The Dynamics of Indian Labour: Ramifications for Future of Work and Sustainability

Supplementary Tables

Table S1. Variables: Label, Expansion and Definition (Penn World Data).

Variable Name	Variable Label	Expansion	Definition
Labour	lnemp	Logarithm of Employed	Number of persons engaged (in millions)
Gross Domestic Product	lngdp	Logarithm of Real GDP	at constant 2017 national prices (In mil. 2017US$)
Capital	lncap	Logarithm of Real Capital	Capital stock at constant 2017 national prices (in mil. 2017US$)
Work Hours	lnavh	Logarithm of Average Working Hours	Average annual hours worked by persons engaged
Labour Productivity	lnprod	Logarithm of Labour Productivity	$Logarithm\left(\dfrac{Real\ GDP}{Employed}\right)$
Capital Productivity	lncaplab	Logarithm of Capital per Employed	$Logarithm\left(\dfrac{Real\ Capital}{Employed}\right)$
Human Capital	hc	Human Capital	Human capital index, based on years of schooling and returns to education
Total Factor Productivity	rtfpna	Real Total Factor Productivity	Total Factor Productivity at constant national prices (2017 = 1)

Source: based on Penn World Table 10.10 (Feenstra et al. 2015).

Table S2. Variables: Label, Expansion and Definition (Annual Survey of Industries).

Variable Name	Variable Label	Expansion	Definition
Net Value Added	lnnva	Logarithm of Net Value Added	(Value of Output - Value of Raw Materials) - Depreciation
Fixed capital	lncapital	Logarithm of Fixed Capital	Value of Plant and Machinery
Employment	lnlabour	Logarithm of Employed	Directly employed personnel and contract workers
Manager and Supervisor	lnmanager	Logarithm of the count of managers and supervisors	Supervisory and Managerial Staff
Direct employment	lnworkdirect	Logarithm of directly employed workers	Directly employed worker
Contract workers	lnworkcontract	Logarithm of contract workers	Workers sourced through contractor/s
Productivity	lnproductivity	Logarithm of Productivity	$\dfrac{Net\ Value\ Added}{Employed}$
Capital-Labour Ratio	lncaplab	Logarithm of Capital per employed	$\dfrac{Fixed\ Capital}{Employed}$
Managerial Ratio	manager_ratio	Logarithm of Managers and supervisors as a proportion of Employees	$\dfrac{Managers\ and\ supervisors}{Employed}$
Contract Workers Ratio	contractlabour_ratio	Logarithm of Contract Workers as a proportion of Employees	$\dfrac{Contract\ Workers}{Employed}$
Wage Rate Ratio Managers	lnwagem	Logarithm of Wage Rate (Managers)	$\dfrac{Emolument\ of\ Managers\ and\ Supervisors}{Managers\ and\ supervisors}$
Wage Rate Ratio Direct Workers	lnwaged	Logarithm of Wage Rate (Directly Employed Workers)	$\dfrac{Emolument\ of\ Directly\ employed\ Workers}{Directly\ employed\ Workers}$
Wage Rate Ratio contract workers	lnwagec	Logarithm of Wage Rate (Contract Workers)	$\dfrac{Emolument\ of\ Contract\ Workers}{Contract\ Workers}$
Pollution Control Ratio	lnpollutinput	Logarithm of the Ratio of Value of Pollution	$\dfrac{Value\ of\ Pollution\ Control\ Equipment}{Value\ of\ Inputs}$

Control Equipment to
Value of Inputs

Table S3. Descriptive Statistics of variables from ASI 2017-18 [Source: Author(s) computation from the unit records of Annual Survey of Industries (2017-2018)].

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Value-added	50459	2.94	26.76	16.70	2.16
Capital	54545	0.00	27.51	15.61	3.02
Labour	55894	0.00	11.21	3.89	1.74
Count of Managers	49020	0.00	8.73	1.81	1.41
Count of Direct Workers	49089	0.00	11.18	3.40	1.57
Count of Contract Workers	19685	0.00	10.66	4.04	1.56
Productivity	51771	3.00	20.29	12.80	1.09
Capital-Labour Ratio	53863	-10.23	22.52	11.72	2.22
Managerial Ratio	49020	0.00	1.00	0.13	0.12
Contract Workers Ratio	19685	0.00	1.00	0.51	0.26
Wage Rate Ratio Managers	49043	0.00	23.59	14.76	2.13
Wage Rate Ratio Direct Workers	49089	0.79	16.00	11.71	0.62
Wage Rate Ratio contract workers	19685	-5.05	17.36	11.58	0.59
Pollution Control Ratio	3453	-24.30	5.19	-6.38	2.93

Table S4. Weights for networks between labour, economy and technology [Source: Author(s) computation from Penn World Data 10.10].

Network A (Weights)

Variable	Labour	GDP	Capital	Work Hours	Betweenness	Closeness
Labour	0.00	0.20	0.07	0.16	-0.87	-1.37
GDP	0.20	0.00	0.73	0.15	0.87	0.74
Capital	0.07	0.73	0.00	0.46	0.87	0.74
Work Hours	0.16	0.15	0.46	0.00	-0.87	-0.11

Network B (weights)

Variable	Productivity	Capital-labour ratio	Human Capital	Labour Share	Total Factor Productivity	Betweenness	Closeness
Productivity	0.00	0.46	0.42	-0.09	0.33	1.79	1.11
Capital-labour ratio	0.46	0.00	0.47	0.00	0.00	-0.45	0.39
Human Capital	0.42	0.47	0.00	0.00	0.20	-0.45	0.34
Labour Share	-0.09	0.00	0.00	0.00	0.07	-0.45	-1.55
Total Factor Productivity	0.33	0.00	0.20	0.07	0.00	-0.45	-0.29

Note: Using the estimator EBICglasso. Networks are weighted and signed. The bootstrap type is non-parametric.

Table S5. Occupation: categories and subcategories [Source: National Classification of Occupation 2004 (https://labour.gov.in/sites/default/files/CodeStructure.pdf)].

Categories	Subcategories
Legislators, Senior Officials and Managers	Legislators and Senior Officials, Corporate Managers, General Managers
Professionals	Physical, Mathematical and Engineering Science Professionals, Life Science and Health Professionals, Teaching Professionals, Other Professionals
Technicians and Associate Professionals	Physical and Engineering Science Associate Professionals, Life Science and Health Associate Professionals, Teaching Associate Professionals, Other Associate Professionals
Clerks	Office Clerks, Customer Services Clerks
Service Workers and Shop & Market Sales Workers	Personal and Protective Service Workers, Models, Sales Persons and Demonstrators
Skilled Agricultural and Fishery Workers	Market Oriented Skilled Agricultural and Fishery Workers, Subsistence Agricultural and Fishery Workers

Craft and related Trades Workers	Extraction and Building Trades Workers, Metal, Machinery and Related Trades Workers, Precision, Handicraft, Printing and Related Trades Workers, Other Craft and Related Trades Workers
Plant and Machine Operators and Assemblers	Stationary Plant and Related Operators, Machine Operators and Assemblers, Drivers and Mobile-Plant Operators
Elementary Occupations	Sales and Services Elementary Occupations, Agricultural, Fishery and Related Labourers, Labourers in Mining, Construction, Manufacturing and Transport

Table S6. Relationship between variables and the emerging networks [Source Author(s) computation from the unit records of Annual Survey of Industries (2017-2018).

Variables (in Rows) / Networks (in Columns)	A	B	C	D
	Membership in Networks (Yes/No)			
Value-added	Yes	Yes	No	No
Capital	Yes	Yes	No	No
Labour	Yes	No	No	No
Managerial staff	No	Yes	No	No
Direct employment	No	Yes	No	No
Contract workers	No	Yes	No	No
Productivity	No	No	Yes	Yes
Capital-labour ratio	No	No	Yes	Yes
Managerial staff ratio	No	No	Yes	No
Contract workers ratio	No	No	Yes	No
Wage rate managers	No	No	No	Yes
Wage rate ratio direct workers	No	No	No	Yes
Wage rate ratio contract workers	No	No	No	Yes

Table S7. Network weights for EBICglasso estimation [Source: Author(s) computation from the unit records of Annual Survey of Industries (2017-2018)].

Network A (Weights)

Variable	Labour	Capital	Value-added	Betweenness	Closeness
Labour	0.00	0.17	0.63	-0.58	-0.38
Capital	0.17	0.00	0.45	-0.58	-0.76
Value-added	0.63	0.45	0.00	1.16	1.13

Network B (Weights)

Variable	Capital	Value-added	Managerial Ratio	Direct Workers Ratio	Contract Workers Ratio	Betweenness	Closeness
Capital	0.00	0.40	0.13	0.05	0.02	-0.45	-0.54
Value-added	0.40	0.00	0.30	0.43	0.33	1.79	1.76
Managerial Ratio	0.13	0.30	0.00	0.24	0.20	-0.45	-0.51
Direct Workers Ratio	0.05	0.43	0.24	0.00	-0.04	-0.45	-0.14
Contract Workers Ratio	0.02	0.33	0.20	-0.04	0.00	-0.45	-0.58

Network C (Weights)

Variable	Productivity	Capital-labour Ratio	Contract Workers Ratio	Managerial Ratio	Betweenness	Closeness
Productivity	0.00	0.47	-0.18	0.07	0.87	0.90

Capital-labour Ratio	0.47	0.00	-0.12	0.02	-0.87	-0.38
Contract Workers Ratio	-0.18	-0.12	0.00	-0.18	0.87	0.72
Managerial Ratio	0.07	0.02	-0.18	0.00	-0.87	-1.24

Network D (Weights)

Variable	Productivity	Wage Rate Ratio Managers	Wage Rate Ratio Direct Workers	Wage Rate Ratio contract workers	Capital-labour Ratio	Betweenness	Closeness
Productivity	0.00	0.13	0.26	0.29	0.36	1.38	1.56
Wage Rate Ratio Managers	0.13	0.00	0.37	0.24	0.06	-0.15	-0.73
Wage Rate Ratio Direct Workers	0.26	0.37	0.00	0.13	-0.01	0.61	0.23
Wage Rate Ratio contract workers	0.29	0.24	0.13	0.00	0.10	-0.92	-0.06
Capital-labour Ratio	0.36	0.06	-0.01	0.10	0.00	-0.92	-1.00

Note: Using the estimator EBICglasso. Networks are weighted and signed. The bootstrap type is non-parametric.

Supplementary Figures
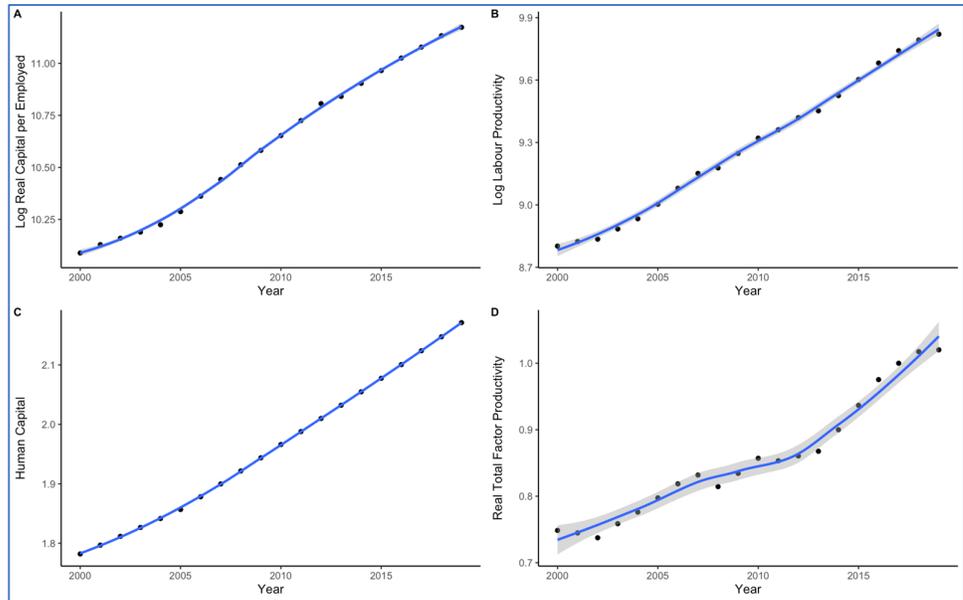
Figure S1. Technology, Productivity, and Human Capital during 2000-2019 [Source: Author(s) computation from Penn World Data 10.10].
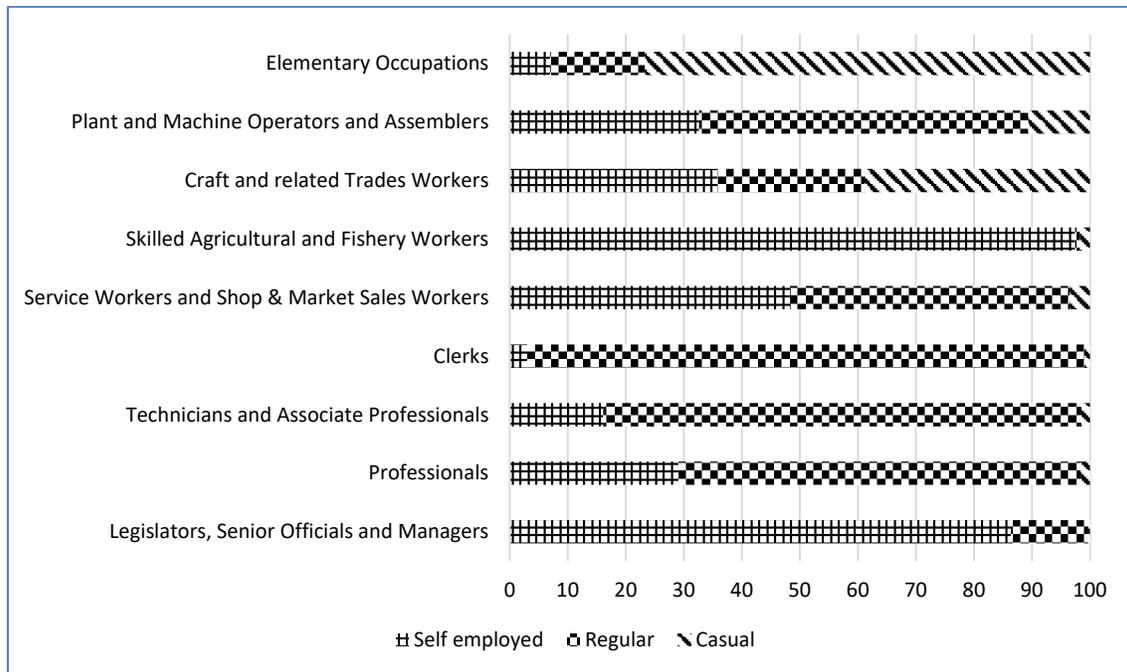
Figure S2. Occupations by Employment Status (in Million) 2019-20 [Source: Author(s) computation from unit records of Periodic Labour Force Survey 2019-20].
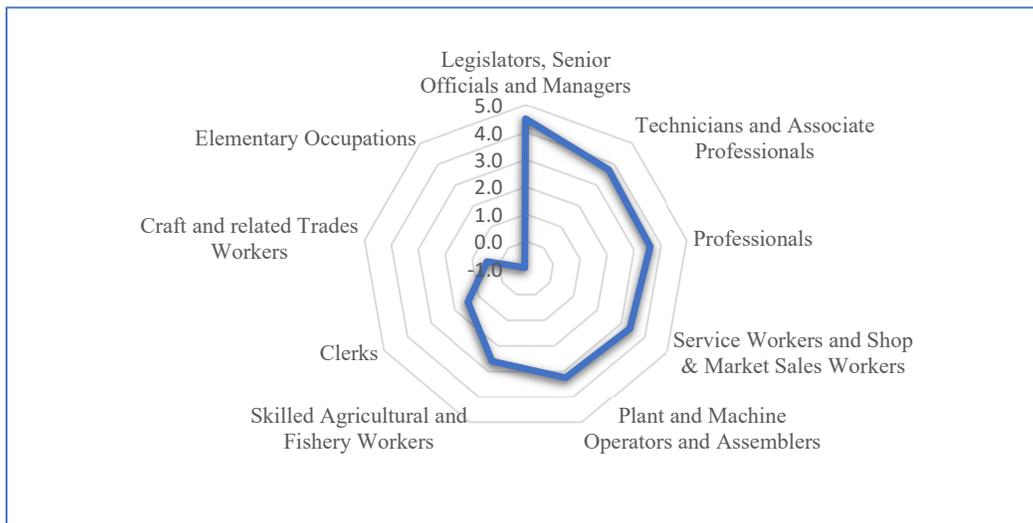

Figure S3. Annual growth rate (CAGR) of Occupational size during 2011-12 - 2019-20 [Source: Author(s) computation from unit records of NSS 68th Round and Periodic Labour Force Survey 2019-20].
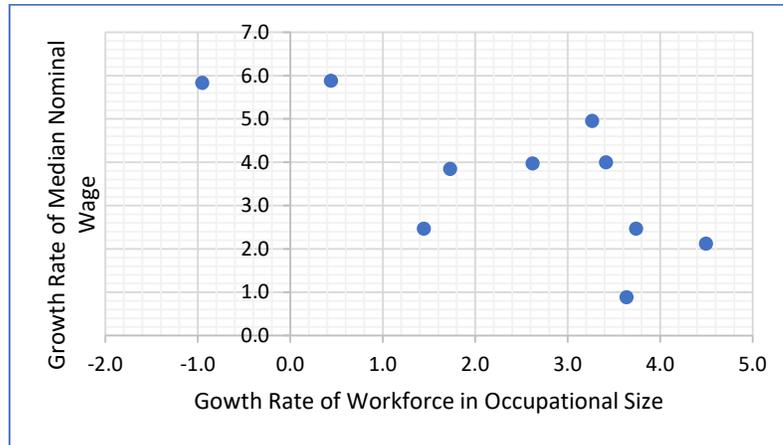
Figure S4. Compound annual growth rate (CAGR) of Occupational size and Growth Rate of Median Nominal Wage during 2011-12 - 2019-20 [Source: Author(s) computation from unit records of NSS 68th Round and Periodic Labour Force Survey 2019-20].

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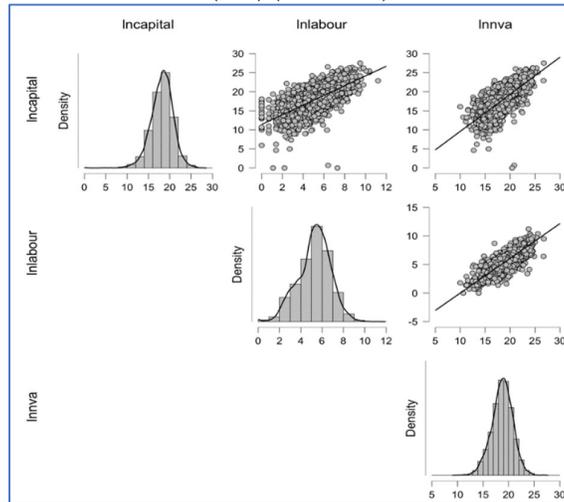
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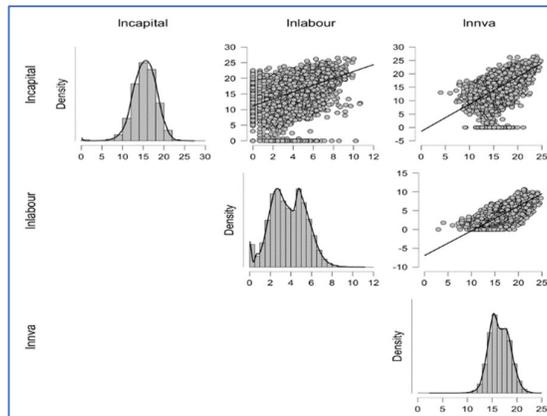
Figure S5. Correlational Plots and Density (Units with ISO certification) [Source: Author(s) computed from the unit records of Annual Survey of Industries 2017-2018].

Random Forest Classification

Trees	Predictors per split	n(Train)	n(Validation)	n(Test)	Validation Accuracy	Test Accuracy	OOB Accuracy
85	1	31228	7808	9758	0.896	0.898	0.985

Note. The model is optimized with respect to the *out-of-bag accuracy* .

Data Split

| Train: 31228 | Validation: 7808 | Test: 9758 | Total: 48794 |

Confusion Matrix

		Predicted	
		ISO Certification (Yes)	ISO Certification (No)
Observed	ISO Certification (Yes)	121	883
	ISO Certification (No)	109	8645

ROC Curves Plot
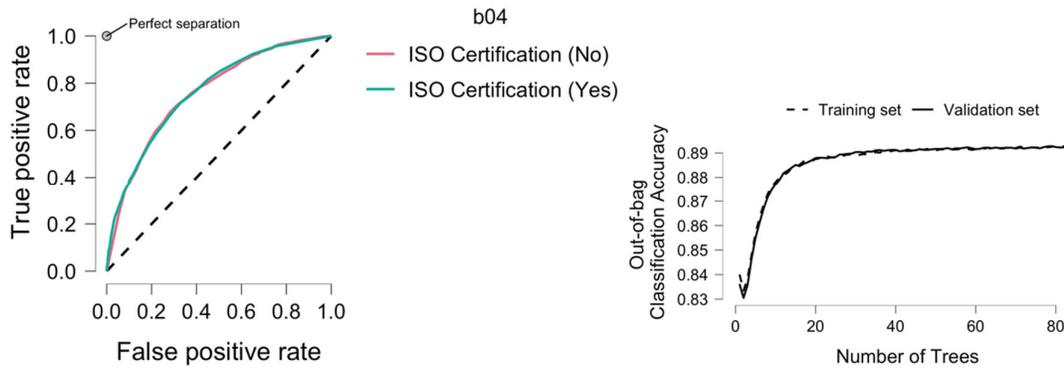
Evaluation Metrics

	Precision	Recall	F1 Score	Support	AUC
ISO Certification (Yes)	0.526	0.121	0.196	1004	0.769
ISO Certification (No)	0.907	0.988	0.946	8754	0.765
Average / Total	0.868	0.898	0.869	9758	0.767

Note. Area Under Curve (AUC) is calculated for every class against all other classes.