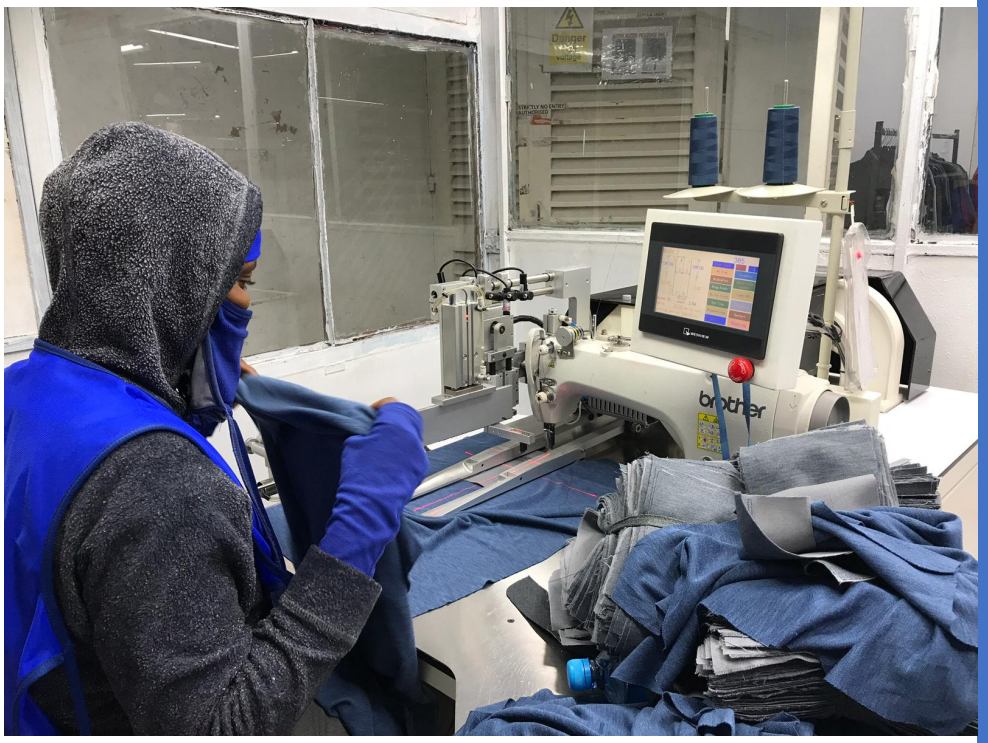

Digital technologies and ‘value’ capture in Global Value Chains; Empirical Evidence from Indian Manufacturing Firms

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Dr. Karishma Banga

Context

- Four-fold categorisation of upgrading in the GVC literature; process, ***product***, functional and chain upgrading
- ***Focus: Digitalisation as a driver of product upgrading in GVCs***
- India case-study
  - Outlier in manufacturing GVCs (Baldwin, 2011; Athukorala, 2013)
  - Ranks high in terms of exports of digital services compared to other countries but value-added by India's digital services in its manufacturing sectors is lower than many developing countries (Banga, 2019).

Drivers of product upgrading

- **International trade**
  - Learning-by-exporting (Almeida and Fernandes, 2008)
  - Learning-by-importing (Kugler and Verhoogen's study, 2009; Goldberg et al.', 2010)
  - Learning by two-way trading (Veugelers et al., 2013; Lo Turco and Maggioni, 2015).
    - Indian GVC firms produce 2% more sophisticated goods (Banga, 2017).
- **Governance**
  - Higher probability of affiliate introducing new products (Brambilla, 2009; Guadalupe et al., 2012).
  - MNEs transfer knowledge (Arnold and Javorcik, 2009)
  - MNEs provide local producers with better inputs, technical know-how and support
- **Technological capabilities**
  - Distinctive firm-specific learning strategies (Giuliani and Bell, 2005)
  - Organisational, managerial and technical capabilities for generating technical change (Lall, 2001)

Digital capabilities and upgrading in manufacturing GVCs.

- **Pathways of impact**
  - Use of multi-purpose technology in production; productivity increases and cost-savings which can be re-invested (Eg. Megh industries in Kenya)
  - Information flows and knowledge spillovers
  - Digital engineering shrinking product development timelines and costs (Bain and Company, 2017); rapid proto-typing, 3D visualisation and printing; testing and validation.
  - Changeover costs, faster delivery times and higher quality (Hyundai firm in India, Ray and Miglani, 2018)
  - E-commerce; new opportunities for product diversification and higher market access in Bangladesh (ITC, 2018)
- **Shifting towards 'digital competence'**
  - Digitalised products tend to involve very complex knowledge; highly tacit (Andrews et al., 2016).
  - Internet connectivity has resulted in 'thin integration' in East African firms (Foster et al., 2018).
  - Suppliers' managerial capabilities matter for reaping benefits in the digital economy (Mayer, 2018)

Firm-level product sophistication

- Sales weighted average product sophistication: $\mathrm{PSI}_{it} = \sum_k \frac{Sales_{it}^k}{\sum_k^K Sales_{it}^k} \; PRODY^k$

- $PRODY^k$ is Hausmann et al.'s index (2007) calculated as $PRODY^k = \sum_c \underbrace{\left(\frac{X_c^k / X_c^\bullet}{\Sigma_c (X_c^k / X_c^\bullet)} \right)}_{\varphi_c^k} Y_c$

- GDP per capita (PPP) in constant 2011 US dollars collected for 267 countries from the World Development Indicators database.

- Product level (four-digit level) export data collected (in thousands of US dollars) from WITS in UNCOMTRADE.

- Increase in this variable captures product upgrading by movement into more sophisticated products or diversion of sales towards more sophisticated products.
  - e.g. non-electrical machinery to electrical machinery to electronics
  - e,g, bicycles to motorcycles to passenger cars
  - e.g. manufacture of knitted and crocheted fabrics and articles to manufacturing wearing apparel other than fur.

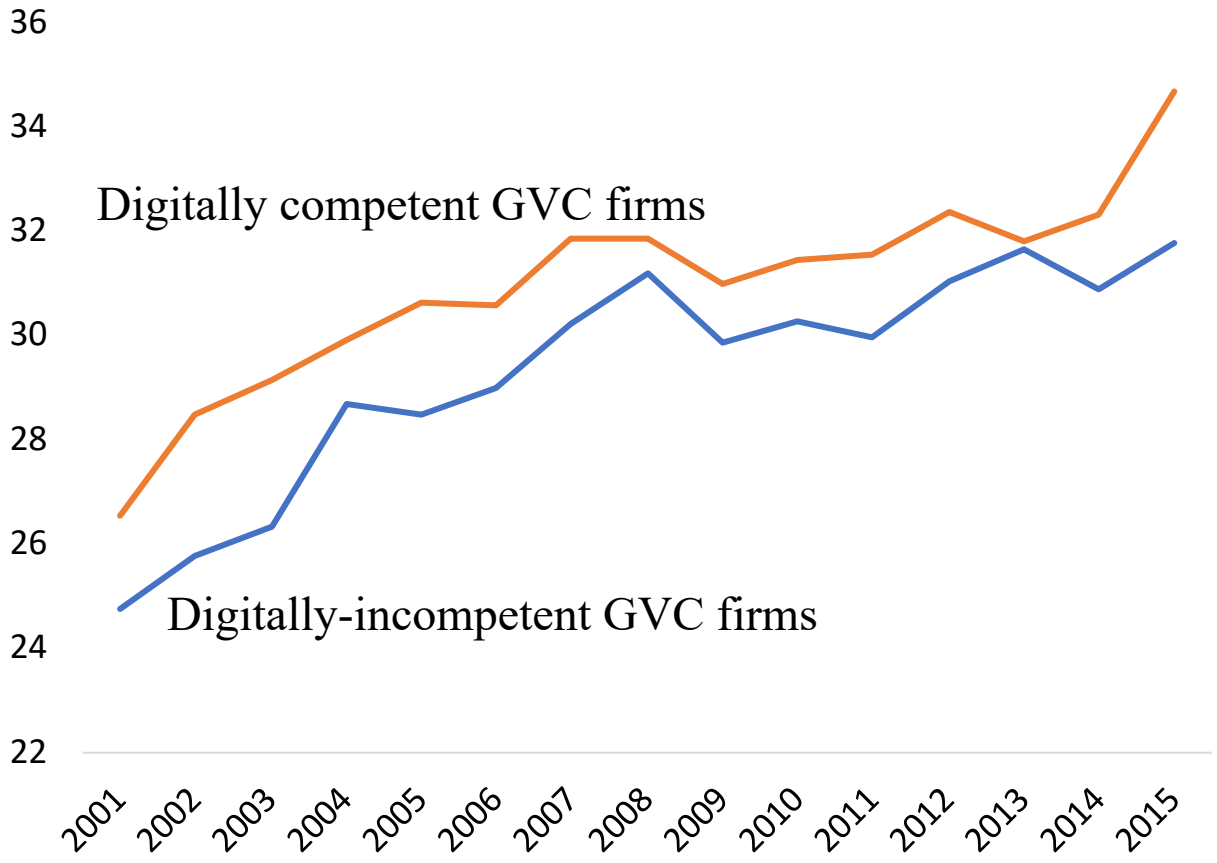
Construction of key variables

- **GVC firms**: firms that are simultaneously importing intermediate and exporting intermediate or final goods (Baldwin and Yan, 2018; Veugelers et al.; 2013)
  - 22,274 firm–year observations, 14% foreign-owned
- **Digital capability: weighted index using PCA drawing information on** a) communication and transport infrastructure b) technology assets, which refers to gross plant, machinery, computer and electrical installations and c) software assets of the firm.
- **Skilled labour share**: managerial compensation as a share in total labour compensation
- **Digitally competent firms**: firms with both digital capability and share of skilled labour above the median levels in the industry.

Preliminary findings

- Manufacturing firm-level GVC panel 2001-2015
- Pharmaceuticals; computers, electronics and optical products; machinery and equipment; other transport equipment; and rubber and plastics rank high in terms of product sophistication (Banga, 2017; Eck and Huber, 2016)
- Computer and electronics; pharmaceuticals, rubber and plastic sectors rank relatively higher on the digital capability index
- Furniture, food, beverages and tobacco rank low on product sophistication, and on digital capability.

Figure 1: Product sophistication, by firm type



Source: Author

Empirical results: dependent variable- PS_{it}

VARIABLES	(1) model 1	(2) model 2	(3) model 3	(4) model 4	(5) model 5
L. (PS_{it})	0.823***	0.822***	0.825***	0.784***	0.795***
	(0.0418)	(0.0418)	(0.0419)	(0.0460)	(0.0447)
L2. (PS_{it})	0.0884	0.0870	0.0850	0.0956	0.101*
	(0.0576)	(0.0573)	(0.0590)	(0.0583)	(0.0576)
Digital capability	0.0101*	0.00997*	0.0102*	0.0108*	0.0116**
	(0.00599)	(0.00593)	(0.00583)	(0.00570)	(0.00567)
Skilled-labour share	0.00706***	0.00715***	0.00771***	0.0202***	0.0169***
	(0.00178)	(0.00179)	(0.00180)	(0.00479)	(0.00361)
Foreign shares	2.95e-05	2.82e-05	4.06e-06	-0.000227	-0.000187
	(0.000204)	(0.000204)	(0.000200)	(0.000205)	(0.00020)
HHI		0.0197**	0.0185**	0.0212**	0.0208**
		(0.00825)	(0.00842)	(0.00957)	(0.00970)
R&D intensity			0.000705	0.000239	0.000336
			(0.000758)	(0.000816)	(0.00081)
Firm Size				0.0218***	0.0189***
				(0.00727)	(0.00605)
Firm Age					-0.012***
					(0.00457)
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Hansen p-val	0.11	0.12	0.16	0.39	0.46
AR (2)	0.10	0.09	0.10	0.17	0.18
Observations	9,208	9,208	9,208	9,206	9,186
Number of firms	1,744	1,744	1,744	1,744	1,736

Empirical results: dependent variable- PS_{it}

VARIABLES	Model1	Model2	Model3	Model4	Model5	Model6
L. (PS)	0.786***	0.792***	0.787***	0.795***	0.791***	0.794***
	(0.0450)	(0.0443)	(0.0461)	(0.0427)	(0.0434)	(0.0456)
L2. (PS)	0.0891*	0.0932*	0.0891*	0.0726	0.0780	0.0904*
	(0.0509)	(0.0522)	(0.0486)	(0.0539)	(0.0536)	(0.0544)
Firm size	0.0169***	0.0163***	0.0127**	0.017***	0.0179***	0.0170***
	(0.00599)	(0.00599)	(0.00579)	(0.0059)	(0.00601)	(0.0065)
Low digital cap.- low skill	**-0.0451***	**-0.0484****	**-0.0479****	**-0.0527****	**-0.0552****	**-0.0518****
	(0.0238)	(0.0242)	(0.0241)	(0.0246)	(0.0247)	(0.0257)
Low digital cap-high skill	-0.00369	-0.00654	-0.00856	-0.0141	-0.0210	-0.0173
	(0.0175)	(0.0173)	(0.0178)	(0.0180)	(0.0177)	(0.0184)
High digital cap-low skill	-0.00981	-0.0139	-0.0110	-0.0155	-0.0188	-0.0196
	(0.0203)	(0.0198)	(0.0192)	(0.0198)	(0.0197)	(0.0197)
Age	-0.0166**	-0.019***	-0.0153**	-0.015***	-0.015***	-0.0141**
	(0.00670)	(0.00659)	(0.00645)	(0.0059)	(0.00594)	(0.00621)
R&D intensity		0.00154*	0.00178**	0.000810	0.000553	0.000642
		(0.00086)	(0.00089)	(0.0009)	(0.00094)	(0.00093)
Labour Productivity			0.0114	-0.00063	-0.000837	-0.000214
			(0.00952)	(0.0125)	(0.0124)	(0.0130)
Multi-product firm				-0.00347	-0.00423	-0.00409
				(0.0040)	(0.00406)	(0.00426)
HHI				0.029***	0.0294***	0.0263**
				(0.0101)	(0.0102)	(0.0107)
Foreign Shares					-0.000115	-0.000117
					(0.00207)	(0.00020)
Time FE	yes	yes	yes	yes	yes	yes
Industry FE	no	no	no	yes	yes	yes
Observations	9,383	9,383	9,383	9,097	9,047	9,047
No. of firms	1,757	1,757	1,757	1,701	1,684	1,684
Instruments	41	44	49	70	73	64
AR(2)	0.11	0.138	0.114	0.081	0.100	0.132
Hansen's p-val.	0.51	0.540	0.574	0.522	0.527	0.170

Empirical findings

- **Positive and significant impact of digital capability**
- **Positive and significant impact of skilled-labour share**
- **Digitally-competent firms are producing 4-5% more sophisticated goods** digitally-incompetent firms.
- Lagged firm sophistication has a positive and significant impact on current firm sophistication
- A 1% increase in HHI increase product sophistication of GVC firms by 2%.
- Younger and larger firms are significantly more sophisticated (Eck and Huber 2016)
- No significant impact of FDI (Eck and Huber 2016 and Banga, 2017)
- **Robustness checks:** controlling for firm level productivity, magnitude of GVC participation, multi-product firm, alternate lag and variable specification, alternate measurement of explanatory variables, alternate dependent variable.

Limitations

1. Prowess only reports product-level data on sales, and not on exports.
2. Products in Prowess have to be matched to products in the HS trade classification, requiring matching by hand.
3. Controlling for export destinations for firms in the product-sophistication regressions can present novel insights.
4. Information on buyer-supplier relationships is also not available in Prowess, as a result the study cannot identify explicit governance structures that Indian GVC suppliers are operating under.

Thank you!

The full paper is available at :

https://www.wider.unu.edu/publication/digital-technologies-and-%E2%80%98value%E2%80%99-capture-global-value-chains

Q/A?

Key Contributions of the study

- Constructs a novel dataset that provides information on firm-level product upgrading in Indian firms by measuring product-sophistication using Prowess, WDI, WITS
- Lends empirical evidence to the literature examining GVCs in the context of Industry 4.0.
- Takes a quantitative micro-perspective to GVC analysis
  - Most of studies examining India in the GVC context are at the country or industry level
  - Firm-level case studies

Digital development and GVCs

1. **DT and magnitude of participation in global and regional networks**
   - Productivity improvements (Graetz and Michaels, 2015 for developed countries; UNCTAD, 2017 for Asian and Latin American countries)
   - Meeting international standards
   - Efficiencies in logistics
   - AI and big data for product development
2. **DT and the changing structure of GVCs**
   - Reshoring of manufacturing (Banga and te Velde, 2018a; Rodrik, 2018)
   - Limited future offshoring (Dachs et al., 2017)
   - 3D printing and 'on-demand production' (Backer and Flaig, 2017)
3. **DT and changing nature of governance in GVCs**
   - Platforms and governance structures (Humphrey, forthcoming; Butollo, forthcoming)
   - Control in digital global value chains (Foster et al., 2018)

Econometric model

- Equation :

$$\log(PSI_{it}) = \alpha_0 + \alpha_1 \log(PSI_{it})_{t-1} + \alpha_2 \log(PSI_{it})_{t-2} + \beta_1 \log(digital\ capability)_{it}$$
$$+ \beta_2 \log(skilled\ labour\ share)_{it}$$
$$+ \beta_3 \log(\mathrm{R\ \&}\ D\ intensity)_{it}$$
$$+ \beta_4 HHI_{jt} + \beta_5 X_{it} + a_i + a_t + a_j + e_{ijt} \ldots$$

Linking with governance

- GVC literature identifies 'network governance' between trade and FDI based governance structures
- Gereffi et al., (2005)'s framework

	Market	Modular	Relational	Captive	Hierarchy
Complexity of transactions	Low	High	High	High	High
Ability to codify transactions	High	High	Low	High	Low
Supplier competence	High	High	High	Low	Low

- Skill and knowledge of employees in the supplier firm is strongly related to the nature of task requirements (Lakhani et al.'s, 2013); **average skill level in a firm can be used as an inverse proxy for codifiability**
- **Supplier competence is likely to be positively correlated with the digital capability index**
- Firms with high digital competence- higher share of both skilled labour and digital capability- are best placed to deal with complex, less-codifiable transactions i.e. more likely to enter into Relational linkages.

Summary statistics for GVC panel, 2001-2015

Variable	Obs.	Mean	Std. Dev.	Min	Max
Real Sales	22274.00	55.17	202.15	0.010	4773.07
Real GVA	22274.00	25.85	106.94	0	2627.62
Digital capability	22273.00	0.19	0.029	0.001	11.95
Age	22167.00	27.85	18.82	1.000	136.00
GVC firm	22274.00	1.00	0.00	1.000	1.00
Foreign firm	22062.00	0.14	0.35	0.000	1.00
Product sophistication	19488.00	36.68	11.23	0.001	100.00
Labour productivity	22166.00	0.01	0.02	0.000	1.21
HHI	22274.00	0.20	0.21	0.014	1.00
Share of skilled labour	22274.00	7.82	0.90	5.710	8.83
Total persons engaged	22166.00	2523	10483	1	504601