COVID Scarring and Sustainable Recovery Challenges: A Production Function Approach

Saurabh Ghosh
Pawan Gopalakrishnan
Debojyoti Mazumder

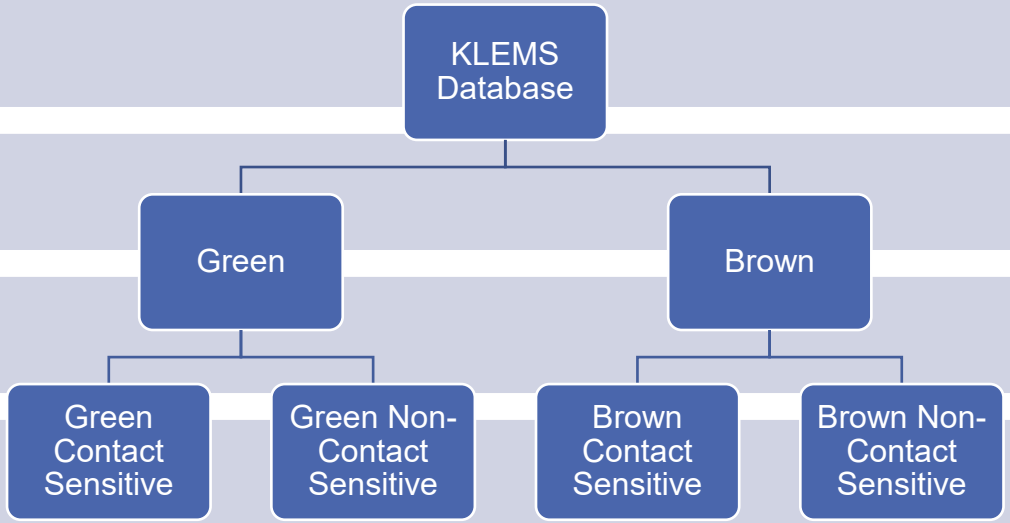
Schema

25 Industries excluding Agriculture and Public Administration

Based on Median Energy Cost

Based on Median of inverse of labour productivity

Pre covid trends in TFP, Labour and Capital



Covid Scarring

- Counterfactual, without covid scenario estimated using endogenous growth model
- Comparted with actuals based with extended data, broadly using KLEMS principles

Cascading

- Important to estimate mutual dependence among industries for future sustainable inclusive growth.
- Cascading quantified using IO- Matrix

Conclusions and Policy

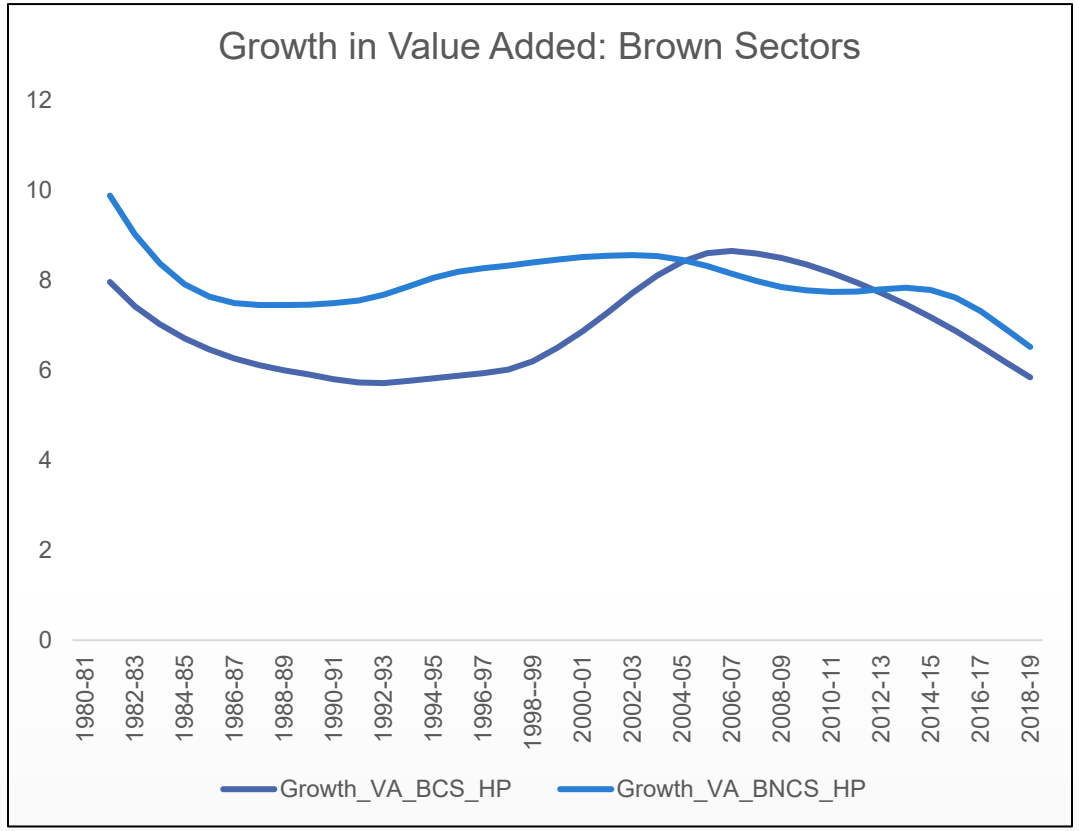
- Carefully calibrated public policy to promote the implementation of greener technologies, by
- Explicitly accounting for interdependence and short-term transitional cost.

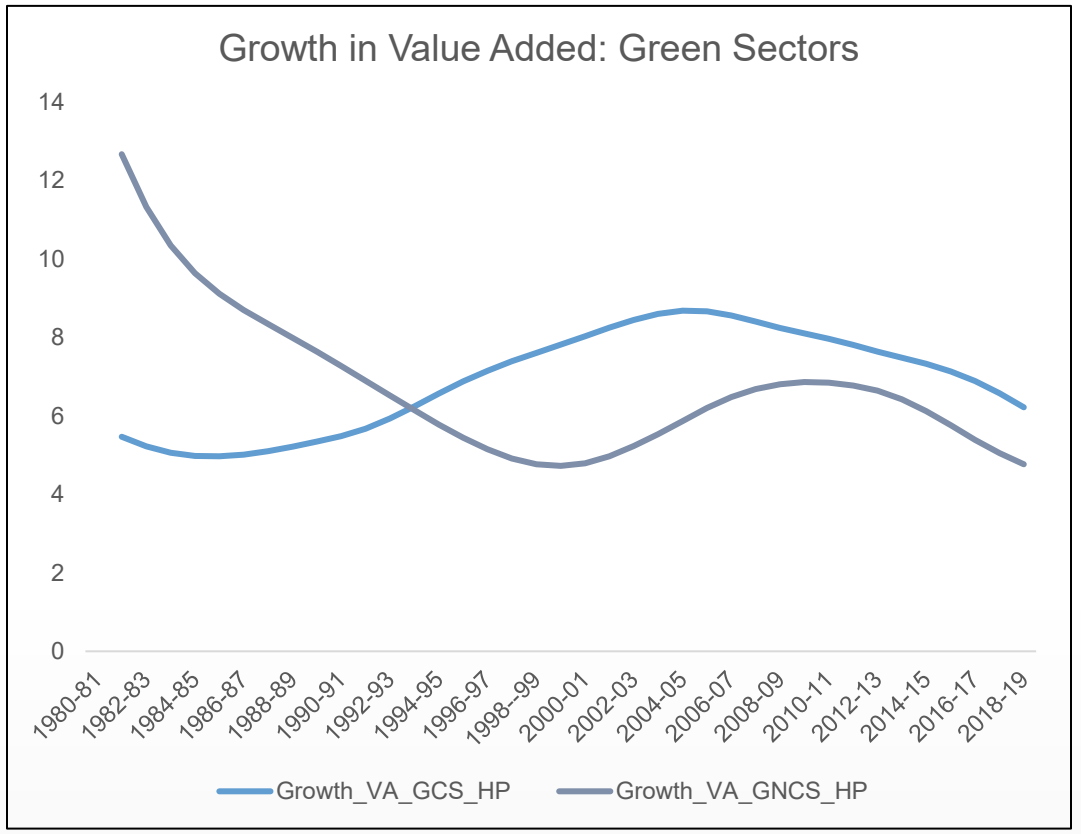
Data and classifications

- Sustainable Growth- discussions were focused around green and brown sectors.
- Covid-19 hit- two divisions -contact sensitive and non-contact sensitive sectors
- Aggregate the factor inputs and GVA of the relevant industries for $\{Brown, Green\} \times$ {contact sensitive and non−contact sensitive} sectors
- For the financial year 2019-20 and 2020-21 -CMIE Prowess and Consumer Pyramid data for

KLEMS Industry Description	Brown or Green	Contact Sensitive
Textiles, Textile Products, Leather and Footwear	Brown	Contact Sensitive
Other Non-Metallic Mineral Products	Brown	Contact Sensitive
Transport and Storage	Brown	Contact Sensitive
Pulp, Paper,Paper products,Printing and Publishing	Brown	Contact Sensitive
Wood and Products of wood	Green	Contact Sensitive
Manufacturing, nec; recycling	Green	Contact Sensitive
Hotels and Restaurants	Green	Contact Sensitive
Construction	Green	Contact Sensitive
Food Products,Beverages and Tobacco	Green	Contact Sensitive
Education	Green	Contact Sensitive
Trade	Green	Contact Sensitive
Health and Social Work	Green	Contact Sensitive
Electrical and Optical Equipment	Brown	Non-Contact Sensitive
Rubber and Plastic Products	Brown	Non-Contact Sensitive
Basic Metals and Fabricated Metal Products	Brown	Non-Contact Sensitive
Business Service	Brown	Non-Contact Sensitive
Post and Telecommunication	Brown	Non-Contact Sensitive
Transport Equipment	Brown	Non-Contact Sensitive
Chemicals and Chemical Products	Brown	Non-Contact Sensitive
Electricity, Gas and Water Supply	Brown	Non-Contact Sensitive
Mining and Quarrying	Brown	Non-Contact Sensitive
Other services	Green	Non-Contact Sensitive
Machinery, nec.	Green	Non-Contact Sensitive
Financial Services	Green	Non-Contact Sensitive
Coke, Refined Petroleum Products and Nuclear fuel	Green	Non-Contact Sensitive

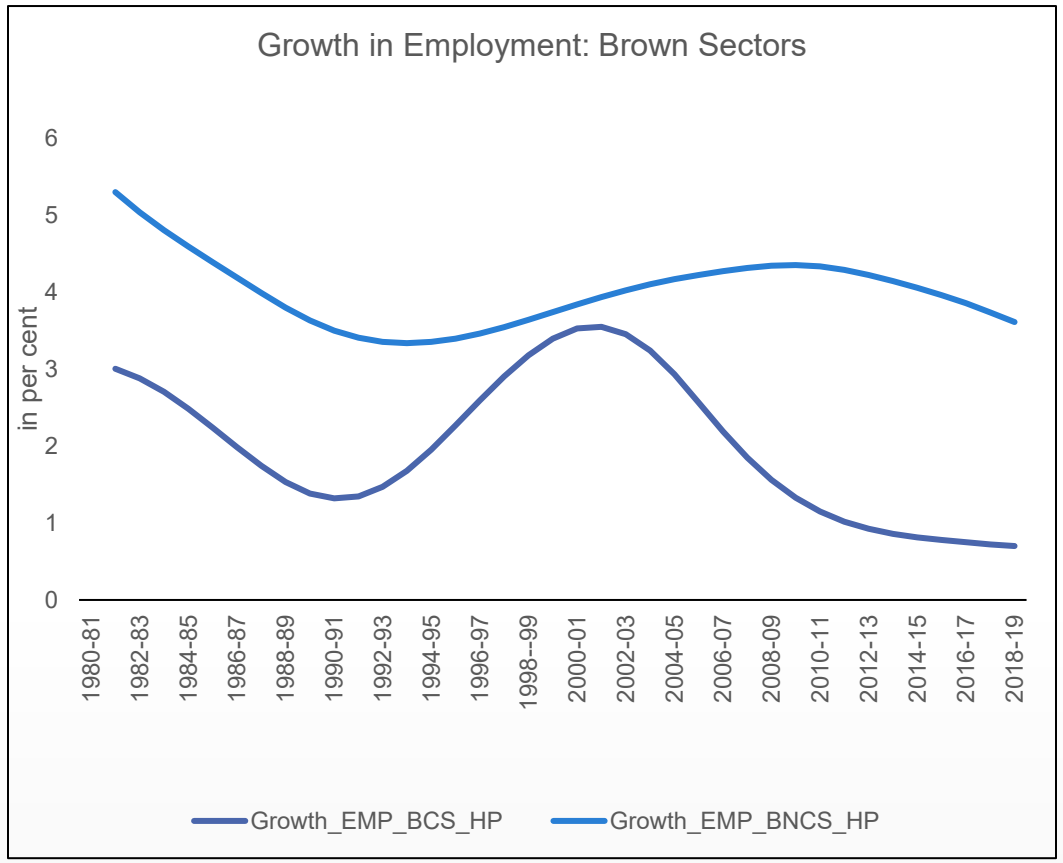
Green and Brown Sectors: Pre-Covid Trends in GVA

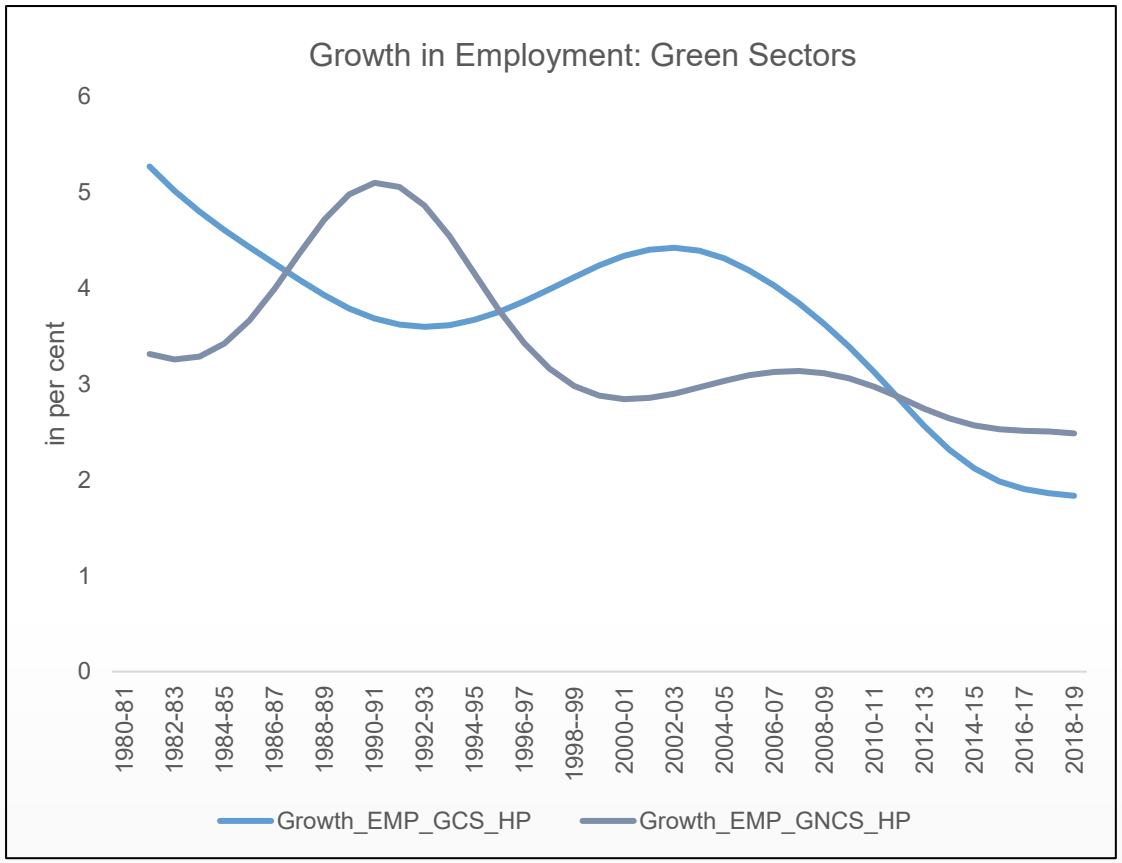




- Growth rate of trend in value added (VA) Brown is more than Green sectors.
- Growth in VA of green non-contact sensitive (GNCS) remained subdued from 1990s.
- Brown non-contact sensitive (BNCS) sector's VA growth was largely stable.

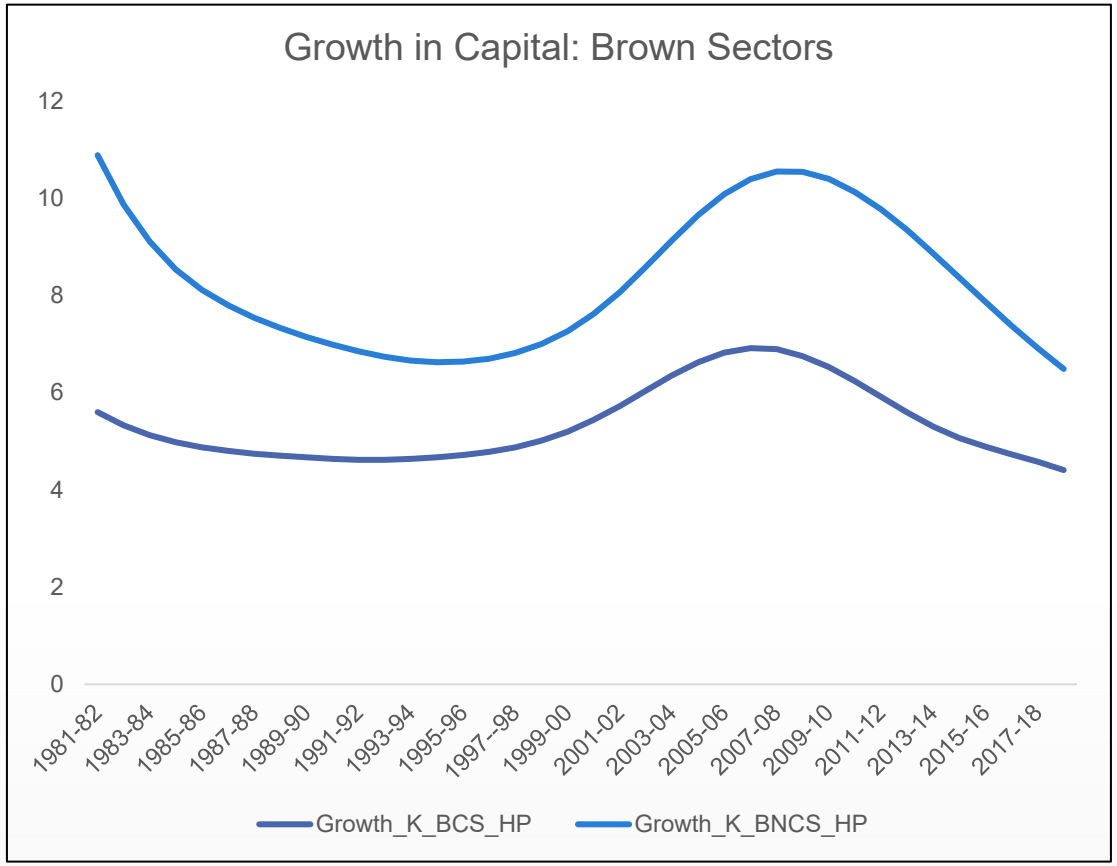
Green and Brown Sectors: Pre-Covid Trends in Employment

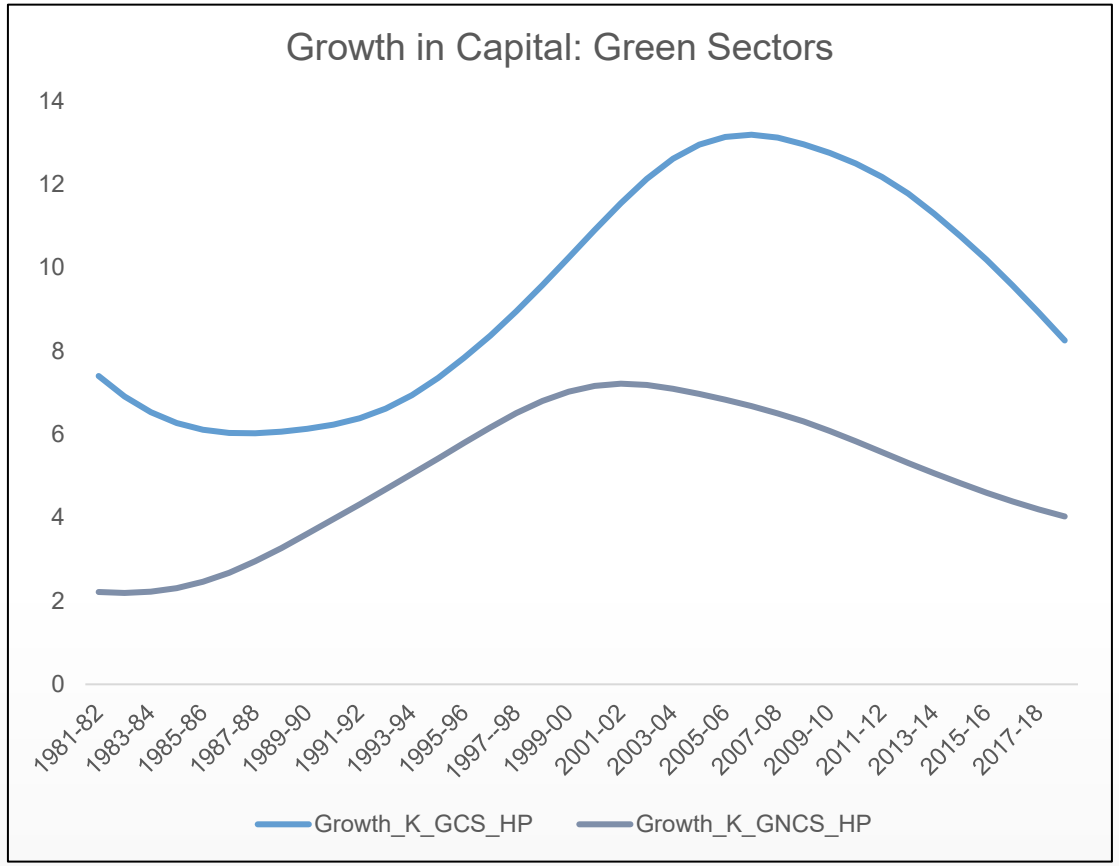




- Broad-based sharp fall in trend employment growth from 2000-01 till 2018-19. BNCS sector witnessed highest growth, even post GFC.
- GNCS sector's employment growth was stable at a lower rate from late 1990s'.

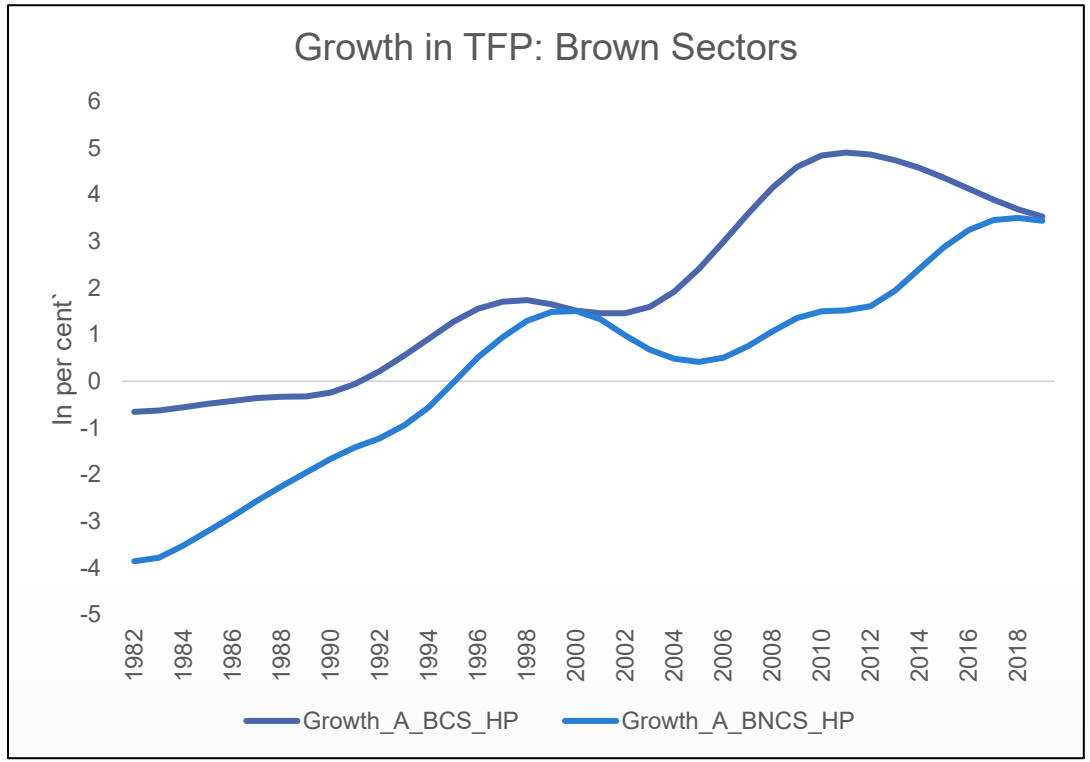
Green and Brown Sectors: Pre-Covid Trends in Capital

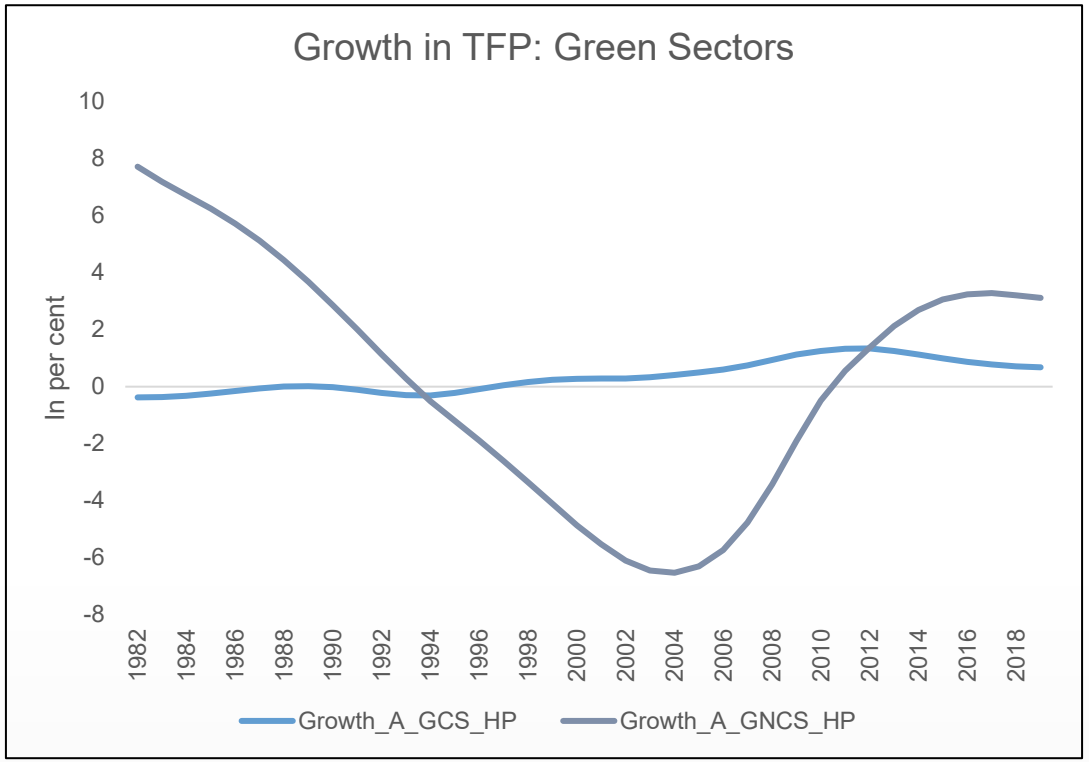




- Growth rate of trend in capital (K) of all the four sectors were slowing down after 2010, too.
- Capital growth for overall green sectors lower than brown sectors.

Green and Brown Sectors: Pre-Covid Trends in TFP Growth





- The slowdown which were visible in GVA, Employment and Capital growth after 2009-10 was largely absent in TFP growth, except for BCS.
- TFP growth in brown sectors on average remained higher than the green sectors TFP growth after 2008-09.

Model Prediction: Pre-Pandemic Scenarios

Methodology

- Cobb-Douglas production function:
- $\boldsymbol{A}_{jt}$ is the effective TFP level for the firm in sector j.
- Firms pay wages and face adjustment cost of investment

- Firms pay tax at the rate T_y to the government.
- The government spends the tax revenue to meet the expense of its own consumption, and on building public capital stock.

Equations

$$Y_{i,j,t} = F\left(K_{ijt}, L_{ij};\ \boldsymbol{A}_{jt}\right) = \boldsymbol{A}_{jt} K_{ijt}^{1-\alpha_j} L_{ij}^{\alpha_j}$$

$$I\ (1 + \frac{b}{2}\ (I/K)), \text{where } b > 0.$$

$$\boldsymbol{A_{j,t}} \equiv\ A_{0,j} K_{G,t}^{\alpha_j}$$

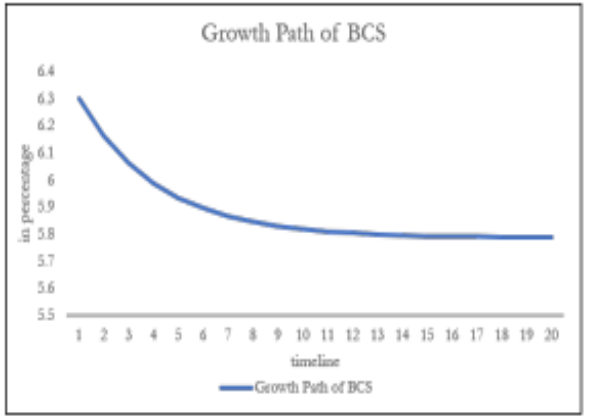
$$T_Y Y_t = g\ Y_t + I_{G,t}$$

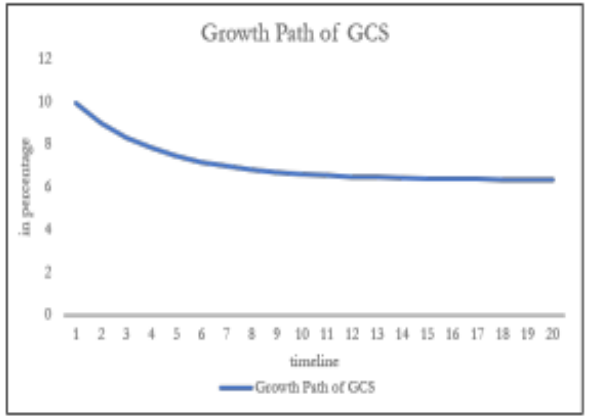
$$\dot{K_G}\ = I_{G,t} -\ \delta_G K_{G,t}$$

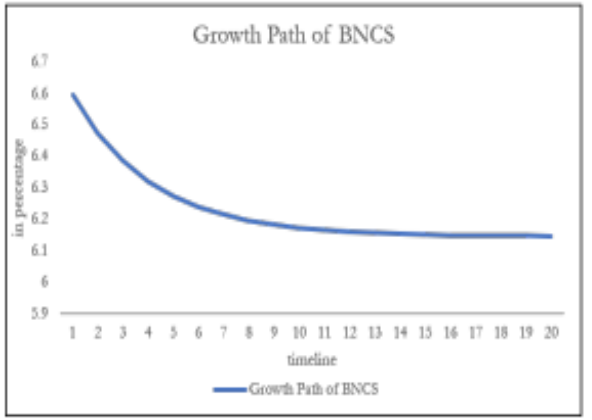
$$\dot{K_{ijt}} = I_{ijt} -\ \delta\ K_{ijt}$$

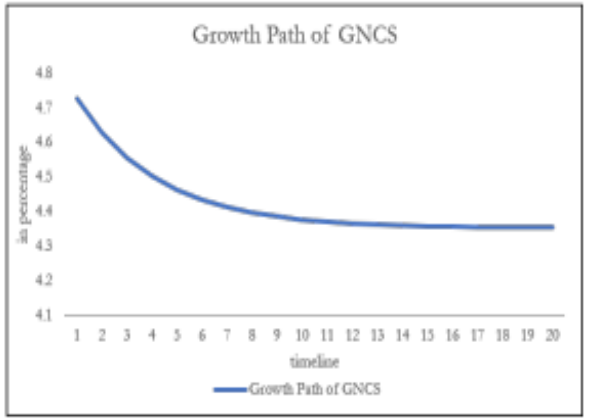
Model Simulation

Sl. No.	Parameters	GCS	BCS	GNCS	BNCS	Source
1	Labour Income Share (α)	0.60	0.47	0.44	0.33	Estimated from KLEMS
2	Depriciation (δ)	0.1	0.1	0.1	0.1	Banerjee and Basu (2019)
3	Marginal adjustment cost of investment (b)	5.45	5.45	5.45	5.45	RCF (2021)
4	Tax to GDP (T_y)	0.25	0.25	0.25	0.25	Estimated
5	Depriciation of public capital (δ_g)	0.14	0.14	0.14	0.14	RCF (2021)
6	Revenue Expenditure to GDP ratio (g)	0.16	0.16	0.16	0.16	Estimated
7	Real rate of return (r)	1.01	1.01	1.01	1.01	Behera, Wahi, and Kapur (2017)
8	$A_{0,j}$	3.98	1.72	1.556	1.405	Estimated from KLEMS
9	Effective Labour (L^{α})	0.64	1	1.06	1.17	Calibrated





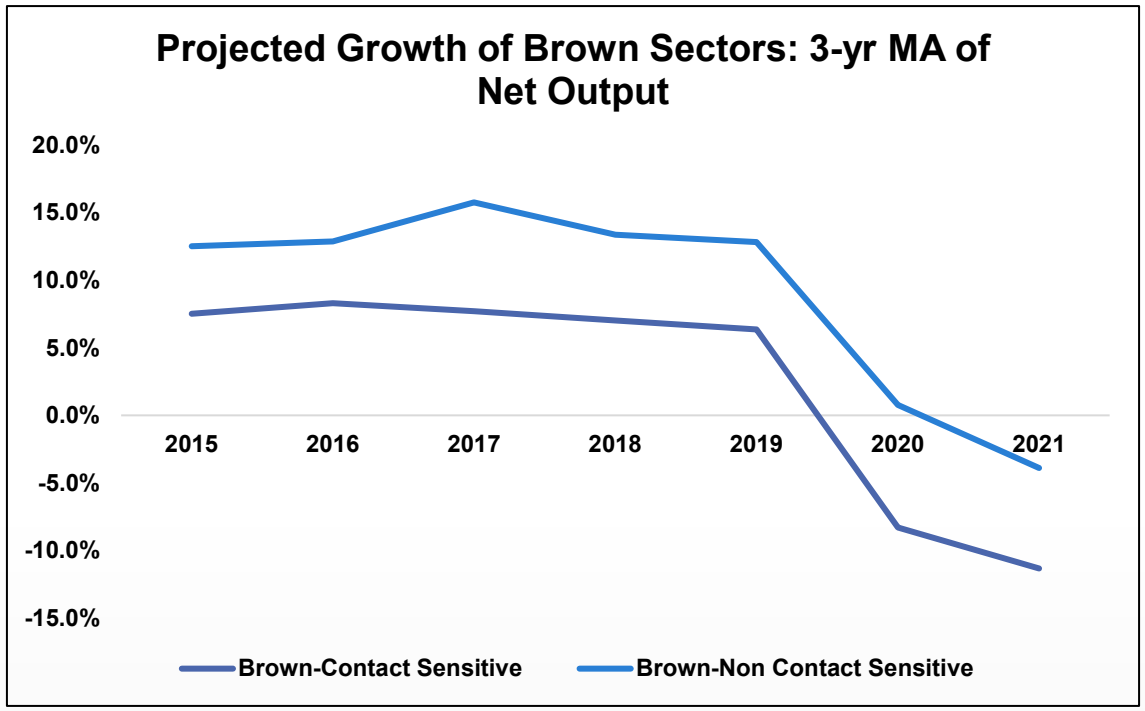


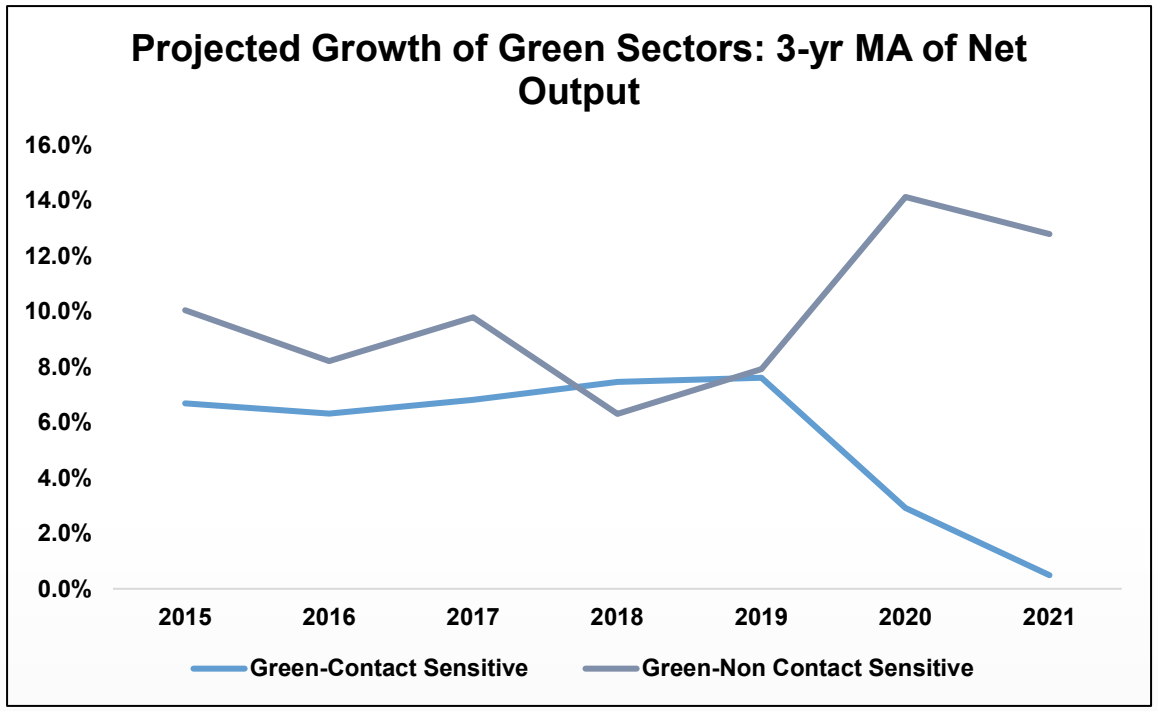


Concordance Methodology for Projections

- The official KLEMS data ends in 2019.
- Concordance between KLEMS database and two major CMIE databases
  - Between Prowess and KLEMS for projecting capital
  - Between CP and KLEMS for projecting labour
- Net output is then computed using the standard Cobb-Douglas production function for the period 2008-2021
- Growth rates are then computed for 2020 and 2021 for the four subsectors, and the 3-yr moving average growth paths are reported.

Projected Growth

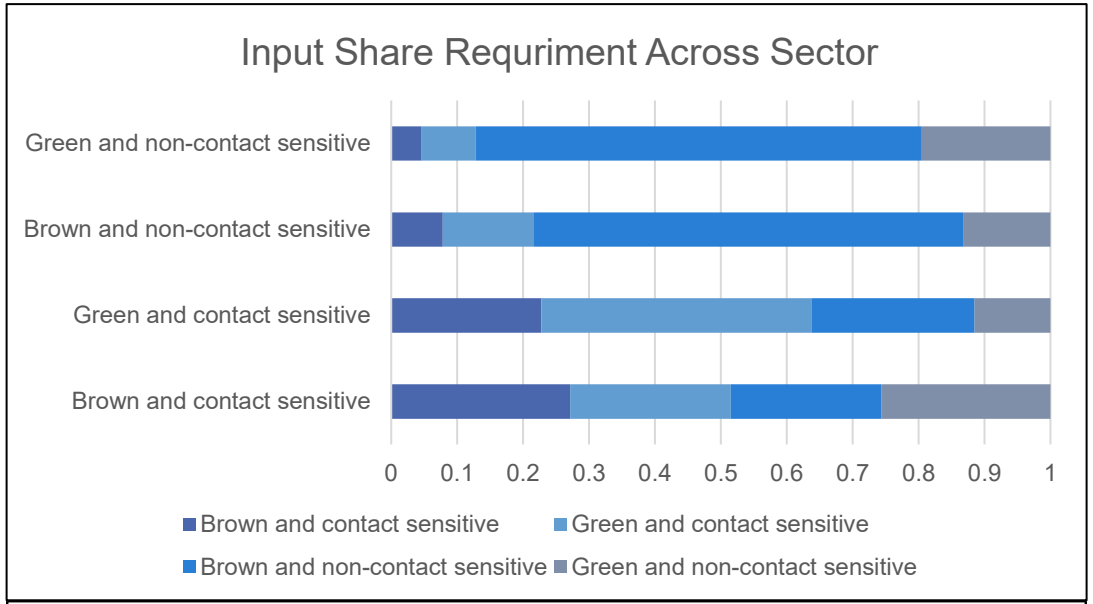


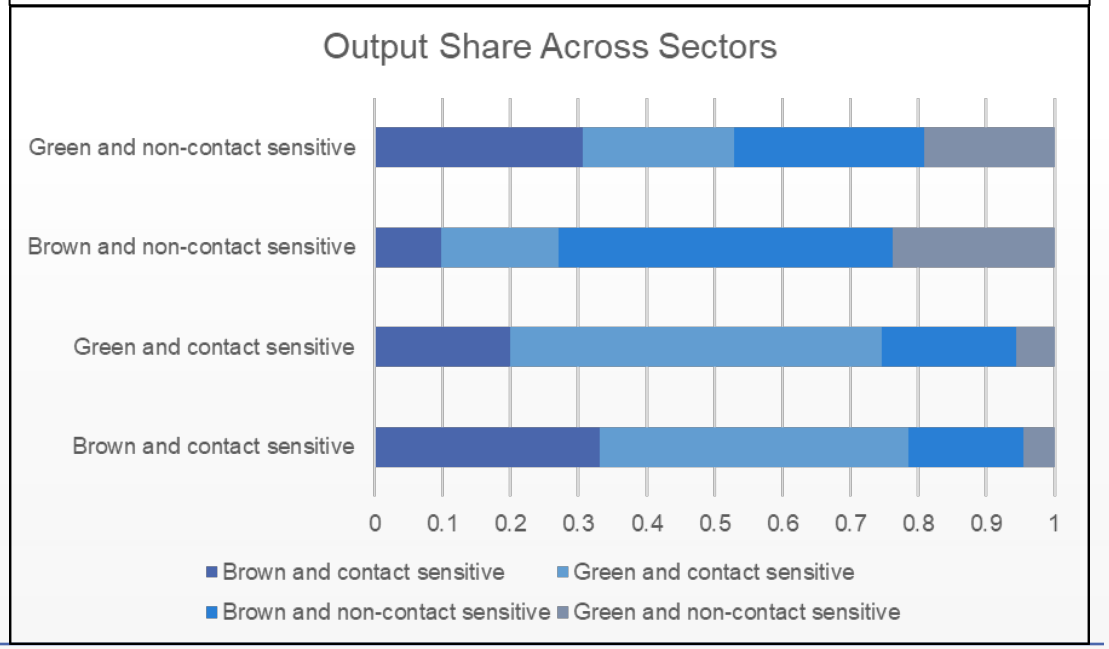


- Brown sectors contracted more than the Green sectors; CS contracted more than NCS – suggests resilience in the green sectors
- Scarring Contraction: GCS (>6 per cent), BCS (>17 per cent), BNCS (>10 per cent)

Cascading Effect

- Cross-industry metrics which help understand the true impact and (FSB, 2022)
- Latest available Input-Output (IO) matrix released on 2007-08
  - That is, 130×130 IO matrix, is first compressed to 27×27 IO matrix,
  - Excluding the agriculture and public administration we further reduced it to 4×4 IO matrix.
- There are two stages of concordance which are required:
  - IO matrix of 130 sectors to KLEMS's 27 industries concordance
  - KLEMS to $\{B, G\} \times \{CS, NCS\}$
- Green sector depend heavily on brown sectors for inputs.
- Around 45 per cent of total output produced by the BCS sector goes to of GCS sector as input.





Conclusion

- Two-fold challenges that include reviving the hard-hit economy and moving towards a greener economy.
- Using KLEMS dataset – four segmentations:
  - brown and green, and
  - contact sensitive and non-contact sensitive industries.
- Pre-pandemic trends: capital and labour have been slowing down since 2010
- Pandemic scarring was lower for the green segment, which highlights its resilience.
- Results indicate considerable interdependence and circularity among the sub-sectors.
- Therefore, transition of the brown to green industries would necessitate
  - Carefully calibrated public to promote the implementation of greener technologies, by
  - Explicitly accounting for interdependence and short-term transitional cost.

Thank you

Green and Brown Sectors: Pre-Covid Trends in TFP

Methodology

- We assume the following Cobb-Douglas production function:

$$Y_{ijt} = A_{ijt}\widetilde{K}_{ijt}^{\alpha_{ij}} H_{ijt}^{\beta_{ij}} \quad (1)$$

where, $i = \{\mathrm{CS}, \mathrm{NCS}\}$ and $j = \{\mathrm{G}, \mathrm{B}\}$. $\widetilde{K}_{ijt}$ represents the aggregate capital input after augmenting capital quality and H_{ijt} is the aggregate labour input after augmenting labour quality for the $\{i,j\}^{th}$ industry sub-category at period t. Whereas Y denotes the GVA and A is the TFP.

- We followed the KLEMS approach to estimate the α_{ij} and β_{ij} by using the cost share of each inputs.

- We divide the GVA of $\{i,j\}$ sector by $\widetilde{K}_{ijt}^{\alpha_{ij}} H_{ijt}^{\beta_{ij}}$ to estimate the TFP for $\{i,j\}$ sector, i.e.,

$$A_{ijt} = \frac{Y_{ijt}}{\widetilde{K}_{ijt}^{\alpha_{ij}} H_{ijt}^{\beta_{ij}}} \quad (2)$$