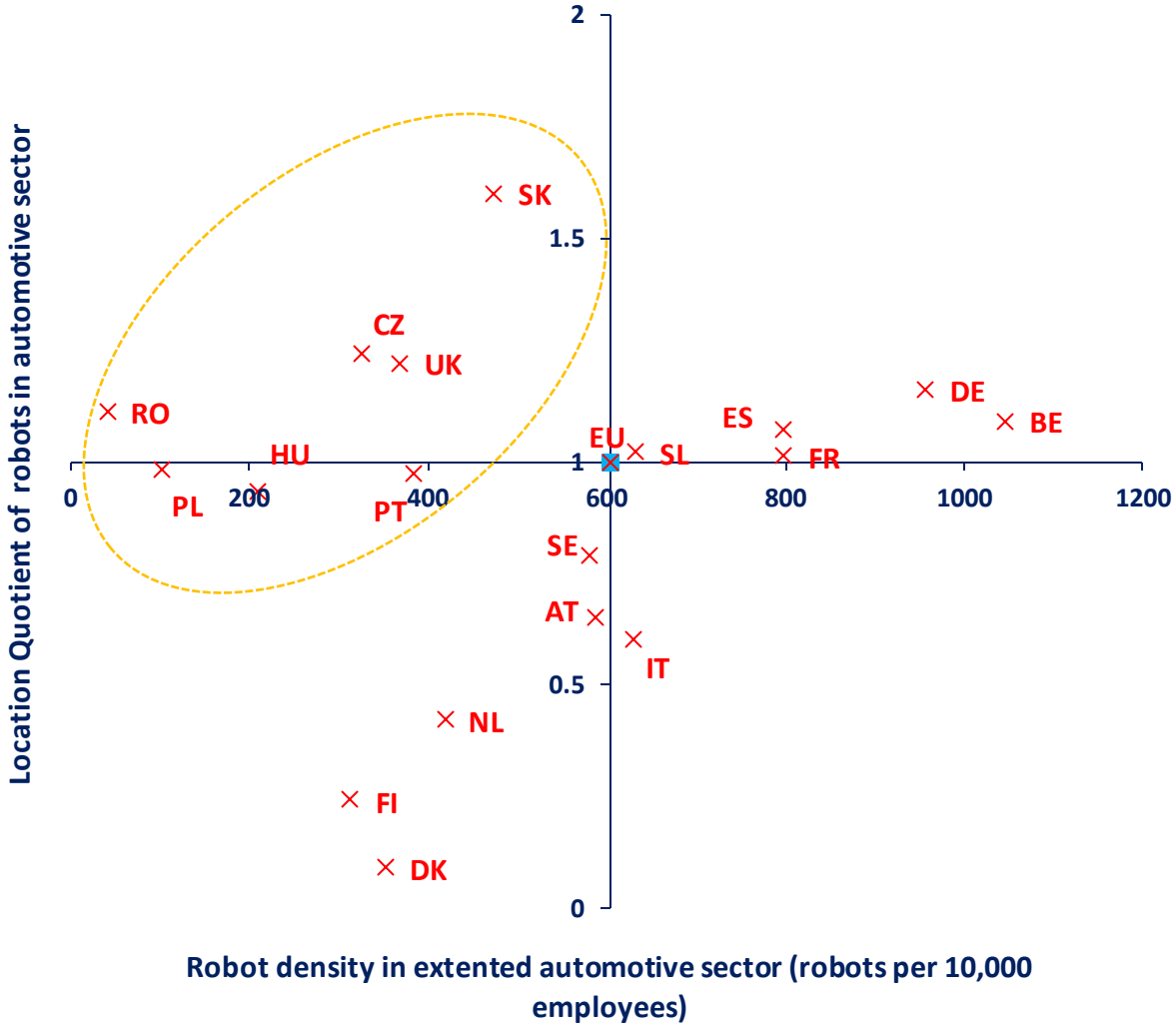
Specialization vs. Diversification

- 44% of robots in automotive sector
- One out of five European motor vehicle is produced in Central and Eastern Europe

Specialisation in automotive sector in Central and Eastern Europe (see LQ values)

Figure 6. **Robot densities in extended automotive sector and Location Quotient of robots in automotive sector in Europe, selected countries, 2015** (LQ; robots in automotive sector to manufacturing robots stock in a given country divided by Europe's average in this respect)



Source: author's calculation based on data of International Federation of Robotics and EU KLEMS

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Specialization vs. Diversification

- Key enabling technologies (KETs) with wide spill-over effects
- The wider the sectoral scope in robot deployment the more could robotisation work as KET

Shifting toward sectoral more diverse robot deployment (except Central and Eastern Europe)

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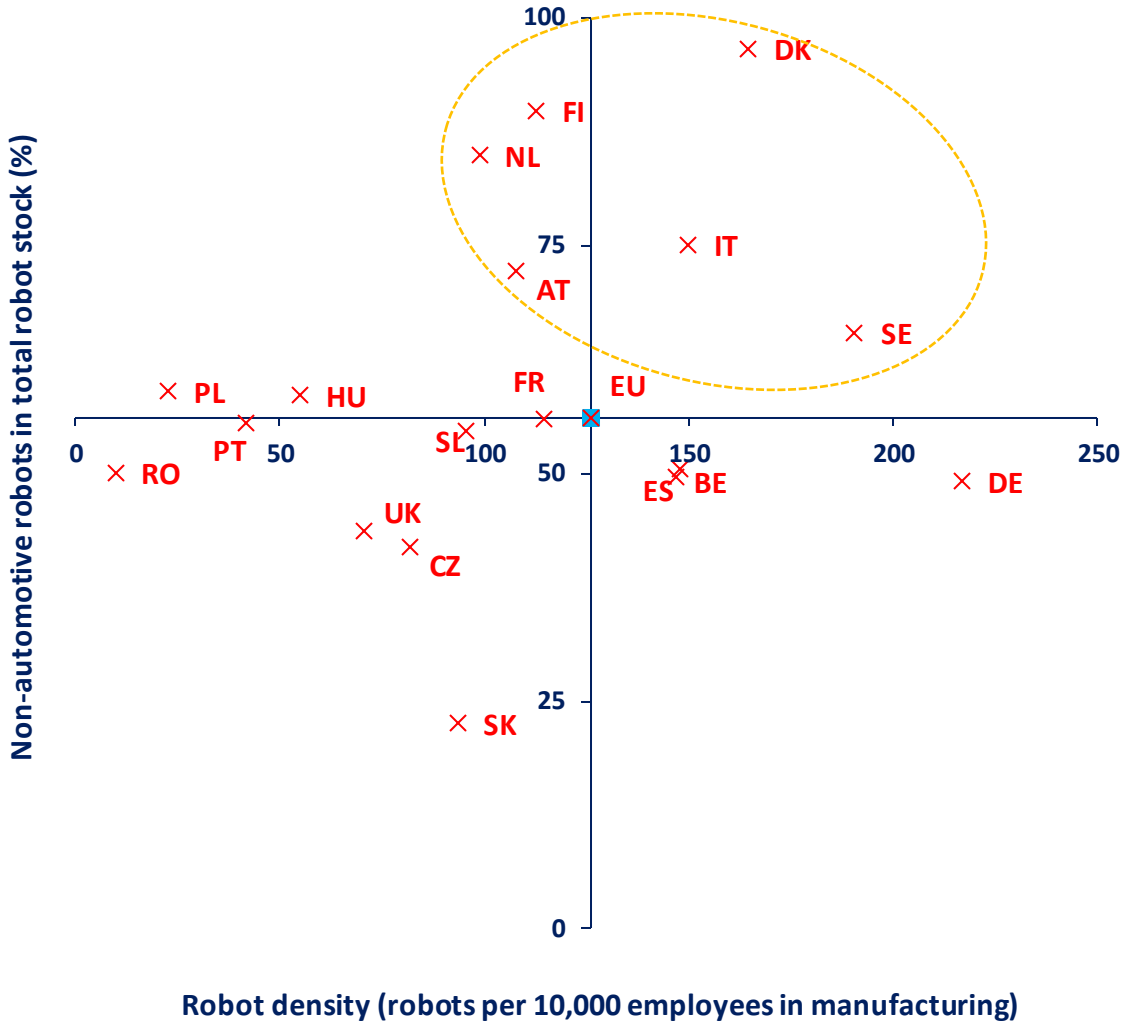
Figure 7. **Robot densities and non-automotive robots in total robot stock (%) in Europe, selected countries, 2015**



Source: author's calculation based on data of International Federation of Robotics and EU KLEMS

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Complex pattern of robotisation divides

- The combination of falling robot prices, high-wages and shrinking manufacturing labour force available **boosts** robotisation.
- The **most developed European countries with mature industries and advanced innovation systems** are becoming highly robotised,
- The pace of industrial robot adoption is much weaker in **European countries with low wages**, **labour-intensive industries** and weak innovation performance.

Robotisation in Europe seems to strengthen the already existing territorial disparities!!!

Group of countries	Robotisation divides					
	driven by robot price vs. human wage competition		shaped by employment structure		across sectoral structure	
	High wages and high robot density	Low wages and low robot density	High robot density and low share of manufac-turing employment	Low robot density and high share of manufac-turing employment	Diversifi-cation in non-auto-motive sectors	Speciali-sation in auto-motive sector
Germany	XXX		X		X	
Large European economies	XX		XX		XX	
Nordic countries	XXX		XXX		XXX	
Central and Eastern Europe		XXX		XXX		XXX

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Race for automated production vs. future of work

There are several ***trade-offs*** between

- the **current employment structures** in which the ongoing deployment of industrial robots are embedded and
- the **potential adverse employment effects** and job losses of robotisation assessed and predicted by studies on the future of work.

	Trade-offs	
	Current deployment of industrial robots	**Expected adverse employment effects (future of work)**
Germany and large economies	Opportunities for reshoring of production which could increase employment (though, mostly fewer and for high-skilled)	Skill-biased job losses
Nordic countries	Helps to keep and strengthen the industrial location, industrial output, and international competitiveness	Skill-biased job losses
Central and Eastern Europe	Finding the ways for sectoral more diverse deployment of robots	Low share of service sector employment offers a room for switching employees to service sector

Back to the narratives

The **dominant narrative** (future of work)

- **aims at addressing the social acceptance of robotisation** and
- tries to respond to people's fear.

The **current deployment** of industrial robots shows that

- there are not only different speed in robotisation but
- **different opportunities and challenges for particular countries**.

Thank you very much for your kind attention

Any questions?

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