



Measuring the Global and Domestic Value Chains

--Based on 2012 China Multi-Regional input-output table

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1. Methodology and Data

Methodology

China Multiregional Input-Output Model

Input \ Output		Intermediate Demand				Final Demand					Output
		A	B	...	G	A	B	...	G	EX	
		$1, \dots, N$	$1, \dots, N$...	$1, \dots, N$						
intermediate Input	A	Z^{AA}	Z^{AB}	...	Z^{AG}	Y^{AA}	Y^{AB}	...	Y^{AG}	E^A	X^A
	B	Z^{BA}	Z^{BB}	...	Z^{BG}	Y^{BA}	Y^{BB}	...	Y^{BG}	E^B	X^B
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	G	Z^{GA}	Z^{GB}	...	Z^{GG}	Y^{GA}	Y^{GB}	...	Y^{GG}	E^G	X^G
	IM	IM^A	IM^B	...	IM^G	FM^A	FM^B	...	FM^G	—	—
	RM	RM^A	RM^B	...	RM^G	0	0	...	0	—	—
Value Added		VA^A	VA^B	...	VA^G						
Input		X^A	X^B	...	X^G						

Note: Z is the matrix of deliveries of domestically produced intermediate inputs, VA is a vector of value added, E is a vector of gross exports, IM is a vector of intermediate imports, RM is a vector of returned domestic value added, X is a vector of gross output.



1. Methodology and Data

- We build a framework tracing value added in one country's exports at the regional level, considering both global value chains (GVCs) and domestic value chains (DVCs).
- Based on this framework, we can trace value added in China's exports at the provincial level, and makes some applications.



1. Methodology and Data

$$\hat{V}\hat{B}\hat{E} = \begin{bmatrix} V^1 B^{11} E^1 & V^1 B^{12} E^2 & \dots & V^1 B^{1G} E^G \\ V^2 B^{21} E^1 & V^2 B^{22} E^2 & \dots & V^2 B^{2G} E^G \\ \vdots & \vdots & \vdots & \vdots \\ V^G B^{G1} E^1 & V^G B^{G1} E^2 & \dots & V^1 B^{1G} E^G \end{bmatrix}$$

$$\hat{M}\hat{B}\hat{E} = \begin{bmatrix} M^1 B^{11} E^1 & M^1 B^{12} E^2 & \dots & M^1 B^{1G} E^G \\ M^2 B^{21} E^1 & M^2 B^{22} E^2 & \dots & M^2 B^{2G} E^G \\ \vdots & \vdots & \vdots & \vdots \\ M^G B^{G1} E^1 & M^G B^{G1} E^2 & \dots & M^1 B^{1G} E^G \end{bmatrix}$$

$$\hat{R}\hat{B}\hat{E} = \begin{bmatrix} R^1 B^{11} E^1 & R^1 B^{12} E^2 & \dots & R^1 B^{1G} E^G \\ R^2 B^{21} E^1 & R^2 B^{22} E^2 & \dots & R^2 B^{2G} E^G \\ \vdots & \vdots & \vdots & \vdots \\ R^G B^{G1} E^1 & R^G B^{G1} E^2 & \dots & R^1 B^{1G} E^G \end{bmatrix}$$

Note: $\mathbf{A}=\mathbf{Z}/\mathbf{X}$ is a matrix of domestic input coefficients, $\mathbf{V}=\mathbf{VA}/\mathbf{X}$ is a matrix of direct value-added coefficients, $\mathbf{B}=(\mathbf{I}-\mathbf{A})^{-1}$ is Leontief inverse matrix, $\mathbf{M}=\mathbf{IM}/\mathbf{X}$ is a matrix of intermediate imports coefficients, $\mathbf{R}=\mathbf{RM}/\mathbf{X}$ is a matrix of returned domestic value added coefficients.



1. Methodology and Data

(1) Based on backward-looking linkage

- The gross exports of a country can be decomposed into the sum of four terms:
 - Domestic value added created by province itself (DVA, $DVA^s = V^s B^{ss} E^s$).
 - Dvalue added created by other provinces (Domestic vertical specialization, DVS, $DVS^s = \sum_{r \neq s} V^r B^{rs} E^s$).
 - Foreign value added (Foreign vertical specialization, FVS, $FVS^s = \sum_r M^r B^{rs} E^s$).
 - Returned domestic value added (RDV, $RDV^s = \sum_r R^r B^{rs} E^s$).



1. Methodology and Data

- **(1) Based on backward-looking linkage**

- DVA shares in gross exports (DVAS, $DVAS^s = \frac{V^s B^{ss} E^s}{E^s}$).

- DVS shares in gross exports (DVSS, $DVSS^s = \frac{\sum_{r \neq s} V^r B^{rs} E^s}{E^s}$).

- FVS shares in gross exports (FVSS, $FVSS^s = \frac{\sum_r M^r B^{rs} E^s}{E^s}$).

- RDV shares in gross exports (RDVS, $RDVS^s = \frac{\sum_r R^r B^{rs} E^s}{E^s}$).

- $DVAS + DVSS + FVSS + RDVS = 1$,

$$DVAS^s + DVSS^s + FVSS^s + RDVS^s = 1$$



1. Methodology and Data

(2) Based on forward-looking linkage

- the value-added that is originated from a province but is embedded in the gross exports from all other province of that country.
- The value-added exports to gross export ratio (VAX ratio) based on forward-looking linkage as defined by Johnson & Noguera (2012) can be used as a summary measure of value-added content of gross exports.

$$VAXR^s = \frac{\sum_r V^r B^{rs} E^s}{E^s}$$

- The VAX ratio at this level is not upper-bounded by one.



1. Methodology and Data

Data

- China's multiregional input-output (CMRIO) table in 2012, developed by State Information Center (SIC).

China's 8 regional input-output table :

- CMRIO in 2012 covering **8 regions** (the NorthEast, the JingJin, the NorthernCoast, the EasternCoast, the SouthernCoast, the Central, the NorthWest, the SouthWest), and **17 sectors** including primary industry(1 sector), secondary industry(14 sectors), tertiary industry(2 sectors).



1. Methodology and Data

China's 31 regional input-output table :

- CMRIO in 2012 covering **31 provinces** (BeiJing, TianJin, HeBei, ShanXi, NeiMengGu, LiaoNing, JiLin, HeiLongJiang, ShangHai, JiangSu, ZheJiang, AnHui, FuJian, JiangXi, ShanDong, HeNan, HuBei, HuNan, GuangDong, GuangXi, HaiNan, ChongQing, SiChuan, GuiZhou, YunNan, XiZang, ShaanXi, GanSu, QingHai, NingXia, XinJiang) except Hong Kong, Macau, Chinese Taipei, and **42 sectors** including primary industry(1 sector), secondary industry(25 sectors), tertiary industry(16 sectors).



2. China Multiregional Input-Output Table in 2012

China Multi-regional Input-Output Model in 2012

Unit: Billion Yuan⁺

Input/ Output _i	Intermediate Demand _i								Final Demand _i			Total _i
	NorthEast _i	JingJin _i	NorthernCoast _i	EasternCoast _i	SouthernCoast _i	Central _i	NorthWest _i	SouthWest _i	Intraregional _i	Interregional _i	Export _i	Output _i
NorthEast _i	7017.29 ⁺	217.04 ⁺	127.01 ⁺	271.82 ⁺	129.32 ⁺	199.43 ⁺	173.77 ⁺	84.91 ⁺	4027.64 ⁺	633.51 ⁺	463.52 ⁺	13345.27 ⁺
JingJin _i	231.65 ⁺	3471.40 ⁺	399.99 ⁺	182.91 ⁺	71.84 ⁺	310.89 ⁺	211.90 ⁺	48.31 ⁺	2468.28 ⁺	583.40 ⁺	825.82 ⁺	8806.39 ⁺
NorthernCoast _i	153.40 ⁺	354.99 ⁺	14181.23 ⁺	306.99 ⁺	87.47 ⁺	621.62 ⁺	225.76 ⁺	63.77 ⁺	5750.85 ⁺	375.26 ⁺	1352.13 ⁺	23473.47 ⁺
EasternCoast _i	213.42 ⁺	182.64 ⁺	123.78 ⁺	17511.82 ⁺	401.06 ⁺	1187.80 ⁺	385.87 ⁺	227.51 ⁺	6236.02 ⁺	4251.51 ⁺	4781.99 ⁺	35503.42 ⁺
SouthernCoast _i	95.91 ⁺	87.28 ⁺	38.11 ⁺	341.41 ⁺	9798.31 ⁺	483.06 ⁺	142.64 ⁺	465.16 ⁺	5629.28 ⁺	788.38 ⁺	4688.28 ⁺	22557.82 ⁺
Central _i	199.15 ⁺	325.41 ⁺	403.90 ⁺	1835.40 ⁺	552.29 ⁺	15096.64 ⁺	500.87 ⁺	317.41 ⁺	8671.13 ⁺	1347.67 ⁺	655.58 ⁺	29905.45 ⁺
NorthWest _i	210.63 ⁺	258.33 ⁺	366.39 ⁺	942.98 ⁺	310.12 ⁺	656.49 ⁺	4484.47 ⁺	281.43 ⁺	2466.97 ⁺	589.80 ⁺	488.73 ⁺	11056.35 ⁺
SouthWest _i	57.01 ⁺	43.17 ⁺	49.40 ⁺	203.86 ⁺	404.83 ⁺	257.92 ⁺	225.98 ⁺	7640.89 ⁺	5680.02 ⁺	540.92 ⁺	410.54 ⁺	15514.54 ⁺
Import _i	510.19 ⁺	1032.42 ⁺	729.81 ⁺	3218.46 ⁺	3618.25 ⁺	369.05 ⁺	263.54 ⁺	285.49 ⁺	2074.83 ⁺		- ⁺	- ⁺
Value Added _i	4656.64 ⁺	2833.69 ⁺	7053.84 ⁺	10687.75 ⁺	7184.32 ⁺	10722.56 ⁺	4441.54 ⁺	6099.68 ⁺				
Total Input _i	13345.27 ⁺	8806.39 ⁺	23473.47 ⁺	35503.42 ⁺	22557.82 ⁺	29905.45 ⁺	11056.35 ⁺	15514.54 ⁺				

- The transation of domestically produced intermediate input between the Central and the East Coast is 1835.4 billion Yuan, and is largest.
- The transation of domestically produced intermediate input between the JingJin and the NorthEast is 231.6 billion Yuan, and is smallest.



3. Industry Backward-linkage Coefficient in 2012

Regional industry backward-linkage coefficient in 2012

Industries	NorthEast	JingJin	NorthernCoast	EasternCoast	SouthernCoast	Central	NorthWest	SouthWest
Agriculture	0.78	0.80	0.78	0.71	0.67	0.76	0.77	0.68
Mining	0.80	0.90	1.03	0.86	0.71	0.93	0.79	0.91
FoodTob	1.00	0.93	1.09	0.88	0.91	1.03	0.96	0.84
Clothing	1.15	1.06	1.27	1.12	0.93	1.14	1.04	1.05
WoodProd	1.08	1.05	1.24	1.09	0.98	1.10	1.00	1.02
PaperProd	1.11	1.07	1.33	1.07	0.94	1.12	1.02	1.02
CokeChem	1.00	0.94	1.31	1.02	0.90	1.15	1.03	1.03
NonMetProd	1.05	1.08	1.26	1.09	0.95	1.11	1.01	1.04
Metal	1.14	1.14	1.29	1.15	0.95	1.17	1.05	1.07
Mechanical	1.14	1.02	1.30	1.09	0.86	1.14	1.04	1.11
TransportEq	1.07	0.95	1.43	1.11	0.99	1.13	1.09	1.13
EleMachEq	1.17	0.99	1.45	1.03	0.78	1.08	1.08	1.09
OthManProd	0.97	0.86	1.21	0.90	0.81	1.07	0.98	0.93
EleGasWater	1.10	1.21	1.17	1.06	0.98	1.08	1.00	1.00
Construction	1.11	1.14	1.23	1.12	0.96	1.14	1.07	1.11
TraStorPost	0.77	0.80	0.72	0.75	0.70	0.77	0.82	0.72
OthService	0.79	0.77	0.80	0.75	0.67	0.76	0.74	0.74
Total	17.22	16.72	19.92	16.78	14.68	17.67	16.49	16.51



3. Industry Backward-linkage Coefficient in 2012

Regional industry backward-linkage coefficient:

- The NorthernCoast, the Central and the NorthEast have a greater driving influence on the overall industry of China.
- The SouthernCoast, the NorthWest, the SouthWest the JingJin and the EasternCoast have a less driving influence on the overall industry of China.
- Metal, TransportEq, Construction, Clothing, Mechanical, PaperProd and EleMachEq have a greater driving influence on the national economy.
- Agriculture, TraStorPost and OthService have a less driving influence on the national economy.



3. Industry Backward-linkage Coefficient in 2012

Interregional industry backward-linkage coefficient in 2012

Industries	NorthEast	JingJin	NorthernCoast	EasternCoast	SouthernCoast	Central	NorthWest	SouthWest
Agriculture	0.31	0.84	0.30	0.36	0.27	0.42	0.57	0.26
Mining	0.55	0.92	0.61	0.99	0.45	0.76	0.84	0.59
FoodTob	0.45	1.20	0.45	0.55	0.41	0.63	0.86	0.35
Clothing	1.38	1.95	0.50	0.64	0.48	0.88	1.28	0.84
WoodProd	0.65	1.75	0.55	0.83	0.62	0.81	1.11	0.63
PaperProd	1.15	1.56	0.60	0.79	0.75	1.04	1.52	0.80
CokeChem	0.68	0.97	0.92	0.98	0.82	1.14	0.97	0.88
NonMetProd	0.81	1.65	0.73	1.33	0.72	0.95	1.22	0.80
Metal	0.98	1.14	0.72	1.51	1.02	1.18	1.16	0.85
Mechanical	1.05	1.24	0.59	1.11	0.75	1.27	1.50	0.96
TransportEq	0.72	1.07	0.71	1.03	1.07	1.18	1.90	1.16
EleMachEq	1.22	1.14	0.67	0.88	0.57	1.16	1.71	0.86
OthManProd	0.89	0.87	0.61	0.70	0.56	1.12	1.24	0.81
EleGasWater	1.11	2.10	0.90	1.39	0.92	0.92	1.01	0.65
Construction	0.88	1.76	0.62	1.34	0.80	1.01	1.41	1.01
TraStorPost	0.41	0.71	0.32	0.40	0.33	0.55	0.86	0.45
OthService	0.47	0.71	0.32	0.36	0.27	0.48	0.69	0.41
Total	13.70	21.57	10.12	15.21	10.78	15.48	19.83	12.31



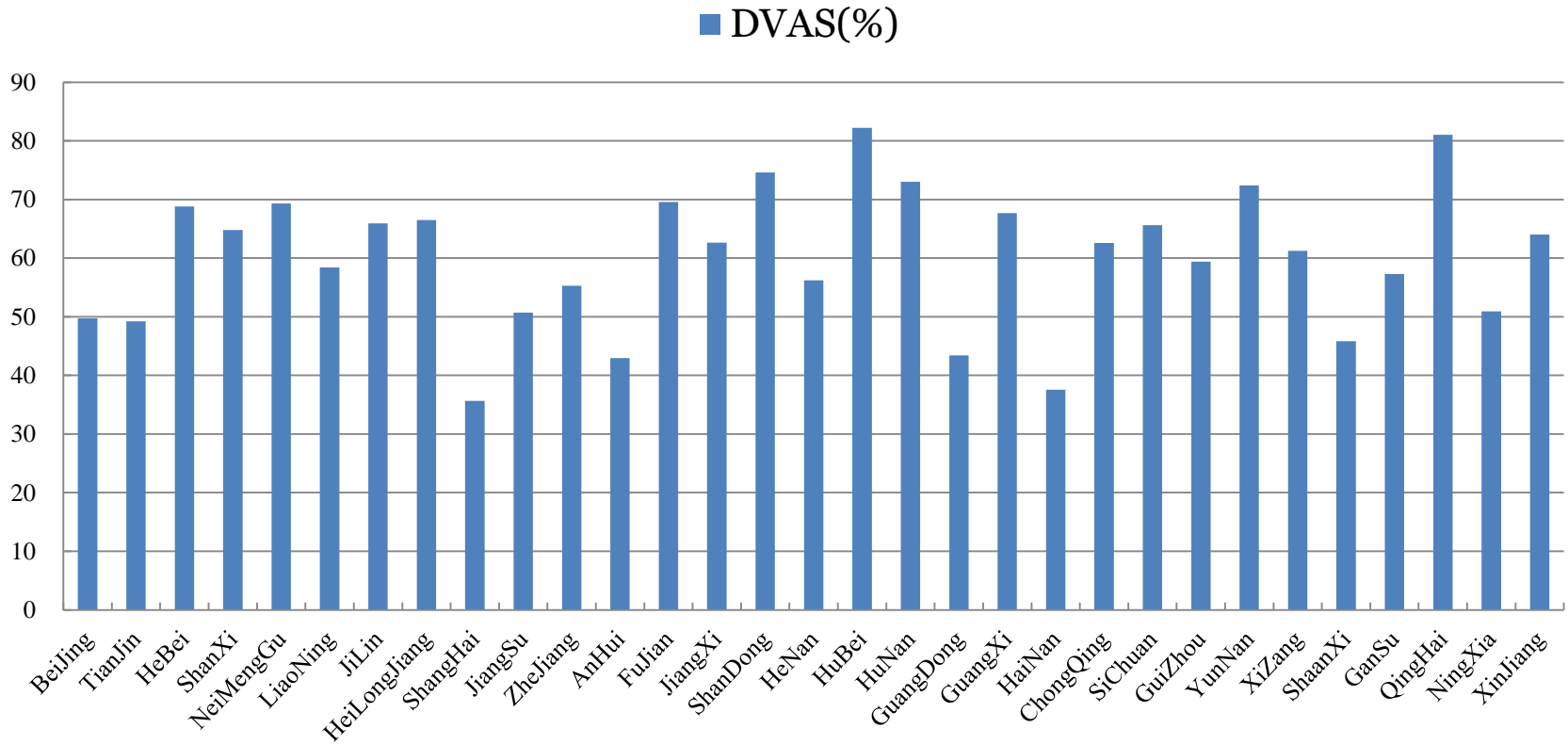
3. Industry Backward-linkage Coefficient in 2012

Interregional industry backward-linkage coefficient:

- The JingJin, the NorthWest, the EasternCoast and the Central have a greater driving influence on other regions.
- The NorthernCoast, the SouthernCoast, the SouthWest and the NorthEast have a less driving influence on other regions.
- EleGasWater, TransportEq, Construction, Metal, Mechanical have a greater driving influence on other regions.
- Agriculture, TraStorPost, OthService and FoodTob have a less driving influence on other regions.



4. Domestic value added in China's exports at the provincial level





4. Domestic value added in China's exports at the provincial level

- Among the sources of value of every province's export, domestic value added has the highest share.
- Domestic value added share (DVAS) is between 35.66% and 82.24%.
- DVASs in Hubei (82.24%), Qinghai (81.04%), Shandong (74.59%), Hunan (73.04%) and Yunnan (72.40%) are higher, while DVASs in Shanghai (35.66%), Hainan(37.57%), Guangdong (43.41%), Tianjin (49.22%), Beijing(49.71%) are lower.

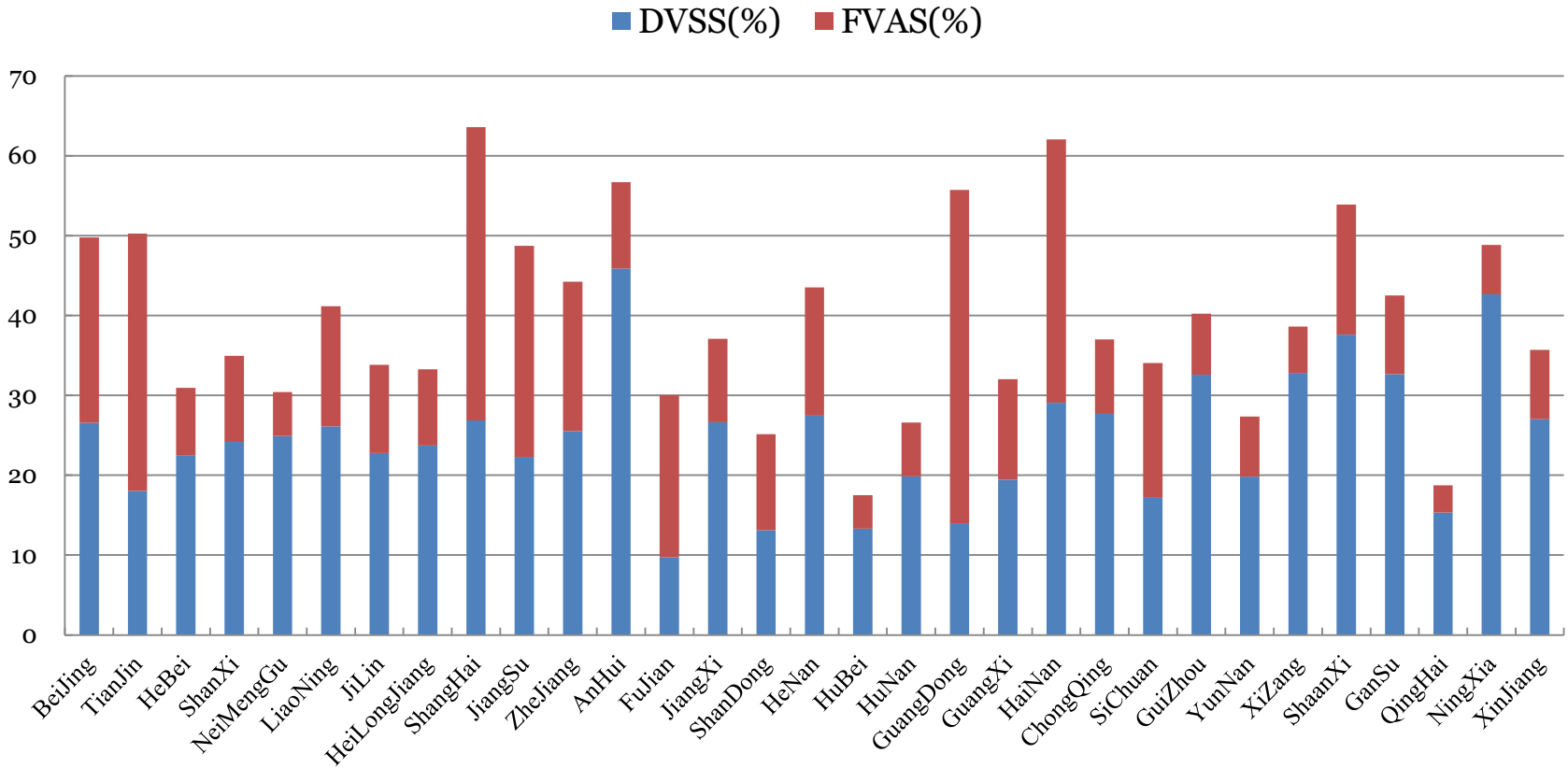


4. Domestic value added in China's exports at the provincial level

- As a result, DVASs in coastal provinces are relatively lower.
- Is the level of economic development related to DVAS?
- DVAS and GDP per capita in provinces show a strong negative correlation, The Pearson correlation coefficient between DVAS and GDP per capita is -0.664.



5. Domestic vertical specialization (DVS) and Foreign vertical specialization (FVS)





5. Domestic vertical specialization (DVS) and Foreign vertical specialization (FVS)

- DVS share (DVSS) is between 9.72% and 35.88%, FVS share (FVSS) is between 3.40% and 41.76%.
- The correlation between DVSS and FVSS in provinces is not definite. DVSS in a province can be higher, while FVSS in other province can be higher.
- For example, DVSS in Guangdong is 13.99%, FVSS in Guangdong is 41.76%. DVSS in Jilin is 22.77%, FVSS in Jilin is 11.06%.

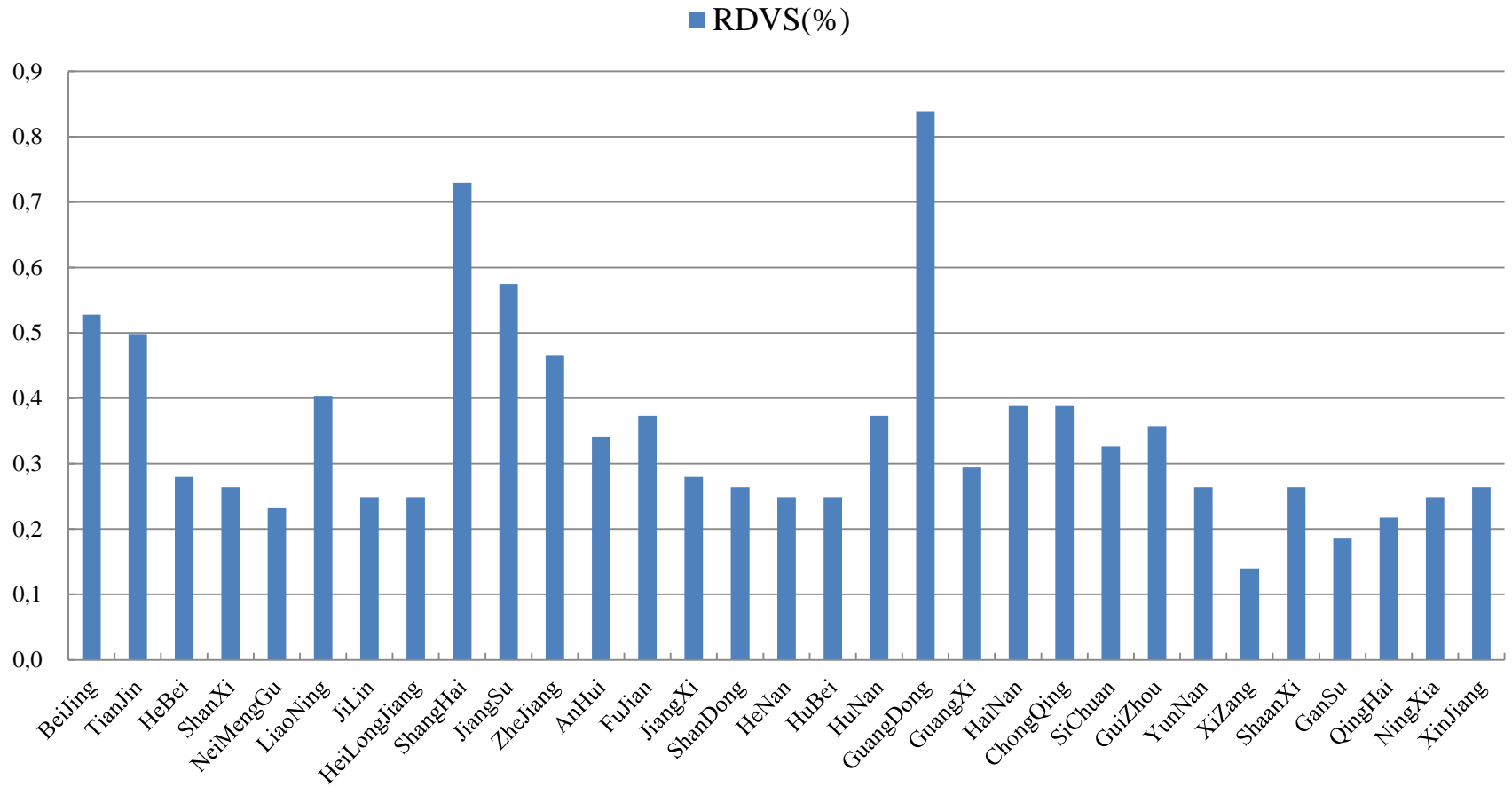


5. Domestic vertical specialization (DVS) and Foreign vertical specialization (FVS)

- The correlation between DVSS and GDP per capita in provinces is not remarkable.
- The correlation between FVSS and GDP per capita in provinces is remarkable, The Pearson correlation coefficient between FVSS and GDP per capita is -0.626. It means that exports in coastal provinces rely on more imported intermediates.



6. Returned domestic value added (RDV)



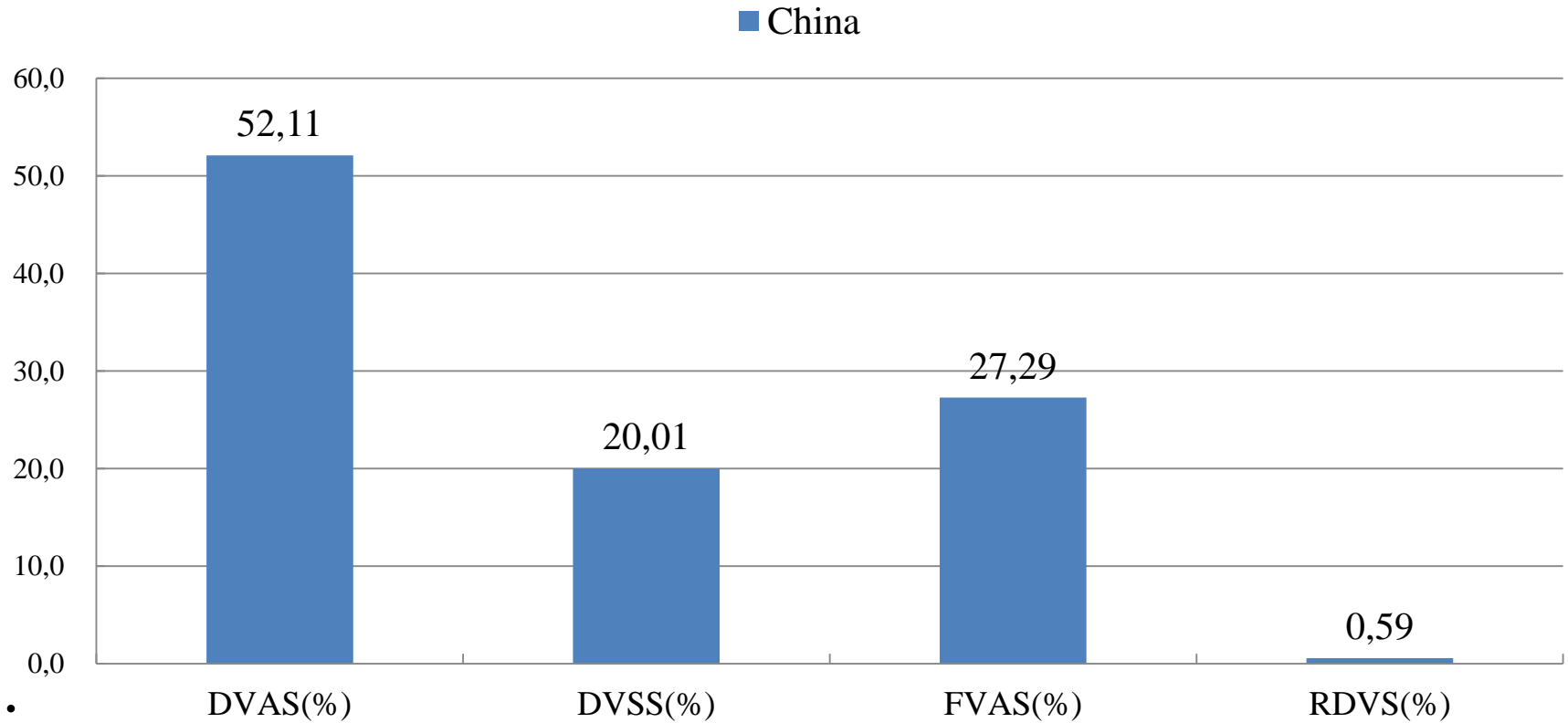


6. Returned domestic value added (RDV)

- Among the sources of value of every province's export, returned domestic value added has the lowest share.
- Returned domestic value added share (RDVS) is between 0.14% and 0.84%.
- RDVSs in Guangdong (0.84%), Shanghai (0.73%), Jiansu (0.57%), Beijing(0.53%) and Tianjin (0.50%) are higher, while RDVSs in Tibet (0.14%), Gansu (0.19%), Qinghai (0.22%) and Inner Mongolia (0.23%) are lower.
- RDVS and GDP per capita in provinces show a strong positive correlation, The Pearson correlation coefficient between RDVS and GDP per capita is 0.658.



DVAS, DVSS, FVSS, RDVS of China



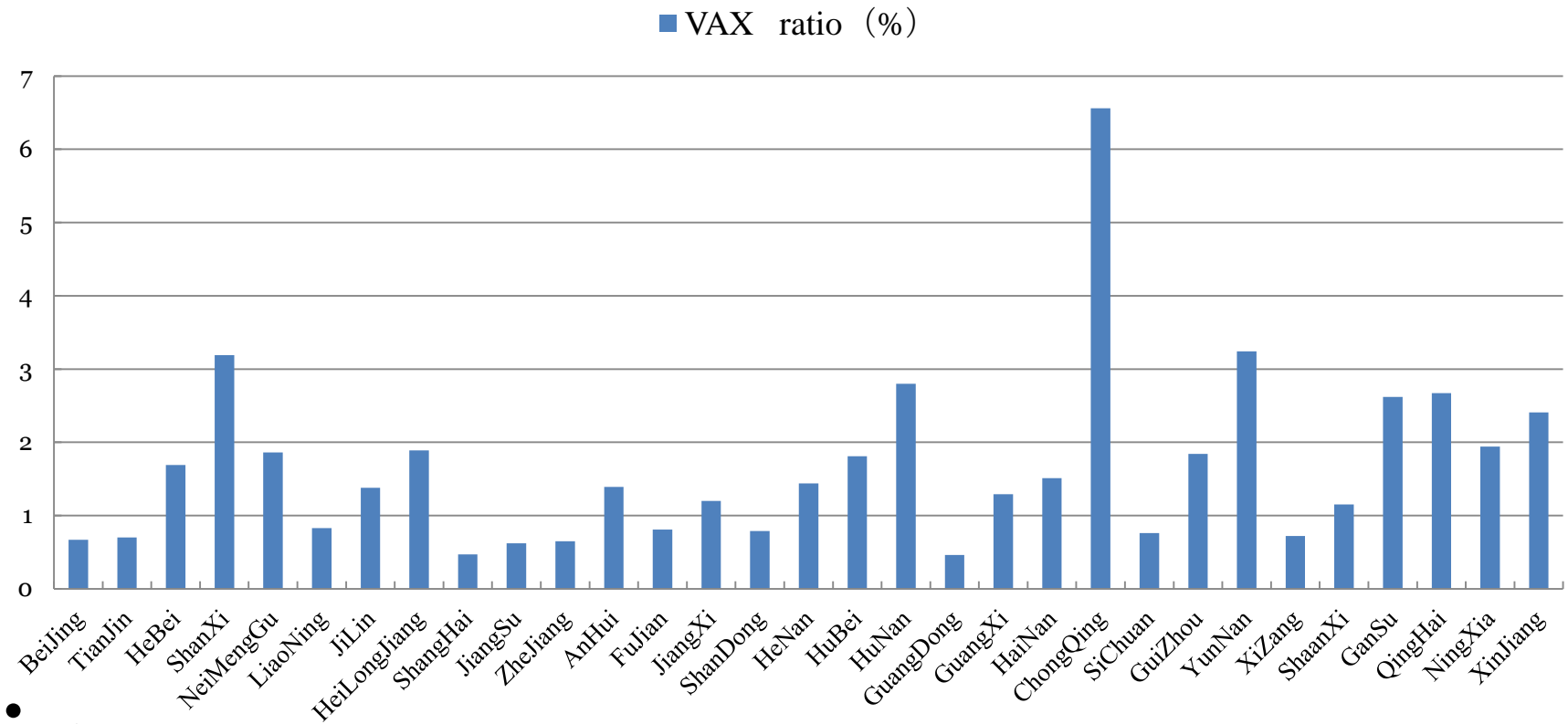


DVAS, DVSS, FVSS, RDVS of China

- Nationally, DVAS in China's gross exports is 52.11%, DVSS is 20.01%, FVSS is 27.29%, RDVS is 0.59%.
- The degree of participating global value chains (GVCs) is higher than domestic value chains (DVCs).
- Although China's gross exports is as high as 13666.59 billion Yuan, the added value of the actual export is 9856.37 billion Yuan only.



7. The value-added exports to gross exports ratio (VAX ratio)





7. The value-added exports to gross exports ratio (VAX ratio)

- The VAX ratio at this level is not upper-bounded by one.
- The VAX ratios in Guangdong (0.46), Shanghai (0.47), Jiangsu (0.62), Zhejiang (0.65), Beijing (0.67) and Tianjin (0.70) are less than 1. those provinces are mainly belong to coastal regions.
- The VAX ratios in Chongqing (6.56), Yunnan (3.24), Shannxi (3.19), Hunan (2.80), Qinghai (2.67), Gansu (2.62), Xinjiang (2.41), Ningxia (1.94), Heilongjiang (1.89), Inner Mongolia (1.86), and Guizhou (1.84) are more than 1.8. those provinces are mainly belong to central and western regions.



7. The value-added exports to gross exports ratio (VAX ratio)

- Result suggests that the gross exports by traditional statistical method are overestimated in coastal provinces , and are underestimated in central and western provinces.
- The gap among every province's export will narrow if measured by value added export.
- The differences of two statistical method can be explained by domestic production links between provinces. Exports in coastal provinces import intermediates from central and western provinces, the gross exports in coastal provinces contains value added from central and western provinces.



Summary

- we conduct this application at both 8-region and 31-province level
- the coastal regions/provinces holding the larger share of the Chinese economy, as well as the external trade and industrial linkages. thus they play the important role in economic development.
- the inter-regional linkages still weak comparing with the regional level international linkages, especially for south coastal region
- provincial level export's domestic value added ratio and FVSS are correlated with the per capita GDP. Overall, The degree of participating global value chains (GVCs) is higher than domestic value chains (DVCs)



Summary

- The correlation between DVSS and GDP per capita at provincial level is not remarkable, while the correlation between DVSS and FVSS is also different. DVSS in a province can be higher, while FVSS in another province can be more.
- the coastal regions' export are over estimated if we tracing their origin value added source, the coastal provinces exports are clearly bigger than their value added. The difference among each province's export will be narrowed if measuring by value added export.
- the regional disparity and difference of economic structure and development pattern is getting distingushed, thus the inter-regional/provincial linkages should be further investaged to promote the economic development among region/province.



Thank You!