Digitalisation and automation across business models and work-organisational effects

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Outline

• Background

• Process automation and digital production technologies
• Drivers of automation in automotive: structural and economic
• Technology choice, organizational integration and business models
• Case study South Africa: OEMs
• Work organizational effects: some reflections
Background

• Robotising Regions: National and Province-based Industrial Policy for Robotisation in China (co-authors: Federico Frattini and Giorgio Prodi), in preparation for *New Political Economy*

• What is driving robotisation in the automotive value chain? Empirical evidence on the role of FDIs and domestic capabilities in technology adoption (co-authors: Guendalina Anzolin and Antonello Zanfei), *Technovation*, RR.

• Digitalization, industrialization, and skills development: opportunities and challenges for middle-income countries (co-authors: Justin Barnes, Anthony Black, Timothy Sturgeon) in: Andreoni et al. (eds.) *Structural Transformation in South Africa: The challenges of inclusive industrial development in a middle-income country*, Oxford: Oxford University Press, 2021.


Process automation and digital production technologies

• What kind of automation?

• What degree of digital maturity?
From a case study on Spain (low diffusion of 4IR technologies)

<table>
<thead>
<tr>
<th>Industry 4.0 technology</th>
<th>Timing</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of the production process with ERP system</td>
<td>Since 2016. Still in progress</td>
<td>Process control and stability; real-time information; predictive maintenance; 100% traceability = no paperwork</td>
</tr>
<tr>
<td>Automation (cobots)</td>
<td>Since 2017. Few examples</td>
<td></td>
</tr>
<tr>
<td>AGVs</td>
<td>Since 2017. Fast development</td>
<td>Being rented. Adoption easy to justify (cost/benefit)</td>
</tr>
<tr>
<td>Inventory control and automation</td>
<td>Since 2017. Still in progress</td>
<td></td>
</tr>
<tr>
<td>3D printing</td>
<td>Initially in 2012; most adopters since 2019</td>
<td>Limited use (no production): prototypes, tools, etc.</td>
</tr>
<tr>
<td>Virtual reality</td>
<td>Only in R&amp;D</td>
<td>Training</td>
</tr>
<tr>
<td>Augmented reality</td>
<td>Only in R&amp;D</td>
<td></td>
</tr>
<tr>
<td>Artificial intelligence</td>
<td>Since 2018</td>
<td>Only for very specific problems</td>
</tr>
<tr>
<td>Data analysis systems</td>
<td>To be developed</td>
<td></td>
</tr>
</tbody>
</table>

Alaez-Aller et al., 2020 chapter 4.
Process automation and digital production technologies

- What kind of automation to expect where?
- What degrees of heterogeneity?

- Stages of the automotive value chain and countries (EU – non-EU)

- OEMs:
  - Lower heterogeneity across “sister OEMs/benchmark plants” within same automotive companies and higher comparability (e.g. Toyota)
  - Higher heterogeneity for different product/market segments (different skills, cost structures)

- Tier 1 (including co-located extended OEM plants):
  - Cascade effect depending on component-OEMs match and business models (e.g. Valeo)

- Tier 2-3:
  - high heterogeneity across countries given different digital capabilities and skills
Process automation and digital production technologies

• **What kind of functional-tasks automation?**
Drivers of automation: opening the black-box
Drivers of automation in automotive

- Stamping Metal: PRESS SHOP
- Welding Parts: WHITE BODY SHOP
- Painting Cars: PAINT SHOP
- Assembling Parts: ASSEMBLY
Structural and economic drivers of automation

Structural (feasibility)
- Product design specifications (including life cycle)
- Product quality (and customisation)
- Production modularisation (within OEMs and along Tiers-VCs)
- Tasks interdependencies in tech automation within continuous processes
- Process ergonomics and safety

Economic (opportunity)
- Productivity vis a vis CAPEX
- Production volumes and quantity (including market access)
- Costs of automation (robots / cells, robots-line integration/retrofitting)
Structural and economic drivers of automation: technology choices and organisational integration

- Structural (feasibility)
  - Product design specifications (including life cycle)
  - Product quality (and customisation)
  - Production modularisation

- Tasks interdependencies in tech automation within continuous processes
- Process ergonomics and safety

- Economic (opportunity)
- Productivity vis a vis CAPEX

- Production volumes and quantity (including market access)
- Costs of automation (robots / cells, robots-line integration/retrofitting)
Technology choice, organizational integration and business models

1. Labour C/L → Robotisation

2. Complex product system: organisation and technology nexus

**Organisation**
- Economies of scale and process efficiency
- Outsourcing
- Plants specialisation around platforms
- Increasing rigidity in the process, but increasing production flexibility?

**Technology**
- Increases rigidity
- Flexible automation as a response 80-90
- 4IR and CPS

**HOW?**
- Modularity
- Flexibility
- Stability

**Product design**
- Customisation
- Standardisation

Model 1

Model 2
Case study: OEMs in South Africa
<table>
<thead>
<tr>
<th>Company</th>
<th>Model/s produced</th>
<th>Number of vehicles produced</th>
<th>Main technologies object of the interview</th>
<th>Specific area of plant visit</th>
<th>N. of people interviewed</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW</td>
<td>3 Series and X3 (launched in 2018)</td>
<td>76,000</td>
<td>Industrial robots</td>
<td>Body shop</td>
<td>Two</td>
<td>3,500</td>
</tr>
<tr>
<td>Ford</td>
<td>Ranger, Everest</td>
<td>168,000 (ca.)</td>
<td>Industrial robots</td>
<td>Body shop, Final assembly</td>
<td>One</td>
<td>3,700</td>
</tr>
<tr>
<td>Isuzu</td>
<td>Isuzu KB and D-Max</td>
<td>n/a</td>
<td>Industrial robots</td>
<td>n/a</td>
<td>Two</td>
<td>130</td>
</tr>
<tr>
<td>Nissan</td>
<td>NP200, NP300 Hardbody</td>
<td>32,836</td>
<td>Industrial robots</td>
<td>Body shop</td>
<td>Two</td>
<td>2,501</td>
</tr>
<tr>
<td>Toyota</td>
<td>Hilux, Quantum, Corolla 4 doors (and previous models) and Fortuner</td>
<td>242,000</td>
<td>Industrial robots</td>
<td>Body shop</td>
<td>Three</td>
<td>8,539</td>
</tr>
<tr>
<td>VW</td>
<td>Polo new and previous series (designated Vivo)</td>
<td>200,000</td>
<td>Industrial robots, virtual reality, 3DP.</td>
<td>Press shop, Body shop, Paint shop, final assembly</td>
<td>Four</td>
<td>4,167</td>
</tr>
</tbody>
</table>

Case study: OEMs in South Africa
The how? Different Business Models

Japanese (a)

Organisation
Modularization in production
Plants specialisation around platforms

Technology
Modularity
Flexibility
Lower automation
Higher flexibility
Robots are reprogrammed often, and their use present idle times

Stability
Product design
Similar products along different cycles

German (b)

Organisation
Economies of scale
Outsourcing

Technology
Modularity
IN-Flexibility
Increased rigidity
High level of automation
Robots are not reprogrammed (they tend to be used with the same tasks for their entire life)

IN-Stability
Product design
Different products along different cycles

Increasing rigidity in the process, but increasing production flexibility?
### Differences and potential effects on workers skills profiles

#### Japanese automotive model

- Cost reduction and robust process
- Product Flexibility (across cycles)
- Process Flexibility (easy retrofitting and conversions)
- More heterogeneity in automation (only when it makes sense)

More workers in assembly?
Continuous and more cross-functional training?

#### German automotive model

- Product quality/spec driver
- High modularity
- High automation (and linked to product cycle 24H/7Y)

Less workers in assembly?
Highly specialised training?
Work organisational effects: some reflections

• The *how* of robotisation affects:
  • **Speed and depth** of automation / robotisation / digitalisation
  • Potential **displacement** (robots substituting or complementing – e.g. co-bots)
  • **Disproportional impact** of displacement across tasks and types of workers
    • Gender effect given the different distribution of M/F workers along the production line/tasks distribution
  • Disproportional impact on individual **skills profiles and need for training / re-training** (depending on degree of skills transferability)
  • Impact on **organisational models / collective-team skills / changes in supervisory and team coordination roles**
  • Potential positive **gender pull** in the sector given automation-related improved ergonomics, process flexibility, shifts in tasks, new tasks
  • Digitalisation enhanced / Virtual training – simulation
Thanks

Research in South Africa draws on extensive field work conducted with Dr Guendalina Anzolin. With thanks to the Department for Trade and Industry (dti) and companies for access.