Automation and Polarization: Historical Evidence and Scenarios for South Africa

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Covers: Three WIDER Papers

1. Labour market polarization in South Africa, a decomposition analysis

UNU-WIDER : Working Paper : Labour market polarization in South Africa

2. Polarization in the South African labour market, economy-wide scenarios

UNU-WIDER : Working Paper : Polarization in the South African labour market

3. A 2016 social accounting matrix for South Africa with an occupationally disaggregated labour market representation

UNU-WIDER : Working Paper : A 2016 social accounting matrix for South Africa with an occupationally disaggregated labour market representation

Content

- Motivation (DvS)
- A Historical Decomposition (DvS)
- Economy-wide Scenarios (RD)
- Policy Recommendations (RD)

MOTIVATION

- Interpreting DHET's thinking
  - National Skills Development Strategy
  - Employment forecasting
- Evidence from Developed Countries suggests that Technical Change affects:
  - Not only Employment Intensity of Production
  - But also Occupational Composition of Employment within an industry
    - Polarisation
      - "Routine" tasks replaced by machines
      - Employment growth of mid range occupations lagging high and low level occupations
- Three types of task
  - Abstract – dealing with conceptual/management
  - Routine – instructions can be written out precisely
  - Manual – requires human presence
- Does this pattern apply to South Africa?
  - On top of persistent structural unemployment.
- Research Methods
  - Decomposition of historical trends
  - Scenarios in an economy-wide context

Decomposition

Broad Drivers of change in use of skills

1) **Output growth**: use of all skills rises as output grows
2) **Structural change**: skill shares vary across industries
   - Changes in an economy's industry structure will impact on demand for skills
3) **Technical change** impacts on demand for skills & can be seen as:
   - changes in the demand for labour vis a vis capital in an industry
4) **Changes in the skills mix of that labour in an industry**
   - Most associated with our initial question around AI, automation & robotics

Change in total jobs in an occupation = Change in occupational mix within sectors + Change in labour intensity of sectors + Change in sectoral structure + Change in economy-wide output

Decomposition of Employment by Occupation

1) May be an indication of the drivers of change
2) Does not reveal causes of change
3) For example:
   a) Structural change may have large impact
   b) Why structural change took place is not clear
      i. Global demand
      ii. Domestic forces (reduction in mining due the environmental response)
      iii. Policy interventions
4) Analysis is deterministic in nature
   a) Does not involve econometrics
   b) No measure of statistical significance

How should occupational mix be measured?

Occupations?

- South African Standard Classification of Occupations
- Organising Framework for Occupations

Tasks?

- Autor, Levy, Murnane 2002 and subsequent work by Acemoglu, Autor and many co-authors

Task-based Approach to Labour Markets

Machines do not replace occupations but tasks

Task content of occupations is not static over time

Would like detailed task data but

- No systematic task classification

We map occupations to broad task classification

- Abstract tasks
- Routinizable tasks
- Manual tasks

Broad Task Mapping

Broad Task	Occupations
Abstract	1. Legislators, senior officials and managers
Abstract	2. Professionals
Routine	3. Technical and associate professionals
Routine	4. Clerks
Manual	5. Service workers and shop and market sales workers
Routine	6. Skilled agricultural and fishery workers
Routine	7. Craft and related trades workers
Routine	8. Plant and machine operators and assemblers
Manual	9. Elementary Occupation

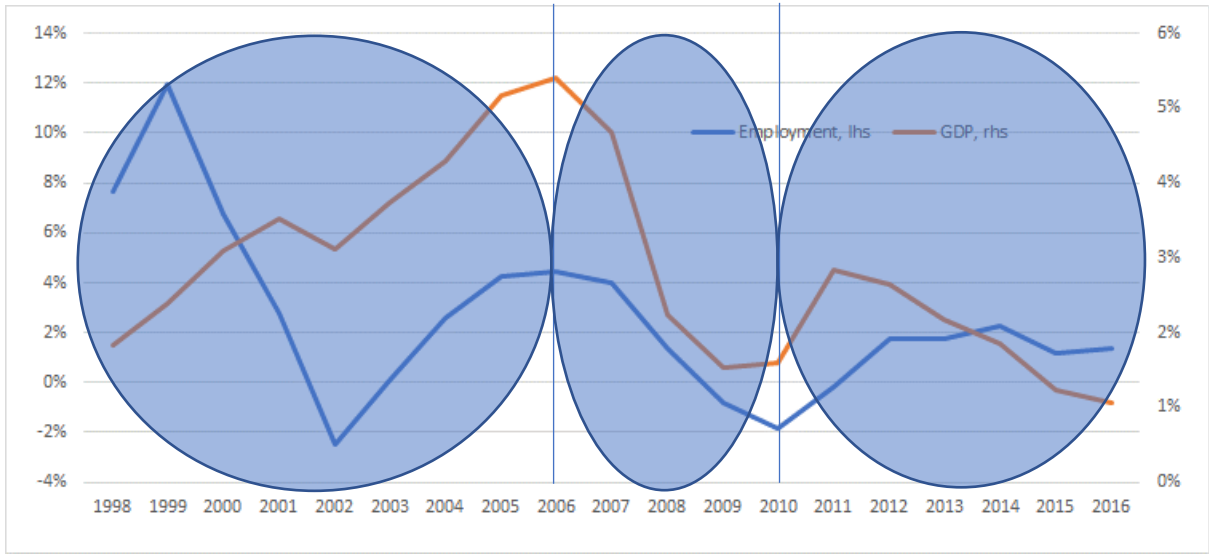
- Labour Market Data Source: PALMS 1993-2017
  - 1 Digit Occupations
  - 1 Digit Industries

1	Agriculture	4	Utilities	7	Transport
2	Mining	5	Construction	8	Finance
3	Manufacturing	6	Trade	9	Other Services

- Additional Data source for output: 1 Digit Industries GDP published by Stats SA

Data Issues

- PALMS data: essentially QLFS published by SSA
- Data is annualised
- 3 year moving average
- Effective period: 1997-2016
- Decomposition over full period but also for sub-periods



Source: (Kerr & Wittenberg, 2017) *and* (Statistics South Africa, 2018)

- Subperiods:
  - Upturn: 1997-2006
  - Downturn: 2006-2010
  - Recovery: 2010-2016
- Analysis for:
  - Occupations
  - Task groups

Decomposition of Employment by Broad Tasks 1996-98 to 2015-17

	Total	Occupational Mix Effect	Technical Change Effect	Structural Change Effect	Growth Effect	Shares 1996-98	Shares 2015-17
			Total Change ('000)			**%**	**%**
Total	5,645	0	-929	314	6,261	100.0	100.0
Abstract	899	20	-61	81	858	13.3	14.3
Routine	1,631	-797	-541	206	2,764	47.6	40.5
Manual	3,115	778	-328	28	2,638	39.1	45.2
			Total Change %				
Total	46.1	0.0	-7.6	2.6	51.2		
Abstract	53.5	1.2	-3.6	4.8	51.2		
Routine	30.2	-14.8	-10.0	3.8	51.2		
Manual	60.4	15.1	-6.4	0.5	51.2		

- Some evidence of polarization:
  - Routine share in total employment drops from 46.6% to 40.5% over the period
    - But that is effect of all causes, not just automation
  - Occupational mix effect is negative for routine, positive for abstract and in particular manual
  - Polarization enhanced by technical change effect
  - Polarization offset by structural change effect
  - Growth effect dominates

Comments on Decomposition Results

- More polarization during
  - Recession (2006–20010)
  - Recovery (2010–2016)
- Technical change has across the board negative effect
  - Production is becoming less labour intensive for all task based categories
  - But somewhat more so for routine labour
  - Labour costs have outstripped those of typical ICT goods for investment
  - Added complication: skill shortages and complementarity of abstract labour with other labour
- Structural change beneficial to routine and abstract but less to manual
  - Results show that employment shifted to industries that require relatively more routine and abstract
  - Supports claims in some literature that developing economies still going through structural transformation
- Preliminary summary based on historical trends
  - While results show some evidence of polarisation in SA, it is mild
  - Results finds some resonance with cross-country analysis found elsewhere but with some caveats
  - Decomposition lacks causality related to potential forces (offshoring, global value chains, labour vs capital costs)
  - Labour market polarisation in SA will be yet another obstacle towards greater income equality in SA

Economy-wide Scenarios

Motivation

- For policy design we would like to know drivers of polarization
- Accounting decomposition is one way to look at the data but does not show the drivers
- Past experience is weak guide to potential future impacts
  - Pace of change is very rapid
  - South Africa lags global adoption
- Instead use structural simulation model to explore drivers

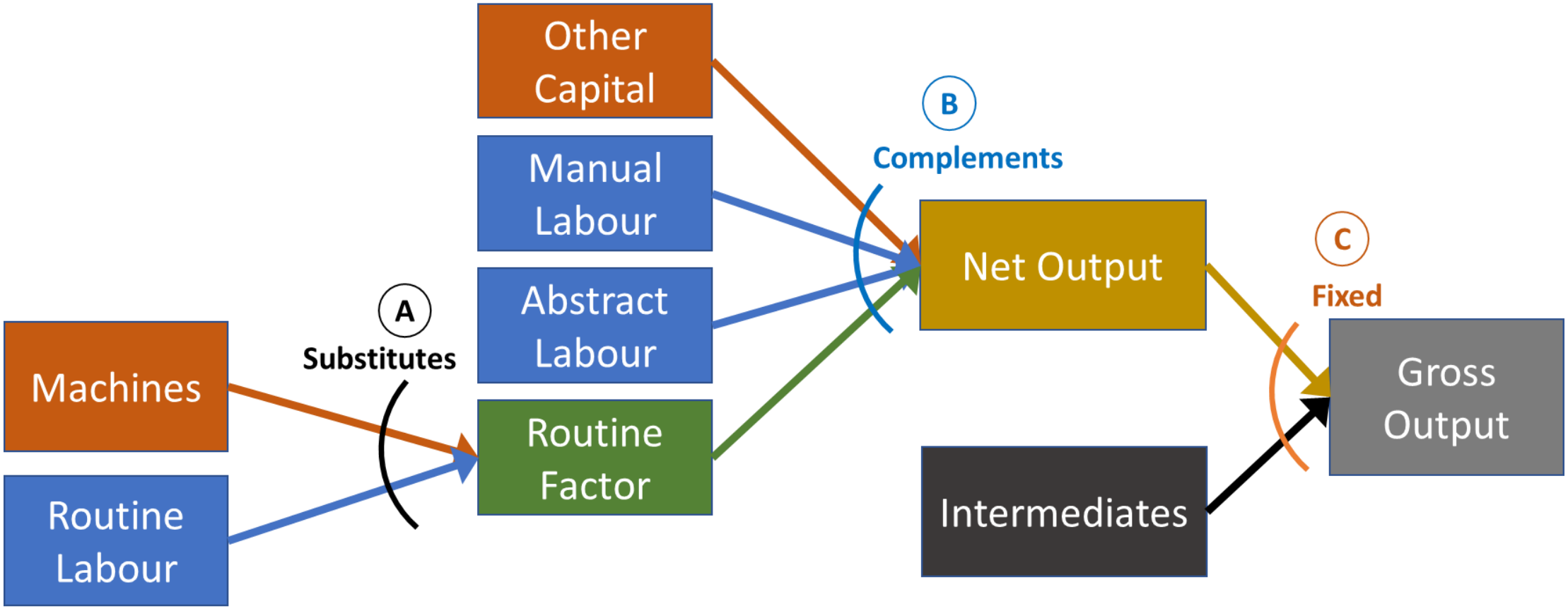
Method

- Economywide model since polarization is an economywide phenomenon
- Adapt a standard CGE model
  - Adaptation on production side to allow polarization
- Based on 2016 SAM with occupational disaggregation
- But no estimates of key parameters
  - Run scenarios with different parameters to explore their influence

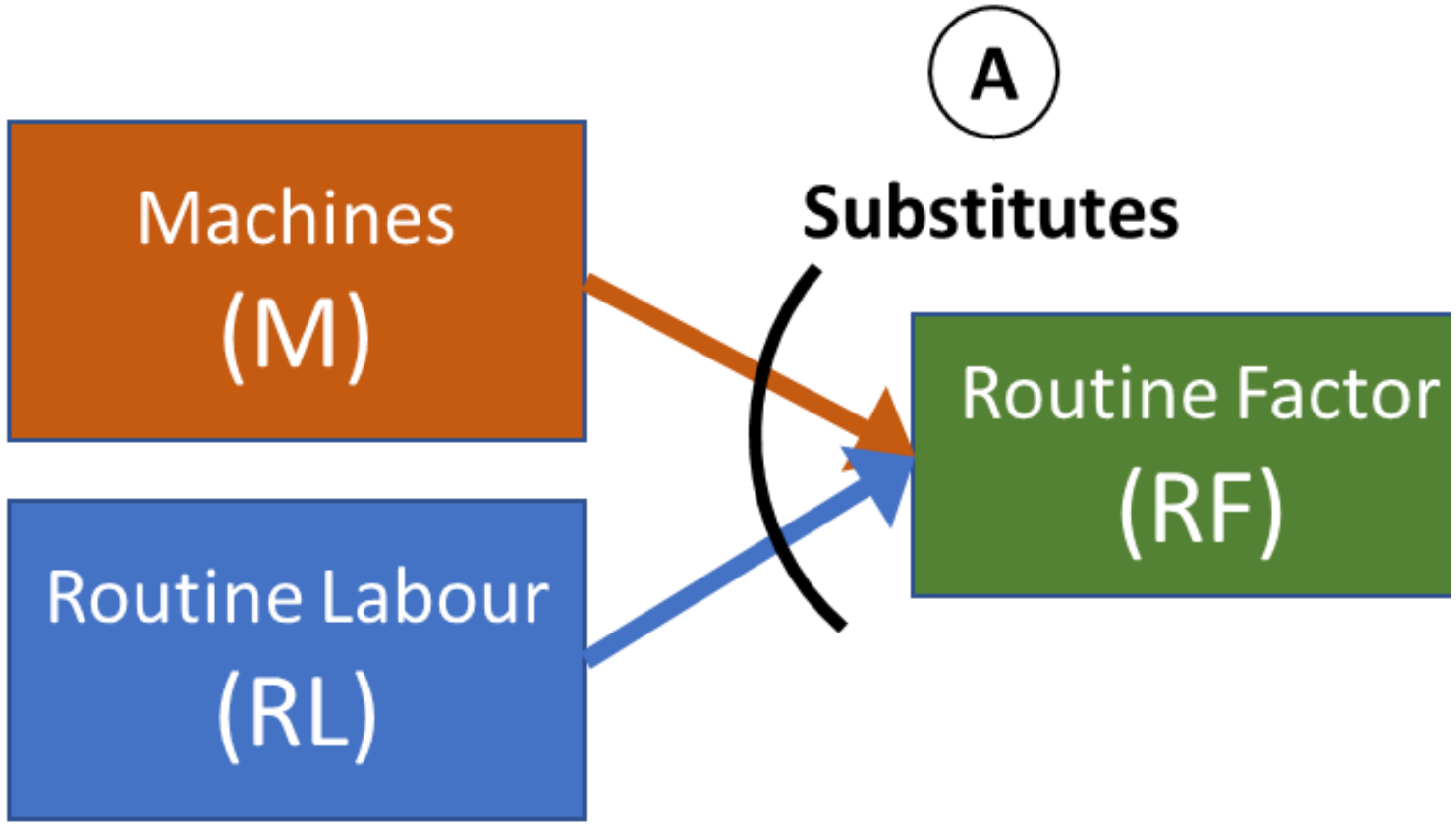
Model Adaptation

- Output produced by completing combination of abstract, manual and routine tasks
  - Abstract and manual tasks require human labour, possibly assisted by non-human inputs.
  - Routine tasks can potentially be done by either machines or humans
- Technological progress expands range of routine tasks machines can do
  - Firms choose to use labour or machines based on relative costs
  - ‘Cost’ could include other influences
- Nested production function

Nested Production Structure

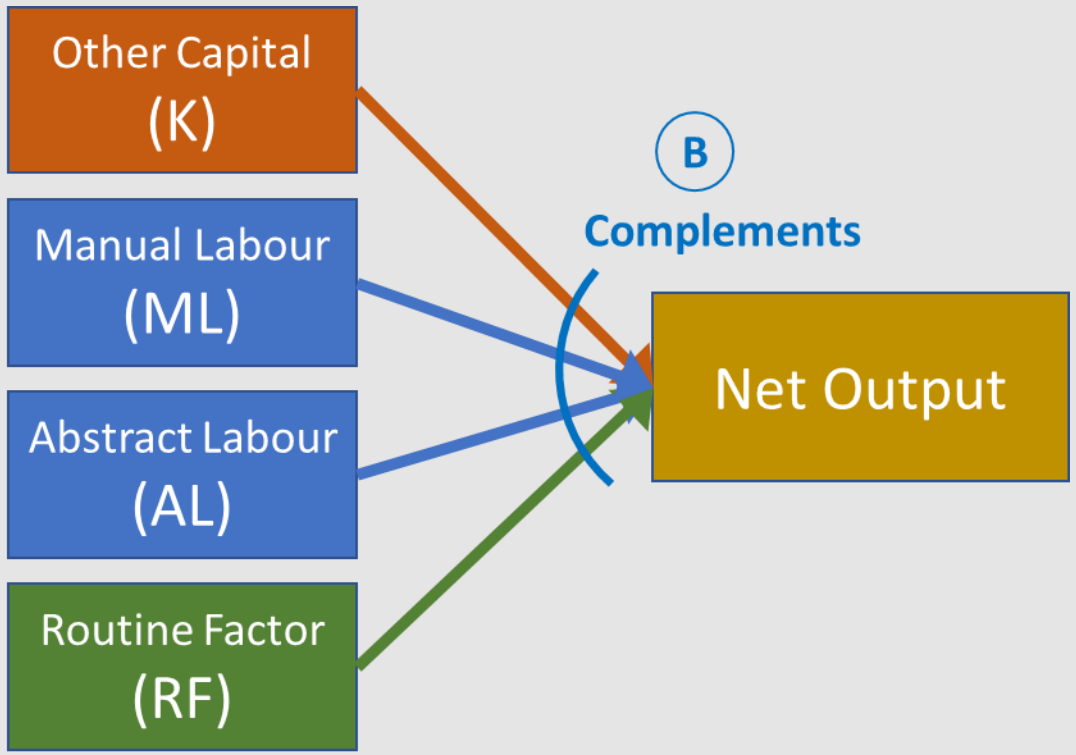


Machines and routine labour combine to produce Routine Factor



- Quantity of “Routine Factor”: time to complete routine task
- ‘Price’ falls because cost of M falls or efficiency rises
- Both effects displace RL
- RF become more M intensive
- But more/cheaper RF available

Routine factor combines with other factors to produce output



- Complementary by definition
- With more RF available, output can expand
- With cheaper RF, cost can be reduced
- Will firm expand output or reduce price?

Key Drivers

- Mix of industry/firm specific and economywide
- Pace of displacement of RL in production of RF
  - Elasticity of substitution between M and RL
- Impact of cheaper/more RF on product output
  - Elasticity of substitution between RF and other inputs
  - Availability of other inputs
- Ability of firm to sell more output
  - Demand system in the economy

Outcome for Routine Labour

- Technical change reduces demand for RL in RF
- But if output rises, demand for RF, and therefore RL, rises
- Net effect depends on the size of these two forces

Can Output Expand?

- If firm passes on reduced cost, demand might rise
  - Monopoly might not pass the reduced cost on
- Where does increased demand come from?
  - Adoption of automation does not induce enough demand
  - So need external sources of demand
- Even if demand rises, complementary inputs may be constrained
- These issues arise in an economy-wide framework
  - Demand constrained by income and competing expenditures
  - Firms have to compete for labour

Scenarios run

- Basic scenario: increase supply of equipment
- Multiple subscenarios
- Allocate to sector through market or by targeting selected sectors
  - Selection by
    - Likelihood of automation
    - Degree of backward and forward linkages
- Supplies of abstract and manual labour fixed or flexible

Which sectors are at risk?

- Frey and Osbourne measure occupations susceptible to automation
- SA sectors at risk identified by
  - "Susceptibility"
    - Map F&O to sectors using occupation weights
  - "Scope"
    - Ratio of routine labour to machines
- 29% workers in high risk occupations
- But only 5% in high scope sectors
- We developed these measures for scenario design, but could explore further

		Scope	
		Low	High
Susceptibility	Low	Agriculture	Mining of gold and uranium ore
		Sale, maintenance, repair of motor vehicles	Mining of metal ores
		Hotels and restaurants	Air transport
		Education	
		Sewerage and refuse disposal	
		Activities of membership organizations	
		Other activities	
	High	Forestry	Publishing, printing, recorded media
		Sawmilling, planing of wood, cork, straw	Plastic
		Construction	Basic precious and non-ferrous metals
		Water transport	Fabricated metal products
			Motor vehicles, trailers, parts
			Other transport equipment

Some conclusions

- Policy – make sure complementary labour is available – training abstract labour/ migration
- Need demand to grow
  - Covid – speeding up adoption?
  - At a bad time, so negative effects are bigger
- Recent evidence elsewhere suggests susceptibility is greater than anticipated
  - AI and big data leading to white collar abstract labour being displaced
- Ignored personal distribution of income – only factor distribution
  - Capital income – owners of machines get more – political power
  - Basic Income Share now before the entrenchment of power of machine owners is too far along