STRUCTURAL TRANSFORMATION, BACKWARD AND FORWARD LINKAGES AND JOB CREATION IN ASIA-PACIFIC LDCS

AN INPUT OUTPUT ANALYSIS

"TRANSFORMING ECONOMIES - FOR BETTER JOBS"

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WHAT, HOW AND WHY

Study the evolution of domestic production linkages

- How have they evolved?
- Increasing backward and forward linkages?
- Comparison to non-LDCs

Use input-output analyses, employment multipliers and network representation

- Quantify direct and indirect backward and forward linkages
- Visually capture linkages using network analysis
- Estimate employment multipliers

Traditionally received less attention

- Structural transformation has resulted in productivity and output growth
- Asia-Pacific LDCs harnessing of potential backward and forward linkages
- Mostly focused on other measures such as exports, productivity etc.

LITERATURE

Existing literature focuses mostly on the tangible benefits of structural transformation

- Labour productivity
- Productive capacities/competitiveness

Hirschman (1958): development of one sector would trigger intermediate demand for inputs produced by other sectors and provide inputs for other sectors

In contrast Davis et al. (2002): spin-off activities in non-farm sector

Choi and Foerster (2017): Magnitude of spillover effects

Acemoglu et al (2007) and Jones (2011): theoretical model to show distortions in input markets

Bartelme and Gorodnichenko (2015): relationship between the strength of industry linkages and aggregate productivity

FRAMEWORK

Partly based on Mercer-Blackman, Foronda and Mariasingham (2017)

Compute numerous summary measures of production linkages: backward agglomeration, participation in production, total agglomeration and employment multipliers

- ADB Multi-Regional Input-Output Tables Database 2018 (2000-2017)
- ILOSTAT

Use these computations to apply network analysis to visualize the linkages and their evolution.

Incoming and outgoing degrees

Betweenness centrality

Density

FRAMEWORK

- Intermediate input matrix:

$$Z^c = \begin{pmatrix} z^c_{1,1} & \cdots & z^c_{1,n} \\ \vdots & z^c_{i,j} & \vdots \\ z^c_{n,1} & \cdots & z^c_{n,n} \end{pmatrix}$$

- Output flow vector and employment vector

$$Y^c = \begin{pmatrix} y^c_i \\ \vdots \\ y^c_n \end{pmatrix};\ e^c = \begin{pmatrix} e^c_i \\ \vdots \\ e^c_n \end{pmatrix}$$

- Technical coefficient matrix:

$$A^c \equiv \begin{pmatrix} z^c_{1,1} & \cdots & z^c_{1,n} \\ \vdots & z^c_{i,j} & \vdots \\ z^c_{n,1} & \cdots & z^c_{n,n} \end{pmatrix} * diag(Y^c)^{-1} = \begin{pmatrix} a^c_{1,1} & \cdots & a^c_{1,n} \\ \vdots & a^c_{i,j} & \vdots \\ a^c_{n,1} & \cdots & a^c_{n,n} \end{pmatrix}$$

- Leontiff inverse matrix:

$$L^c \equiv \left[\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} - \begin{pmatrix} a^c_{1,1} & \cdots & a^c_{1,n} \\ \vdots & a^c_{i,j} & \vdots \\ a^c_{n,1} & \cdots & a^c_{n,n} \end{pmatrix} \right]^{-1} = \begin{pmatrix} l^c_{1,1} & \cdots & l^c_{1,n} \\ \vdots & l^c_{i,j} & \vdots \\ l^c_{n,1} & \cdots & l^c_{n,n} \end{pmatrix}$$

- Backward requirements multiplier: $\sum_{i=1}^{n} l^c_{i.j}$
- The backward linkage of economy cluster k of country c is defined as $BL^c_k \equiv \frac{1}{k}\left(\sum_{\text{for all } j \text{ in } k} \sum_{i=1}^{n} l^c_{i.j}\right)$.
- Similarly, the forward linkage of economy cluster k is defined as $FL^c_k \equiv \frac{1}{k}\left(\sum_{\text{for all } i \text{ in } k} \sum_{j=1}^{n} l^c_{i.j}\right)$.

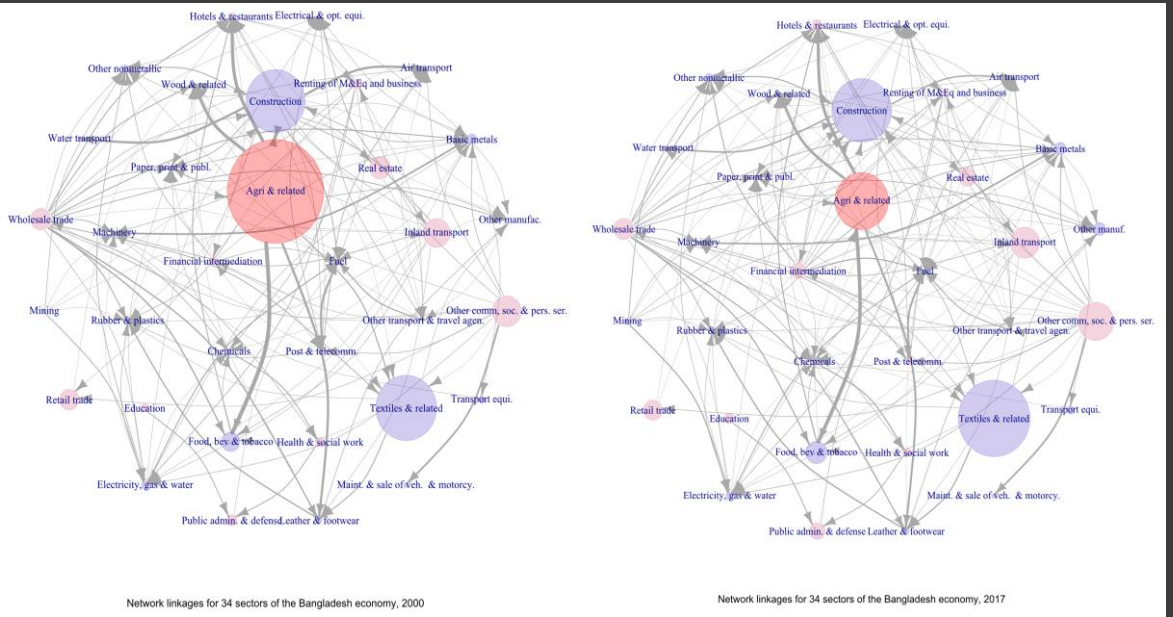
FRAMEWORK

- Production participation matrix (output and input based):

P^c is an nxn matrix; $p^c_{i,j=1}$ if $a^c_{i,j}$>2%, 0 otherwise

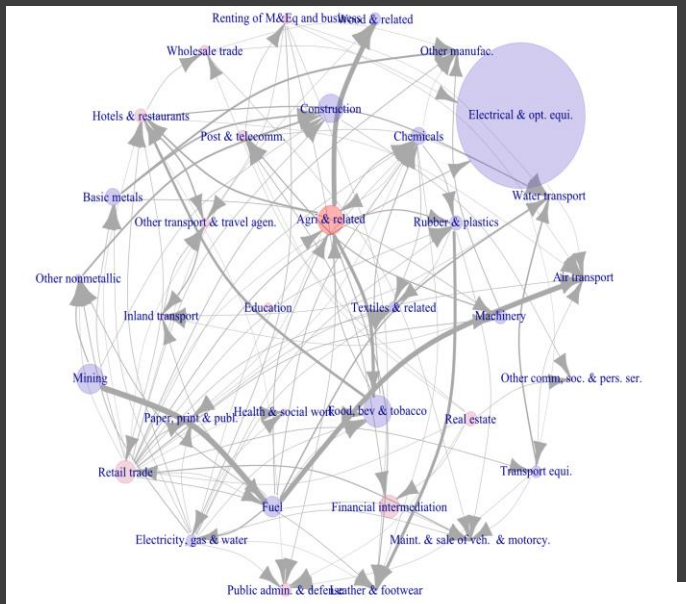
- The *j*-th column total $\sum_{i=1}^{n} p^c_{i.j}$ measures the degree of backward participation-in-production of sector *j*
- The *i*-th row total $\sum_{j=1}^{n} p^c_{i.j}$ represents the degree of forward participation-in-production of sector *I*
- The backward participation-in-production of economic cluster *k* in country *c* is defined as $BPP^c_k \equiv \frac{1}{k}\left(\sum_{for\ all\ j\ in\ k} \sum_{i=1}^{n} p^c_{i.j}\right)$
- The forward participation-in-production of economic cluster *k* is defined as $FPP^c_k \equiv \frac{1}{k}(\sum_{for\ all\ i\ in\ k} \sum_{i=1}^{n} p^c_{i.j})$.
- The participation-in-production of economic cluster *k* is defined as $PP^c_k \equiv \frac{1}{2}(BPP^c_k + FPP^c_k)$.
- The backward agglomeration index for cluster *k* is a product of the degree and strength of backward production linkages and defined as $BA^c_k \equiv BL^c_k * BPP^c_k$
- The total agglomeration for country *c* is $TA^c \equiv \frac{1}{n^2}(\sum_{for\ all\ j} \sum_{i=1}^{n} l^c_{i.j})(\sum_{for\ all\ j} \sum_{i=1}^{n} p^c_{i.j})$.
- Employment multiplier matrix M^c is defined as $M^c \equiv diag(e^c)\ diag(y^c)^{-1}\ L^c$
- The *j*-th column sum $\sum_{i=1}^{n} m^c_{i.j}$ is the total number of additional jobs associated with an additional unit of final demand in sector *j*.
- The employment multiplier for economic cluster *k* of country c is defined as $EM^c_k \equiv \frac{1}{k}(\sum_{for\ all\ j\ in\ k} \sum_{i=1}^{n} m^c_{i.j})$.

NETWORK REPRESENTATION USING COMPUTATIONS: EVOLUTION OF DOMESTIC PRODUCTION LINKAGES

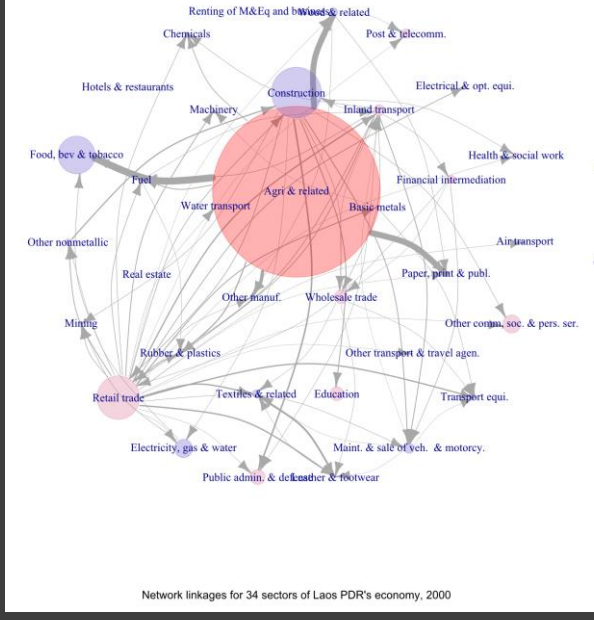


Network linkages for 34 sectors of the Bangladesh economy, 2000

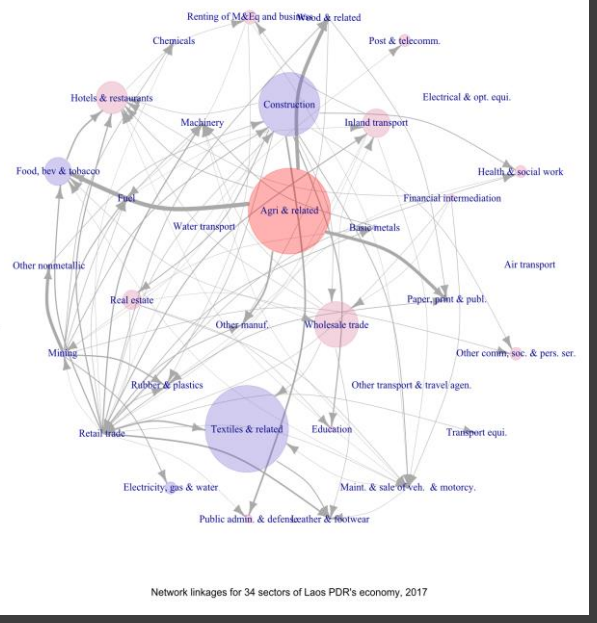
Network linkages for 34 sectors of the Bangladesh economy, 2017



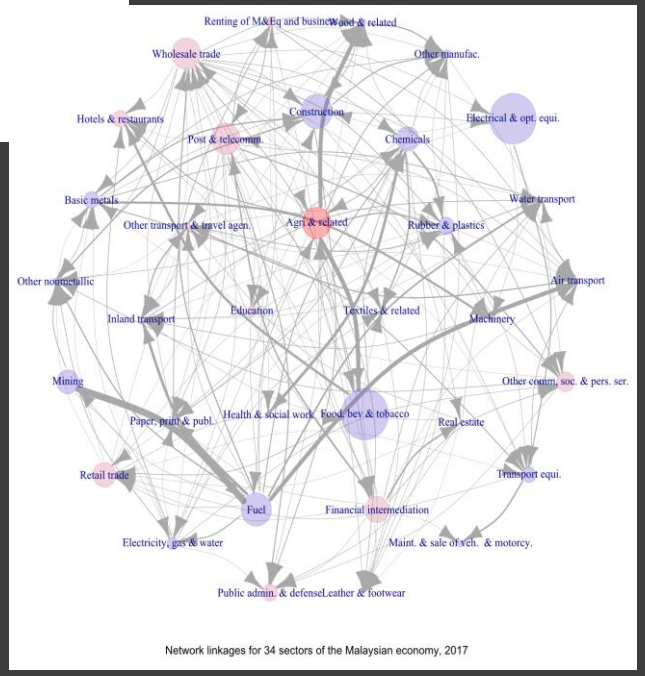
Network linkages for 34 sectors of the Malaysian economy, 2000



Network linkages for 34 sectors of Laos PDR's economy, 2000



Network linkages for 34 sectors of Laos PDR's economy, 2017



Network linkages for 34 sectors of the Malaysian economy, 2017

2000

	Bangladesh		Bhutan		Cambodia		Laos PDR		Nepal		Malaysia	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Agri & related	2	9	0	6	1	11	0	7	3	13	4	8
Mining	0	6	2	7	2	2	3	0	4	2	0	3
Food, bev & tobacco	4	2	3	0	4	1	2	0	3	7	4	3
Textiles & related	5	4	5	3	1	1	4	1	6	0	4	0
Leather & footwear	4	3	5	1	0	0	4	1	5	0	6	0
Wood & related	7	2	3	0	4	0	2	3	4	3	2	0
Paper, print & publ.	9	0	4	1	4	0	3	0	4	0	4	1
Fuel	9	0	0	0	1	0	3	2	7	0	2	9
Chemicals	5	2	5	6	2	2	3	0	6	3	5	6
Rubber & plastics	9	1	3	0	4	4	4	0	2	4	4	3
Other nonmetallic	7	1	4	2	3	0	2	1	5	3	4	1
Basic metals	8	7	6	0	3	3	1	2	2	5	2	3
Machinery	8	0	6	0	4	0	2	0	6	0	2	2
Electrical & opt. equi.	8	0	6	0	1	0	1	0	4	0	2	3
Transport equi.	1	1	6	0	3	0	4	0	5	0	2	4
Other manufac.	7	2	5	6	2	0	3	0	5	5	5	1
Electricity, gas & water	6	8	0	12	3	6	2	2	4	7	2	13
Construction	5	16	3	2	3	2	3	9	3	1	4	1
Maint. & sale of veh. & motorcy.	1	0	2	0	0	0	4	4	4	0	6	0
Wholesale trade	1	19	2	0	4	21	3	4	2	0	2	3
Retail trade	2	1	2	2	5	0	3	26	4	26	2	22
Hotels & restaurants	7	5	2	3	4	5	0	0	4	7	4	7
Inland transport	2	12	3	24	5	16	4	9	2	23	4	1
Water transport	1	0	4	0	0	0	1	0	0	0	5	1
Air transport	8	0	1	0	0	0	1	0	6	0	6	1
Other transport & travel agen.	4	5	2	0	0	0	1	0	9	0	4	1
Post & telecomm.	4	5	5	7	3	8	2	0	6	4	2	4
Financial intermediation	3	8	3	12	2	2	1	3	3	3	2	0
Real estate	1	2	0	9	5	5	0	0	1	17	0	6
Renting of M&Eq and business	2	9	0	0	5	3	0	0	6	10	1	7
Public admin. & defense	2	1	6	6	8	1	3	0	5	0	5	0
Education	0	1	6	2	4	0	1	0	5	2	0	0
Health & social work	2	1	5	0	3	0	2	0	6	0	2	0
Other comm, soc. & pers. ser.	0	11	4	2	4	4	2	0	4	0	2	0

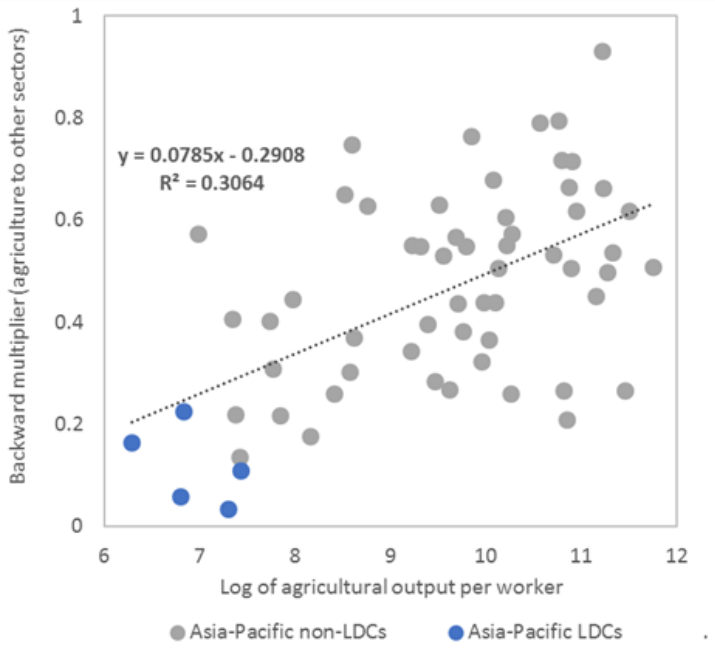
2017

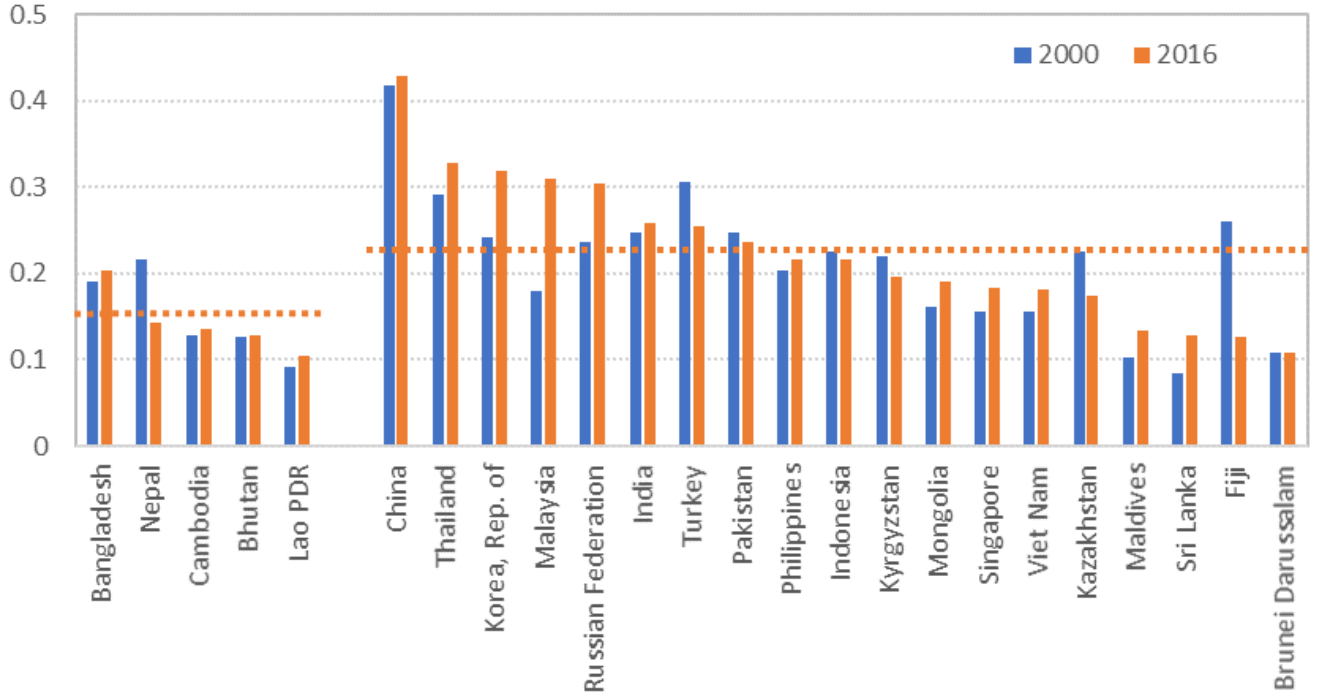
	Bangladesh		Bhutan		Cambodia		Laos PDR		Nepal		Malaysia	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Agri & related	2	9	0	6	1	10	0	5	3	12	5	10
Mining	0	8	3	7	2	3	2	9	3	3	1	3
Food, bev & tobacco	4	3	5	0	5	2	4	1	3	7	3	5
Textiles & related	4	5	5	2	2	2	3	1	6	0	6	1
Leather & footwear	4	4	5	0	0	0	4	0	5	0	9	0
Wood & related	7	2	6	0	3	0	2	2	5	1	7	2
Paper, print & publ.	9	0	9	2	7	0	3	0	5	0	6	2
Fuel	10	0	0	0	1	0	3	1	8	0	2	12
Chemicals	8	3	5	7	3	2	2	0	5	5	4	9
Rubber & plastics	9	1	6	0	6	4	4	0	4	4	6	6
Other nonmetallic	7	2	3	2	2	0	1	1	4	2	9	2
Basic metals	7	7	7	0	3	3	2	1	3	5	5	7
Machinery	7	0	7	0	3	0	5	0	5	0	3	0
Electrical & opt. equi.	9	0	7	1	1	0	0	0	5	0	2	4
Transport equi.	1	1	7	0	3	0	1	0	4	0	6	3
Other manufac.	9	0	5	7	2	0	3	1	4	4	7	4
Electricity, gas & water	6	7	0	14	4	5	1	0	5	10	4	9
Construction	10	8	4	3	3	3	3	10	4	1	6	4
Maint. & sale of veh. & motorcy.	1	0	3	0	0	0	6	5	3	0	2	0
Wholesale trade	1	18	3	1	5	20	3	6	2	0	5	20
Retail trade	1	2	3	14	6	0	4	20	2	20	6	7
Hotels & restaurants	7	5	3	6	5	8	7	1	6	6	5	1
Inland transport	3	13	1	23	4	15	3	4	2	24	8	3
Water transport	2	0	1	0	0	0	0	0	0	0	7	2
Air transport	10	0	3	0	0	0	0	0	2	0	8	3
Other transport & travel agen.	4	5	3	0	0	0	0	0	8	0	7	5
Post & telecomm.	3	4	4	3	4	5	1	0	7	7	3	11
Financial intermediation	2	15	2	19	4	3	0	4	4	6	2	15
Real estate	1	3	0	5	5	9	1	4	2	8	2	6
Renting of M&Eq and business	3	9	4	6	5	8	2	3	4	11	3	5
Public admin. & defense	2	1	2	0	6	0	2	0	2	0	7	0
Education	0	1	2	0	4	0	2	0	2	1	2	0
Health & social work	2	1	5	0	4	0	3	0	7	0	2	0
Other comm, soc. & pers. ser.	0	18	5	0	2	3	2	0	6	3	5	4

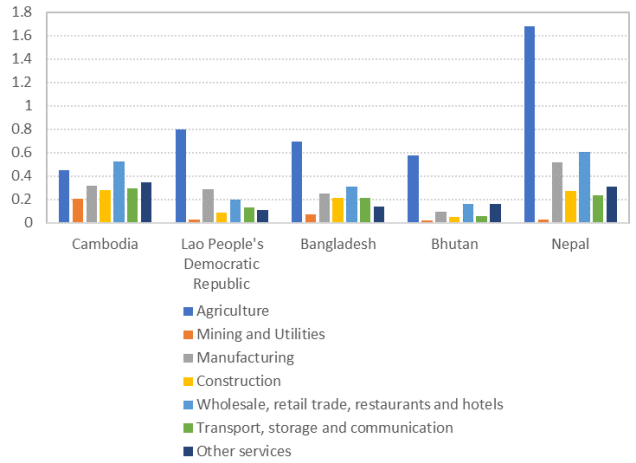
INCOMING AND OUTGOING DEGREES

BETWEENNESS CENTRALITY

	2000						2017					
	Bangladesh	Bhutan	Cambodia	Laos PDR	Nepal	Malaysia	Bangladesh	Bhutan	Cambodia	Laos PDR	Nepal	Malaysia
Agri & related	0	0	1	0	17	47	28	0	10	0	30	30
Mining	0	0	5	0	0	0	0	72	0	53	9	3
Food, bev & tobacco	3	0	69	0	0	0	24	0	70	0	1	14
Textiles & related	52	53	0	0	0	0	9	2	0	0	0	0
Leather & footwear	0	0	0	0	0	0	0	0	0	0	0	0
Wood & related	62	0	0	0	7	0	6	0	0	0	25	36
Paper, print & publ.	0	0	0	0	0	3	0	24	0	0	0	32
Fuel	0	0	0	27	0	34	0	0	0	95	0	28
Chemicals	41	0	0	0	23	27	37	0	4	0	17	15
Rubber & plastics	82.5	0	59	0	0	3	74	0	61	0	19	162
Other nonmetallic	0	18	0	27	38	2	6	27	0	0	0	100
Basic metals	120	0	37	0	50	16	29	0	5	0	77	166
Machinery	0	0	0	0	0	54	0	0	0	0	0	0
Electrical & opt. equi.	0	0	0	0	0	6	0	18	0	0	0	96
Transport equi.	0	0	0	0	0	5	2	0	0	0	0	5
Other manufac.	136.5	5	0	0	54	3	0	4	0	2	60	113
Electricity, gas & water	35	0	66	8	100	107	22	0	27	0	97	68
Construction	180.5	20	59	87	136	13	201	31	25	71	153	78
Maint. & sale of veh. & motorcy.	0	0	0	5	0	0	0	0	0	32	0	0
Wholesale trade	5	0	149	30	0	16	3	0	156	27	0	218
Retail trade	1	0	0	120	82	111	0	6	0	186	61	213
Hotels & restaurants	178.5	0	118	0	22	122	64	20	107	81	24	33
Inland transport	19	142	156	109	75	7	133	1	123	137	100	7
Water transport	0	0	0	0	0	4	0	0	0	0	0	0
Air transport	0	0	0	0	0	13	0	0	0	0	0	2
Other transport & travel agen.	59	0	0	0	0	0	36	0	0	0	0	114
Post & telecomm.	0	254	98	0	12	75	0	53	45	0	83	89
Financial intermediation	59	96	2	0	64	0	24	32	25	0	171	64
Real estate	0	0	28	0	152	0	0	0	80	0	194	58
Renting of M&Eq and business	31	0	33	0	99	72	11	90	53	97	52	7
Public admin. & defense	3	172	5	0	0	0	3	0	0	0	0	0
Education	0	155	0	0	2	0	0	0	0	0	8	0
Health & social work	24	0	0	0	0	0	20	0	0	0	0	0
Other comm, soc. & pers. ser.	0	10	91	0	0	0	0	0	2	0	12	10
Density	*0.128*	*0.101*	*0.086*	*0.066*	*0.129*	*0.094*	*0.138*	*0.114*	*0.094*	*0.070*	*0.125*	*0.147*







AGGLOMERATION, EMPLOYMENT MULTIPLIERS & PRODUCTIVITY