Exchange Rates and Trade Dynamics:

Evidence from China's Provincial Level Data

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Uncoordinated Regional Development

- Implementing a regional coordinated development strategy. …, strengthen measures to promote the formation of a new pattern in the development of the western region, deepen reform, accelerate the revitalization of the old industrial bases in the northeast region, and give full play to the advantages to promote the rise of the middle region. Innovation leads the development of the eastern region and establishes a more effective regional coordinated development mechanism. ……

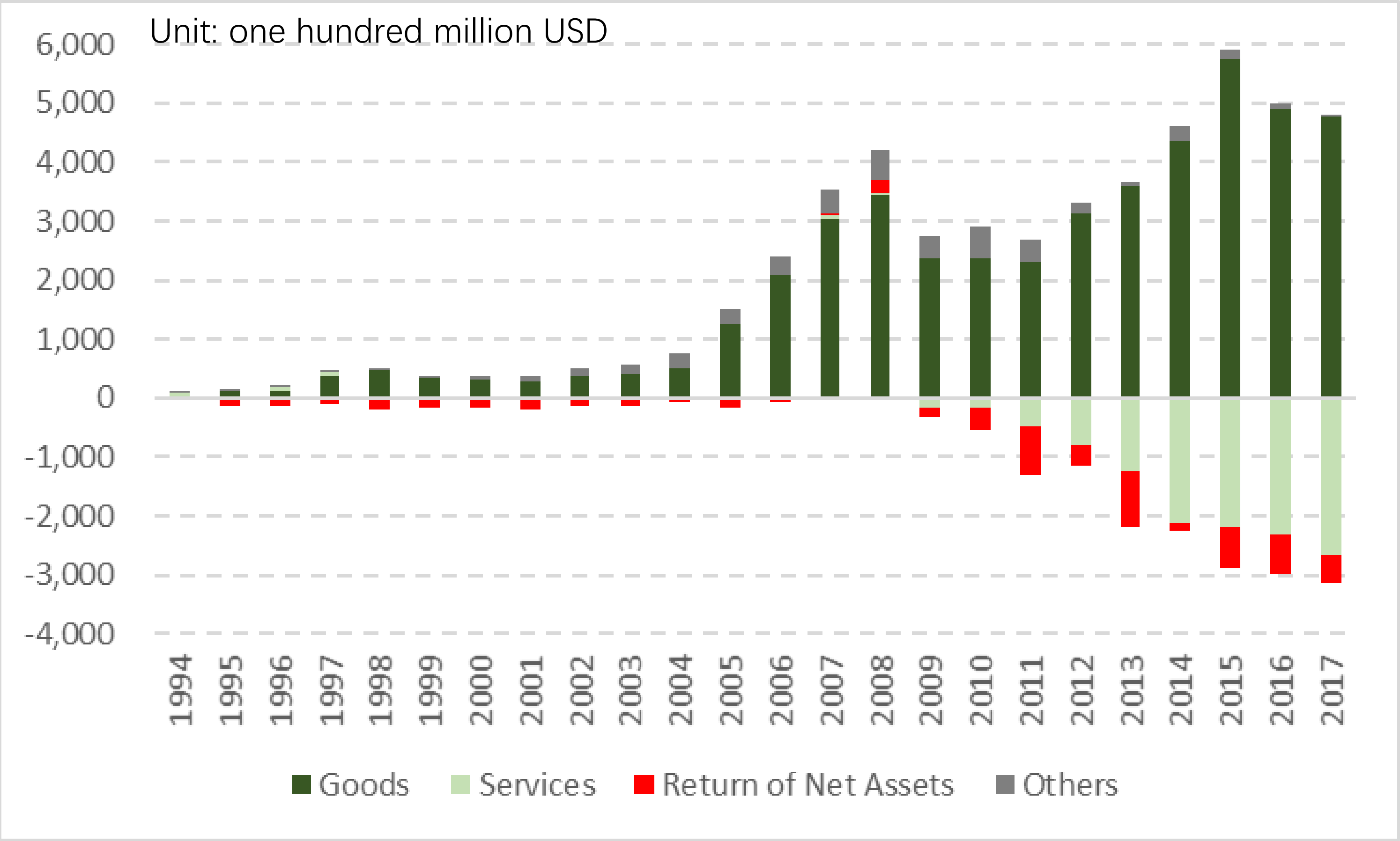
——the 19th CPC National Congress Report

New Pattern of Comprehensive Opening-up

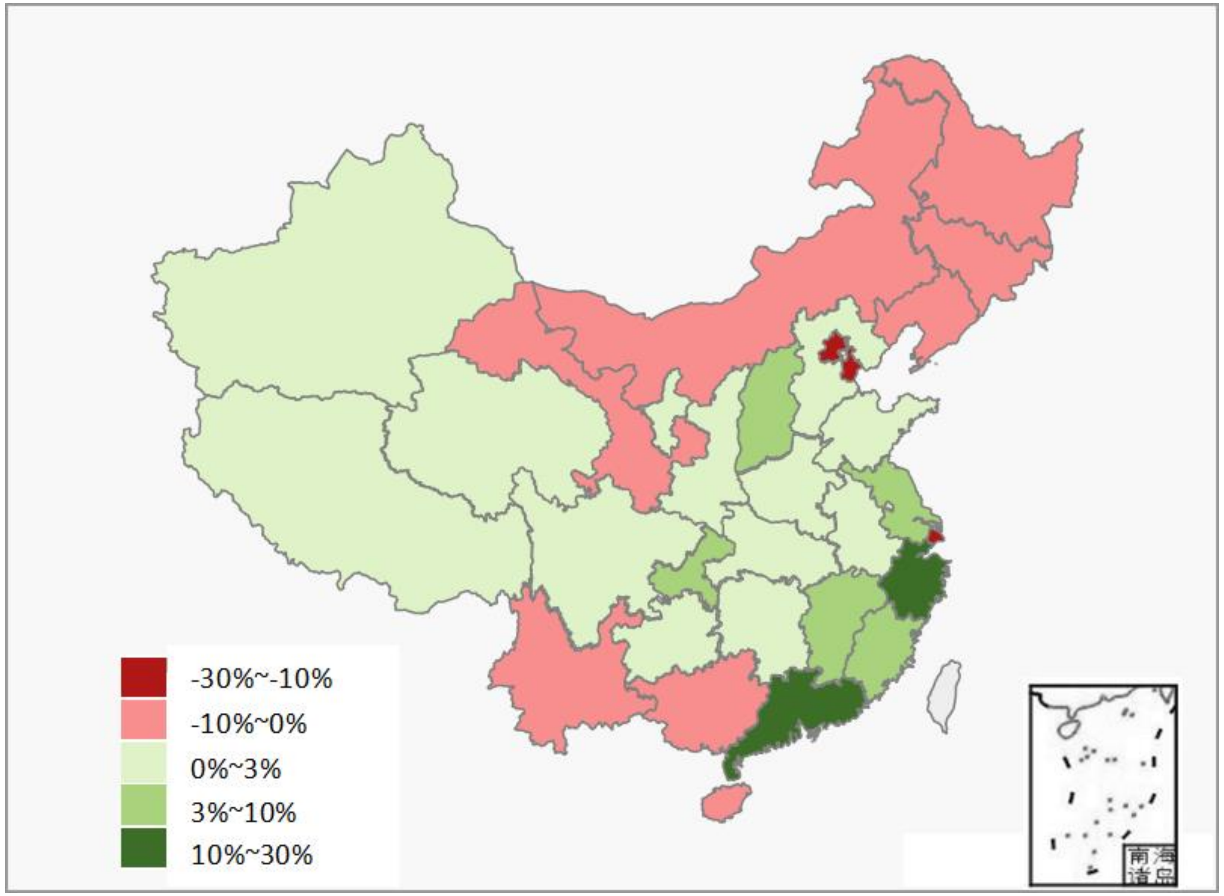
- Promoting the formation of a new pattern of comprehensive opening-up. …… It is necessary to focus on the construction of "One Belt and One Road", adhere to the principle of opening-up and going-out, follow the principle of joint construction and sharing, strengthen the open cooperation of innovation capabilities, and form an open pattern of linkage between the land and the sea and between the east and the west. … Optimize the layout of the regional opening-up and further open up of the western region. ……

——the 19th CPC National Congress Report

Aggregated Trade Surplus

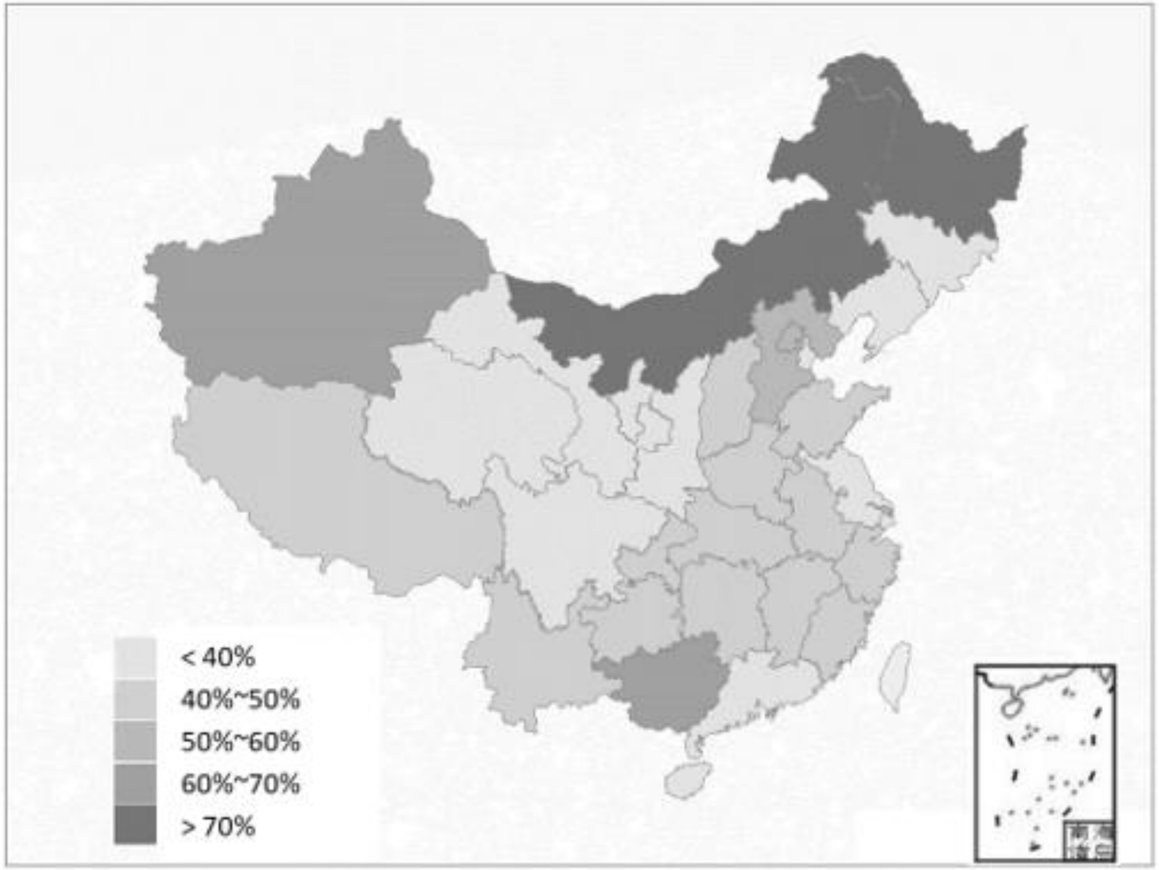


Different Provincial Level Trade Pattern



Net Export/GDP, 2017

Different Provincial Level Exchange Rate Pattern



More Provinces are Needed for Comprehensive Opening-up

Selected east area provinces						
Guangdong		**Fujian**		**Zhejiang**		**BIS Weight**
Hong Kong	27.40%	United States	16.88%	Euro Area	17.60%	Euro Area
United States	13.18%	Euro Area	12.65%	United States	16.49%	United States
Euro Area	8.66%	Chinese Taipei	8.81%	Japan	8.91%	Japan
Japan	8.45%	Japan	7.12%	Korea	5.03%	Korea
Chinese Taipei	7.38%	Hong Kong	6.32%	Chinese Taipei	4.91%	Chinese Taipei
Top 5	**65.07%**	**Top 5**	**51.78%**	**Top 5**	**52.94%**	**Top 5**
Selected middle and west area provinces						
Heilongjiang		**Neimenggu**		**Qinghai**		**BIS Weight**
Russian Federation	61.60%	Russian Federation	34.16%	Japan	19.10%	Euro Area
United States	7.33%	Euro Area	9.06%	Euro Area	15.58%	United States
Euro Area	6.06%	Australia	7.93%	Australia	15.00%	Japan
Saudi Arabia	2.99%	Japan	7.67%	United States	9.42%	Korea
Brazil	2.84%	United States	7.09%	Indonesia	6.68%	Chinese Taipei
Top 5	**80.82%**	**Top 5**	**65.92%**	**Top 5**	**65.77%**	**Top 5**

Beyond traditional export provinces
Beyond traditional major trade partners

What impact does the current exchange rate policy have on regional trade?

- One RMB, different external competitiveness
- Ex post analysis and evaluation
- Emphasize the dynamic relationship between trade and exchange rate
- Focus on regional differences

A Closer Look at the Regional Competitiveness

- Provinces in middle and west areas have the highest appreciation level
- Provinces in east area are more likely to have lower appreciation level.

- Openness：
- East>Middle>West
- Exchange rate shock：
- Middle>West>East

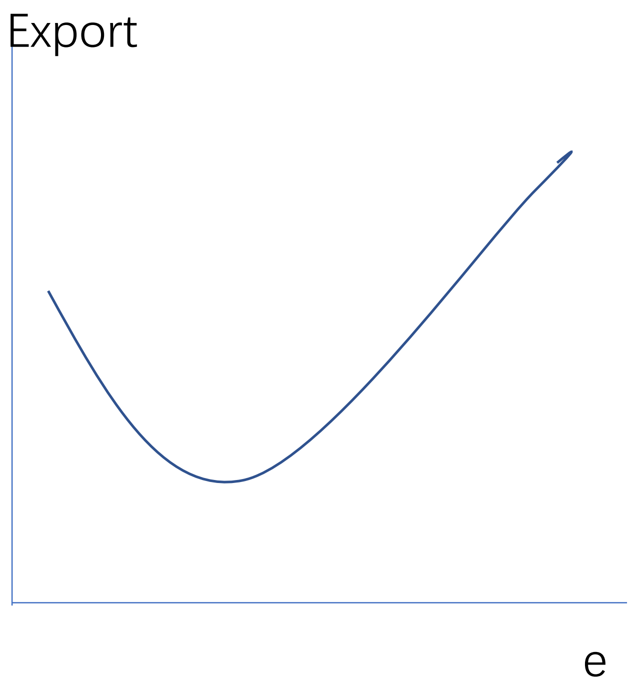
- How to impact trade?

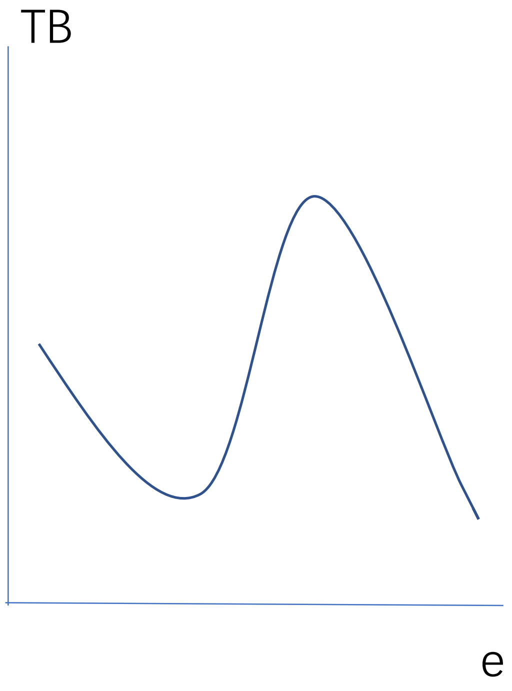
the highest appreciation level of one province's REER within the observation period

	Province Name	Difference
1	Heilongjiang	84.85%
2	Qinghai	80.15%
3	Xinjiang	73.03%
4	Jilin	67.98%
5	Neimenggu	66.82%
6	Xizang	65.61%
7	Ningxia	64.45%
8	Gansu	61.96%
9	Hebei	60.89%
10	Shanxi	57.92%
11	Guangxi	57.73%
12	Shandong	56.91%
13	Hainan	55.96%
14	Hunan	55.43%
15	Jiangsu	54.76%
16	Hubei	54.43%
17	Tianjin	53.87%
18	Shanghai	53.28%
19	Henan	52.84%
20	Zhejiang	52.48%
21	Liaoning	52.45%
22	Shanxi	51.79%
23	Guizhou	51.69%
24	Sichuan	50.75%
25	Anhui	50.73%
26	Jiangxi	50.35%
27	Fujian	48.41%
28	Yunnan	47.27%
29	Chongqing	47.11%
30	Beijing	40.97%
31	Guangdong	40.72%

The Theory- the Relationship between Trade and Exchange Rate

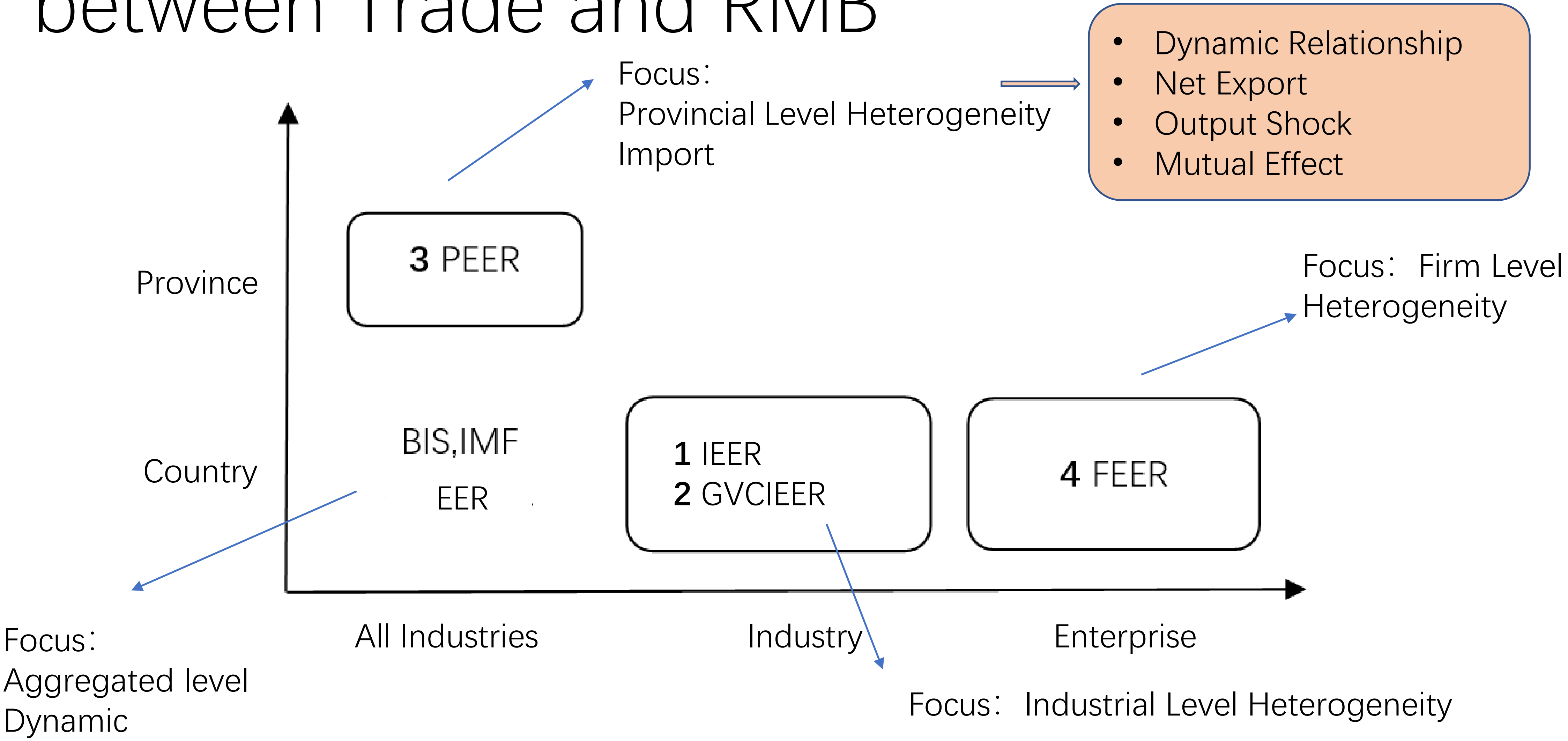
- Theory in literature
- J curve (Marshall-Lerner condition)
- S curve (Backus, 1994)





- Research Focus
- The dynamic feature between trade and exchange rate
- Endogenous issue

The Empirical Studies- the Relationship between Trade and RMB



Data

- Sample period： Oct. 2008-Sep.2017
  - Data started from Jan. 2003
  - Exchange rate regime switch: July 2005
  - International financial: September 2008
- Region: East, Middle and West

Indicator	Data	Method	Seasonal Adjustment
Trade	（Export-Import）/Industrial Value-added	Ratio	Due to the possible negative value of net export, we seasonal adjust export, import and industrial value added and use the adjusted data to count the ratio.
REER	Provincial Level Real Effective Exchange Rate	Take Logarithm	Yes
Output	Electric Energy Production	Take Logarithm	Yes

The Choice of Electric Energy Production as the Monthly Output Data for Each Province

- It is relatively not easy to get monthly output data for each province.
- The missing values in the electric energy production are not too much
- There is no false declaration and inventory adjustment issues comparing with industrial production or industrial value-added data.
- The industrial electric production accounts for about three fourth of the total electric production, it has a strong co-movement with GDP (Hanya Zhang, 2008).
- Note: we also use industrial value added as Output variable

Seasonal Adjustment

- PBoC (People's Bank of China) X-12-ARIMA
  - Despite the regular seasonal adjustment provided by X-12-ARIMA, we use the single variate equal weight model of reg ARIMA module in order to consider Spring Festival effect in China.

Identification scheme (1)

- Time-series VAR models (Sims, 1980) are originated in macroeconomic literature to analyze the dynamic effect of different variables.
- With the introduction of VAR in panel datasets, panel VAR has been applied in many fields (Holtz-Eakin, Newey and Rosen, 1988).
- Following Abrigo and Love (2016), a typical panel VAR model can be written as following linear equations:

$$\mathbf{Y}_{it} = \mathbf{Y}_{it-1}\mathbf{A}_1 + \mathbf{Y}_{it-2}\mathbf{A}_2 + \cdots + \mathbf{Y}_{it-p}\mathbf{A}_p + \mathbf{X}_{it}\mathbf{B} + \mathbf{u}_i + \mathbf{e}_{it}$$

$$i \in \{1,2,\cdots,N\}, t \in \{1,2,\cdots,T_i\}$$

- The model is a *k*-variate panel VAR system of order *p*, where $\mathbf{Y}_{it}$ is a $(1 \times k)$ vector of dependent variables. $\mathbf{X}_{it}$ is a $(1 \times l)$ vector of exogenous variables. In our basic model, we don't assume any exogenous variable, but we do consider output shock as exogenous to both trade balance and exchange rates in our extended model. $\mathbf{u}_i$ and $\mathbf{e}_{it}$ are $(1 \times k)$ vectors of dependent variable-specific panel fixed effects and idiosyncratic errors, respectively. Parameters to be estimated include the $(k \times k)$ matrices $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_p$ and the $(l \times k)$ matrix $\mathbf{B}$.

Identification scheme (2)

- GMM estimator is suitable to estimate the system, for fixed effects or OLS estimation with fixed effects removed after certain transformation will still yield biased results with lagged dependent variables in the right-hand-side of the equation (Nickell, 1981, Judson and Owen, 1999).
- The GMM estimator can be written as follows by transforming the panel VAR model into a more compact form:

$$\mathbf{A} = \left(\widetilde{\mathbf{Y}^*}'\mathbf{Z}\widehat{\mathbf{W}}\mathbf{Z}'\widetilde{\mathbf{Y}^*}\right)^{-1}\left(\widetilde{\mathbf{Y}^*}'\mathbf{Z}\widehat{\mathbf{W}}\mathbf{Z}'\mathbf{Y}^*\right)$$

- where the model has been rearranged as follows:

$$\mathbf{Y}_{it}^* = \widetilde{\mathbf{Y}}_{it}^*\mathbf{A} + \mathbf{e}_{it}^*$$

- where:

$$\mathbf{Y}_{it}^* = \left[\mathrm{y}_{it}^{1*}\ \mathrm{y}_{it}^{2*}\ \cdots\ \mathrm{y}_{it}^{k-1*}\ \mathrm{y}_{it}^{k*}\right]$$
$$\widetilde{\mathbf{Y}_{it}^*} = \left[\mathbf{Y}_{it-1}^*\ \mathbf{Y}_{it-2}^*\ \cdots\ \mathbf{Y}_{it-p+1}^*\ \mathbf{Y}_{it-p}^*\ \mathbf{X}_{it}^*\right]$$
$$\mathbf{e}_{it}^* = \left[\mathbf{e}_{it}^{1*}\ \mathbf{e}_{it}^{2*}\ \cdots\ \mathbf{e}_{it}^{k-1*}\ \mathbf{e}_{it}^{k*}\right]$$
$$\mathbf{A}' = \left[\mathbf{A}_1'\ \mathbf{A}_2'\ \cdots\ \mathbf{A}_{p-1}'\ \mathbf{A}_p'\ \mathbf{B}'\right]$$

- $*$ Denotes the transformation of the original variable. Since our dataset is strongly balanced, first difference (FD) transformation will be used in the estimation. If the original variable is a_{it}, the FD transformation implies that $a_{it}^* = a_{it} - a_{it-1}$.
- $\widehat{\mathbf{W}}$ is an $(L \times L)$ nonsingular, symmetric and positive semidefinite weighting matrix. $\mathbf{Z}_{it}$ is the row vector of the common set of $L \geq kp + l$ instruments, where $\mathbf{X}_{it} \in \mathbf{Z}_{it}$. The GMM estimator is consistent under the assumption that $\mathbf{E}(\mathbf{Z}'\mathbf{e}) = 0$ and rank $\mathbf{E}\left(\widetilde{\mathbf{Y}_{it}^*}'\mathbf{Z}\right) = kp + l$. The weighting matrix can be selected to maximize efficiency (Hansen, 1982).

Identification scheme (3)

- Our identification scheme generally follows the following steps:
  - 1. Sperate sample into three areas: east, middle and west.
  - 2. Use panel unit root test to make sure our variables are stable. When one variable is not stable, we transform the data into the growth rate.
    - The GMM estimator suffers from weak instrument problems when the variable being modeled is near unit root. The moment conditions become completely irrelevant when the variable has unit root（Blundell and Bond， 1998).
  - 3. Do the model selection work by choosing the optimal lag order in both panel VAR specification and moment condition.
    - We consider both Hansen’s (1982) J statistic of overidentifying restrictions and the model selection criteria MMSC proposed by Andrews and Lu (2001).
  - 4. Perform Granger causality Wald tests to see which variable granger causes the other variable. This helps to see whether past values of a variable are useful in predicting another variable given the past values of this variable.
  - 5. Calculate impulse response function (IRF) and forecast-error variance decomposition (FVED). Granger-causality results have been considered in choosing the Cholesky-ordering. Confidence intervals are calculated using 200 Monte Carlo simulations.

Basic Models

- two (Model 1) or three (Model 2)variables for each province:
  - Model 1: without output {Trade, REER}
  - Model 2: with output {Trade, REER, Output},

Major results based on unit root test, model selection test and Granger Causality test for East Area of China

East area			
Variables	**Unit Root Test**	**Model selection of panel VAR model 1**	**Model selection of Panel VAR model 2**
Trade	Stable	First-order panel VAR model, six lags of endogenous variables as instruments	First (or third) -order panel VAR model, six lags of endogenous variables as instruments
REER	Not stable, transformed into growth rate		
Output	Stable		
Granger Causality Test			
	Trade	←	REER
	Trade	—	Output
	REER	→	Output

Major results based on unit root test, model selection test and Granger Causality test for Middle Area of China

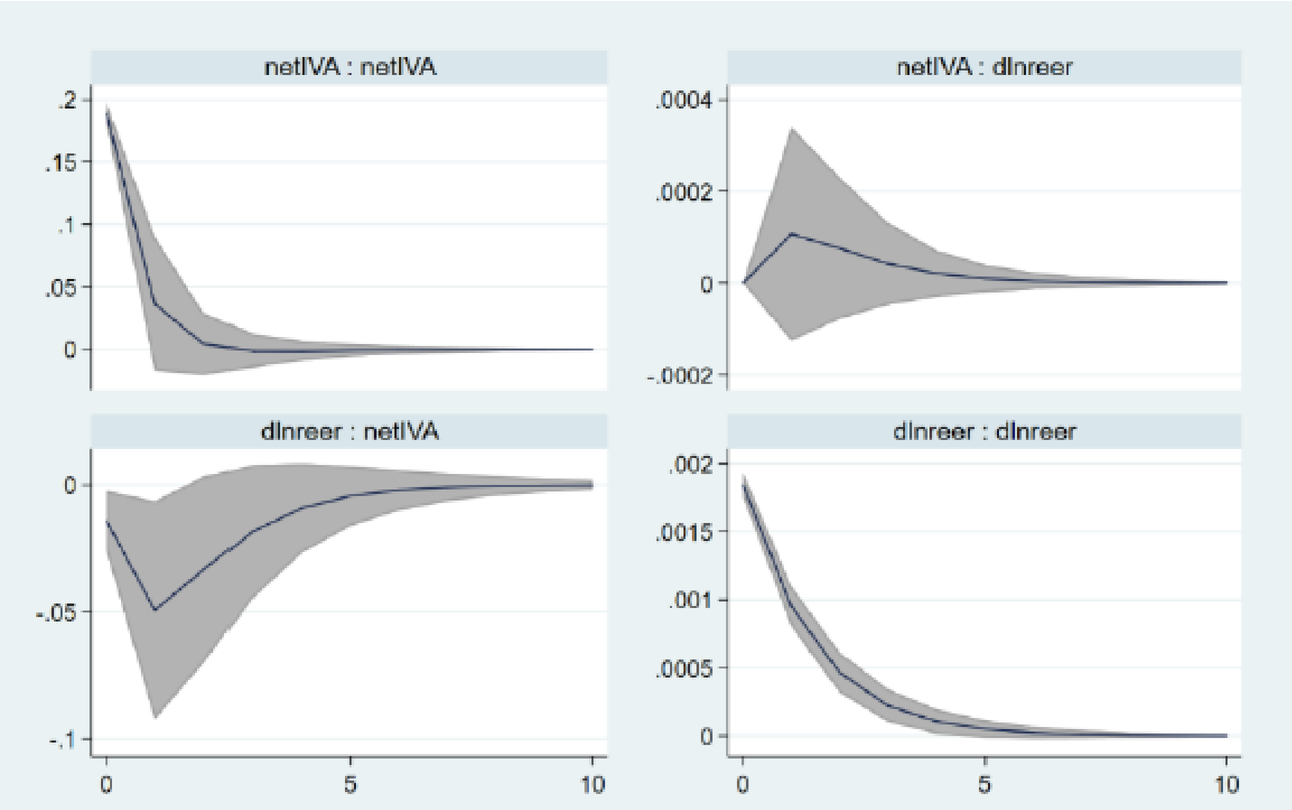
Middle area			
Variables	**Unit Root Test**	**Model selection of panel VAR model 1**	**Model selection of Panel VAR model 2**
Trade	Stable	First-order panel VAR model, six lags of endogenous variables as instruments	First-order panel VAR model, six lags of endogenous variables as instruments
REER	Not stable, transformed into growth rate		
Output	Stable		
Granger Causality Test			
	Trade	←	REER
	Trade	←	Output
	REER	—	Output

Major results based on unit root test, model selection test and Granger Causality test for West Area of China

West area			
Variables	**Unit Root Test**	**Model selection of panel VAR model 1**	**Model selection of Panel VAR model 2**
Trade	Stable	First-order panel VAR model, six lags of endogenous variables as instruments	First-order panel VAR model, six lags of endogenous variables as instruments
REER	Not stable, transformed into growth rate		
Output	Not stable, transformed into growth rate		
Granger Causality Test			
	Trade		REER
	Trade		Output
	REER		Output

Impulse responses in East Area of China (Model 1)

East area	**Trade**	**REER**
Trade		
REER		

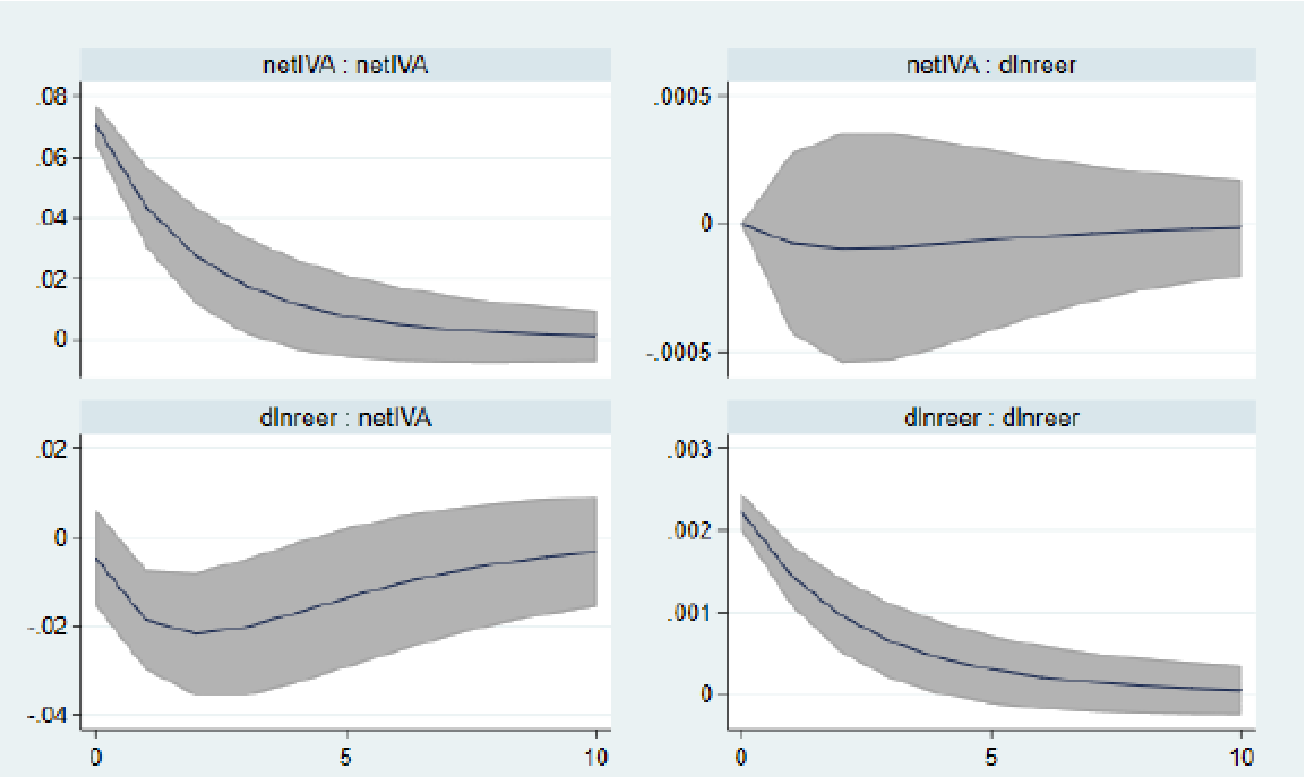


Impulse responses in Middle Area of China (Model 1)

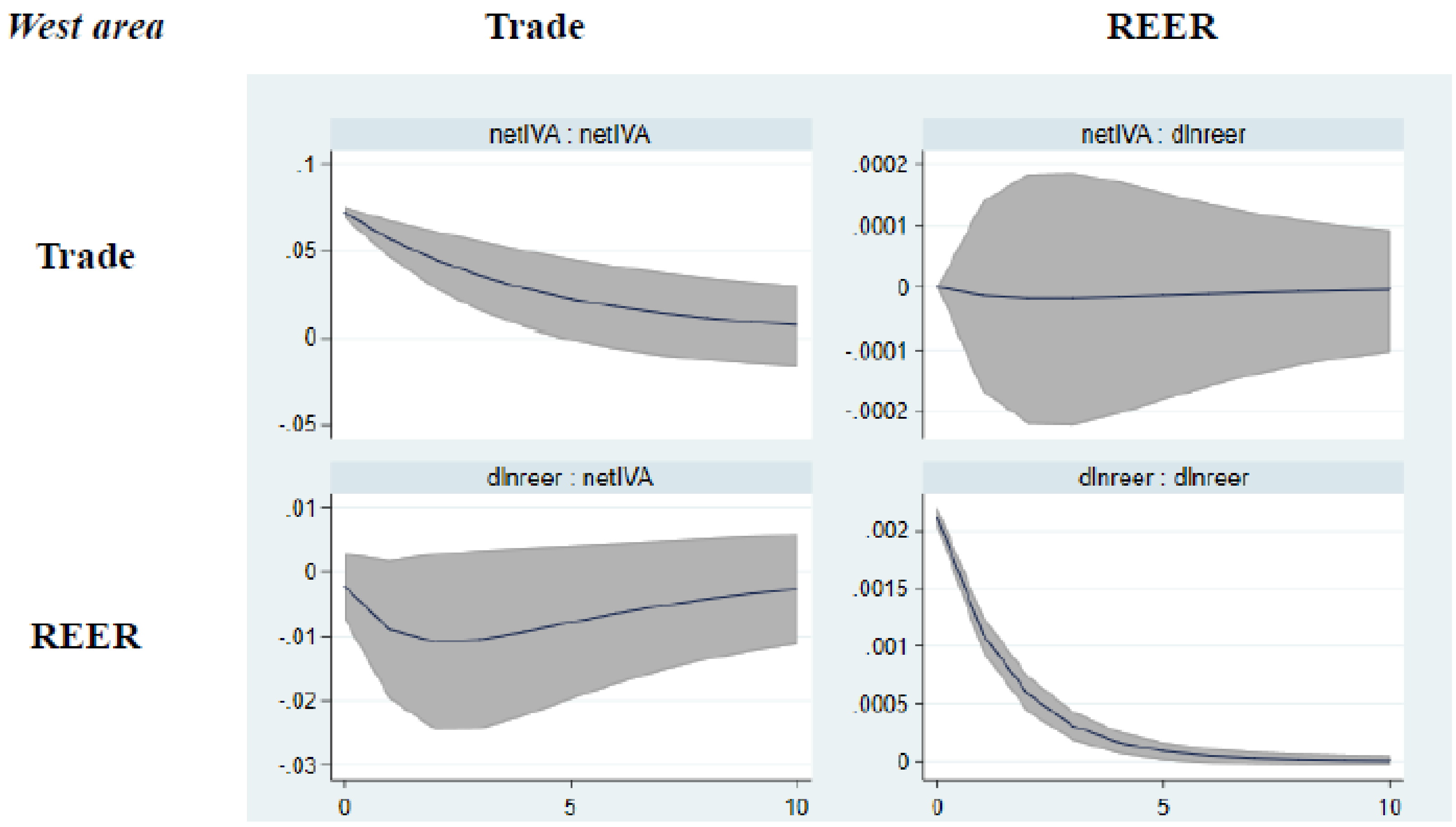
Middle area	Trade	REER

Trade

REER



Impulse responses in West Area of China (Model 1)



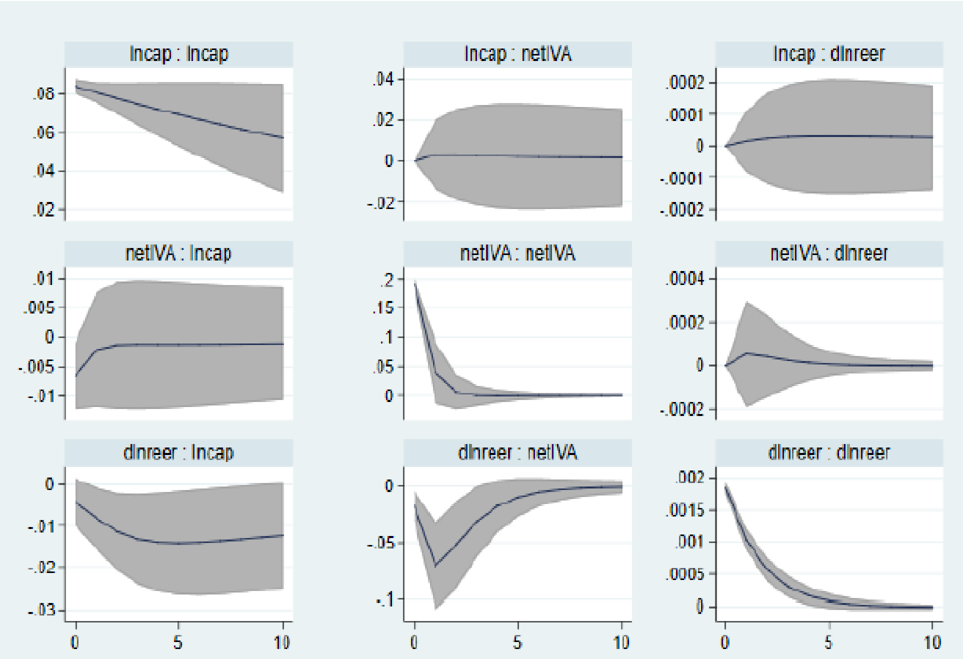
Impulse responses in East Area of China (Model 2)

East area (1lags) **Output** **Trade** **REER**

Output

Trade

REER

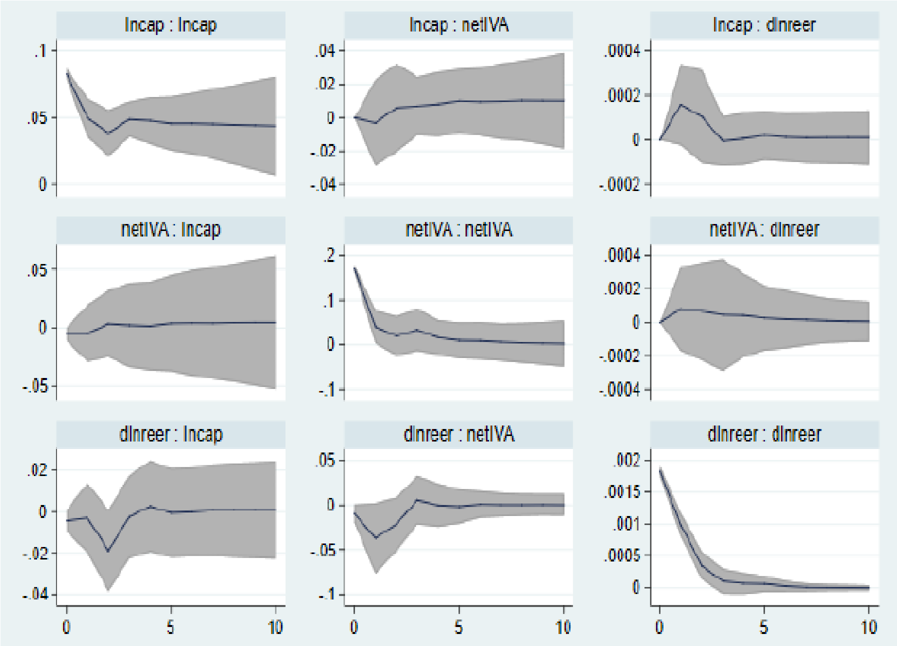


East area (3lags) **Output** **Trade** **REER**

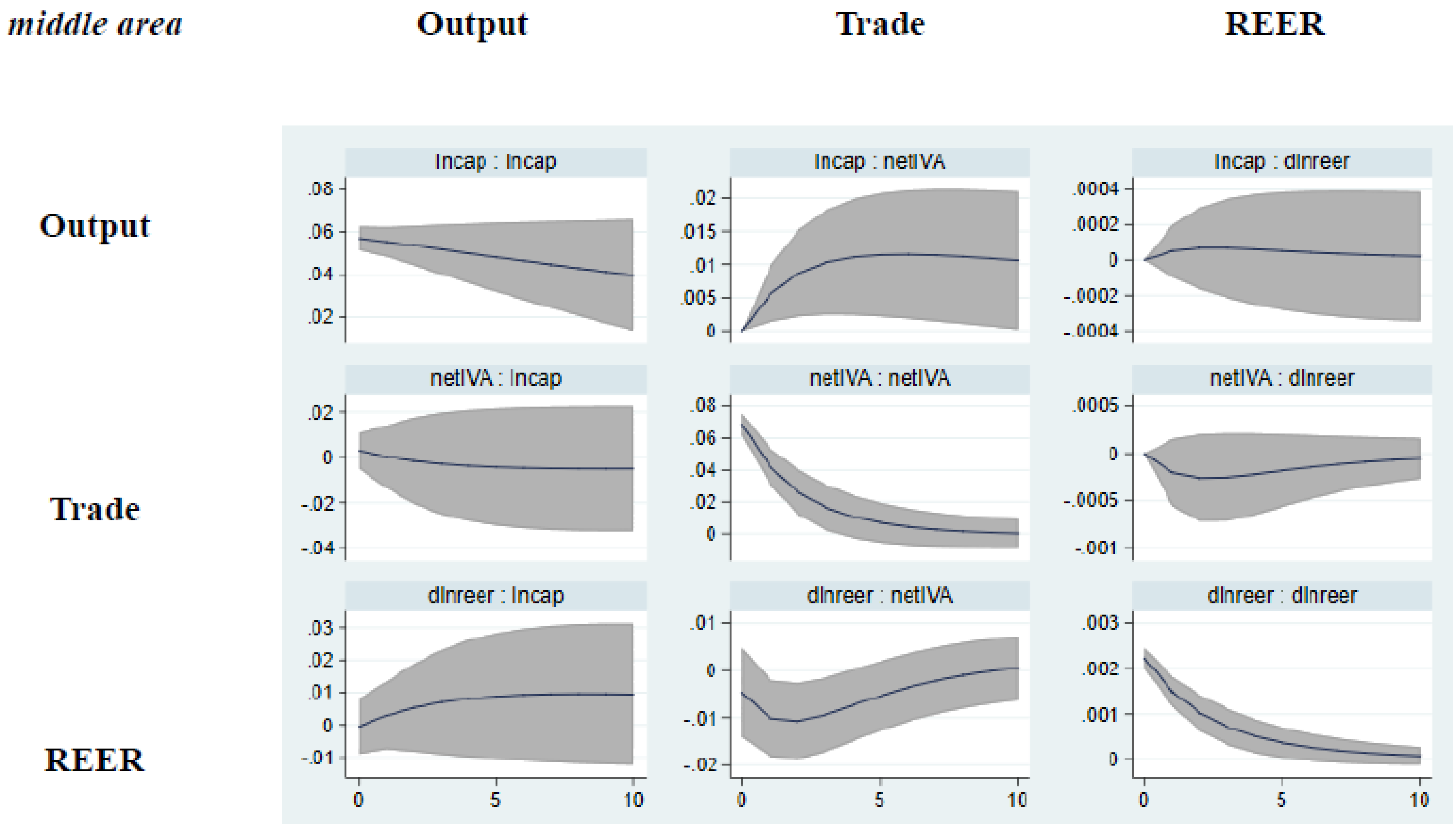
Output

Trade

REER



Impulse responses in Middle Area of China (Model 2)



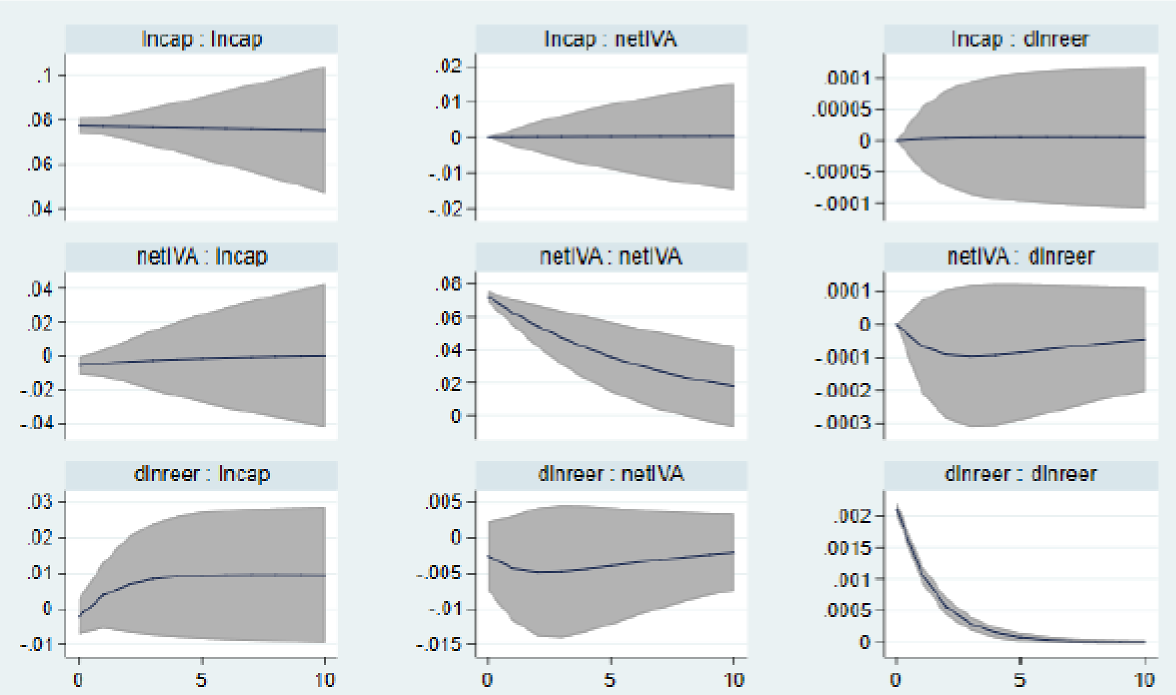
Impulse responses in West Area of China (Model 2)

West area	**Output**	**Trade**	**REER**

Output

Trade

REER



Alternative definition of variables -Industrial value added as Output

	REER is the Granger cause of Trade	Trade is the Granger cause of REER	Response of Trade to REER	Response of REER to Trade
East area	Yes	No	negative	0
Middle area	Yes	No	negative	0
West area	Yes	No	negative	0

Alternative identification schemes -Output as exogenous variable

	REER is the Granger cause of Trade	**Trade is the Granger cause of REER**	**Response of Trade to REER**	**Response of REER to Trade**
East area	Yes	No	negative	0
Middle area	Yes	No	negative	0
West area	No	No	0	0

Major Findings

	Openness	REER appreciation level	Exchange rate shock to trade	Negative effect
East area	Open	Low	To some extent negative	Modest
Middle area	Relatively open	High	Negative	High
West area	Relatively close	High	Not significant	Relatively low

Policy Implications

- We provide a new insight into the sources of regional unbalanced growth – the exchange rate policy might exert different influence on trade in different regions.
- When promoting comprehensive opening-up, this mechanism should be considered.
- Consistent evaluation on the external competitiveness of different provinces and regions is needed.

Thank you!