Income elasticity, Currency Appreciation and Trade Balance ---Based on United States Case

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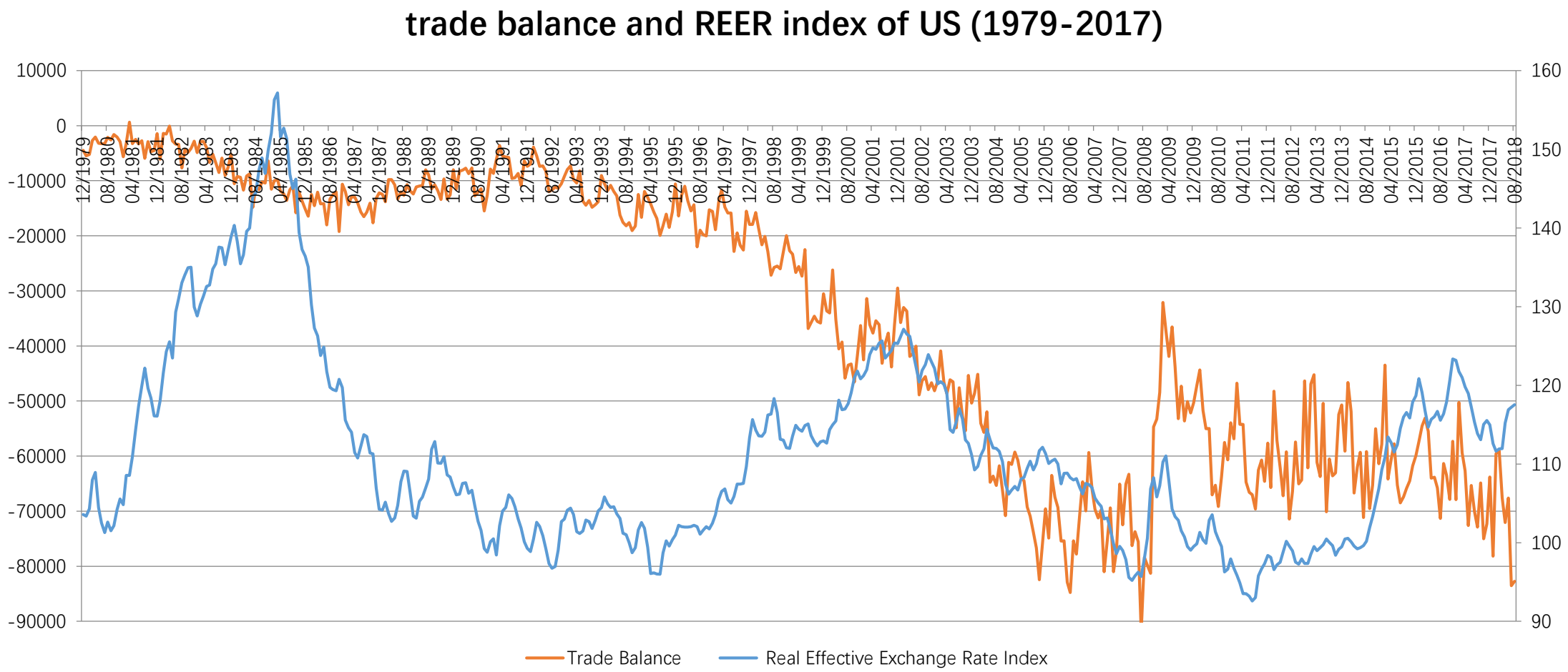
- 1 Introduction
- 2 literature review
- 3 Theoretical Deduction and Research Hypothesis
- 4 Model Setting and Sample Situation
- 5 Empirical test based on United States
- 6 Further explaining
- 7 Conclusion

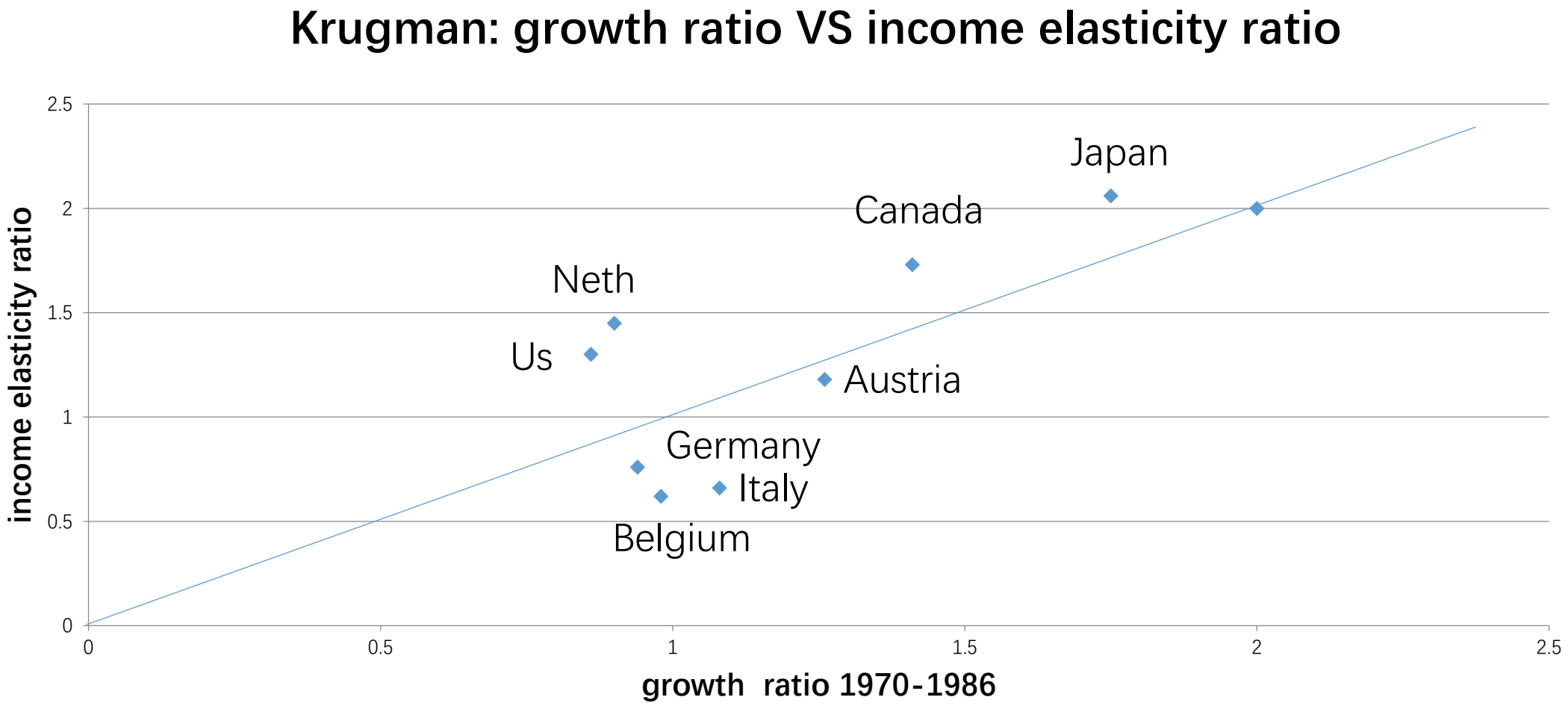
1 Introduction

- Two phenomena
- One is Exchange Rate Adjustment Puzzle
- The other is Krugman's "45-degree rule"

Two phenomena: Exchange Rate Adjustment Puzzle



Two phenomena: 45-degree rule



Question?

- Is there any impact of income elasticity difference on exchange rate elasticity?

2 literature review

- 2.1 Two common understandings
- 2.2 Four points needed further research

2.1 Two common understandings

- First, exchange rate and income both are import factor for trade
- ---(krugman, 1989; Marquez, 1990: Hooper et al, 1998; Yao et al., 2010 ; Aiello et al.2014)

- Second, income may play more import than exchange rate, especially in long run
- ---Harry Johnson(1958) and Houthakker and Magee(1969) the direction of a country's trade condition (surplus or deficit) mainly depends on income elasticity of this country's import and export.

2.2 Four points

- First, researches does not consider the impact of income and exchange rate together

- ---ML-condition related papers often set income as control variable
- (Obstfeld and Rogoff, 2001; Devereus and Engel, 2003; Liu et al.2007;Goldberg and Campa, 2010)

- ---45-degree rule related papers assume that equilibrium exchange rate does not change in long run (krugman, 1989; Caporale ,1999)

2.2 Four points

- Second, related research use aggregate trade data, which can not catch a country's trade structure changes in
- ---trade partners
- ---products structure

2.2 Four points

- Third, the link between income elasticity and growth rate is gradually weakening for the convergence growth rates of major developed economies

- ---Aiello (2014)'s estimations show that, from 1990 to 2012, the relative growth ratio of United States, Britain and Japan were between 0.6 and 0.9, while the income elasticity ratios of these three countries were 0.61, 1.43 and 2.03 respectively

2.2 Four points

- Forth, Krugman deduce 45-degree rule by following assumption:
- high labor growth rate leads to more new products for export, and then higher GDP growth rate and higher export income elasticity for a small-open country

- But if fact
- ---high growth rate does not mean more new product
- ---economic stage or scale may be more explainable

What will we do?

- First, this paper will modify the 45-degree rule with economic stage/scale in industry-level bilateral trade

- Second, this paper will examine the relationship of income elasticity and exchange rate elasticity

3 Theoretical Deduction and Research Hypothesis

- hypothesis 1: modified 45 degree rule
- hypothesis 2: income elasticity condition

3 Theoretical Deduction and Research Hypothesis

- According to Goldstein and Khan (1985) and Bahmani-Oskooee and Coswami (2004)
- the import and export demand equation of one country's bilateral trade can be written as:
- export demand equation： $\mathrm{X} = \mathrm{X}(R, Y^*)$
- import demand equation： $\mathrm{M} = \mathrm{M}(R, Y)$

- And then written into C-D function form,
- $\mathrm{X} = \gamma_0 R^{\alpha_1} Y^{*\beta_1}$
- $\mathrm{M} = \gamma_1 R^{\alpha_2} Y^{\beta_2}$

- The logarithm form of above equation is,
- $\ln X = \gamma_0 + \alpha_1 \ln R + \beta_1 \ln Y^* + \varepsilon_0$
- $\ln M = \gamma_1 + \alpha_2 \ln R + \beta_2 \ln Y + \varepsilon_1$

hypothesis 1

- We subtract above two formula to gain trade balance equation,
- $\ln X - \ln M = \ln(X/M) = \gamma_0 - \gamma_1 + (\alpha_1 - \alpha_2)\ln R + \beta_1 \ln Y^* - \beta_2 \ln Y + \varepsilon_0 - \varepsilon_1$

- rewritten as follows:
- $\ln(X/M) = \gamma_2 - \theta \ln R + \beta_1 \ln Y^* - \beta_2 \ln Y + \varepsilon_2$

- We further assume as Krugman (1989) does, that is $\ln(X/M) = 0$;
- then we have: $\theta = (\beta_1 \ln Y^* - \beta_2 \ln Y)\ln R$

- **hypothesis 1:** $\beta_1/\beta_2 = \ln Y/\ln Y^*$ (modified 45-degree rule)

hypothesis 2

- Case 1: When $\beta_1 \, ln \, Y^* - \beta_2 \, ln \, Y > 0$; that is ${\beta_1}/{\beta_2} > {ln \, Y}/{ln \, Y^*}$, then we have $\theta > 0$, that is exchange rate elasticity is negative, which means that depreciation can improve the trade deficit;
- Case 2: When $\beta_1 \, ln \, Y^* - \beta_2 \, ln \, Y < 0$; that is ${\beta_1}/{\beta_2} < {ln \, Y}/{ln \, Y^*}$, then we have $\theta < 0$, that is exchange rate elasticity is positive, which means that appreciation can improve trade deficit;

- **hypothesis 2:** when the ratio of income elasticity is less than the ratio of income, currency appreciation can improve trade deficit. (income elasticity condition)

4 Model Setting and Sample Situation

- 4.1 Model Setting and Variable Selection
- 4.2 Sample Country Selection and Data Sources

4 Model Setting and Sample Situation

- **4.1 Model Setting and Variable Selection**
- According to derivation process, this paper uses the logarithmic form of bilateral trade balance equation, and regression equation is set to:

- $\ln trade_j = \gamma_0 - \theta \ln R_j + \beta_1 \ln gdp\_f_j - \beta_2 \ln gdp\_usa + \varepsilon_0$

• Table 1 Variables and Data Sources

	Variable	Definition	Data source
Explained variable	balance of trade ($trade_j$)	logarithm of exports minus logarithm of imports.	CEIC
Explanatory variable	national income of trading partner (gdp_f_j)	Nominal gross national product of trading partner J	CEIC
	domestic national income(gdp_usa)	Nominal gross national product of United States	CEIC
	bilateral nominal exchange rate(noex)	indirect quotation method, and standardization year 2010 equaling to 100	IMF
	bilateral real exchange rate (reex)	deflated with domestic and foreign CPI index	IMF
Controlled variable	unemployment rate (unemploy)	unemployment rate of United States	IMF

4.2 Sample Country Selection and Data Sources

- first, this country should be account considerable proportion in total foreign trade of United States;

- second, this paper tries to cover countries at different development stages, in order to examine the impact of economic development on income elasticity and exchange rate elasticity.

4.2 Sample Country Selection and Data Sources

- Sample countries
- Brazil, Canada, China, France, Germany, Japan, Korea, Mexico and United Kingdom are selected as sample countries;

- data
- using sub-industry import and export data according to SITC (Standard International Trade Classification) 2 digit classification from 1996 to 2017

5 Empirical test based on United States

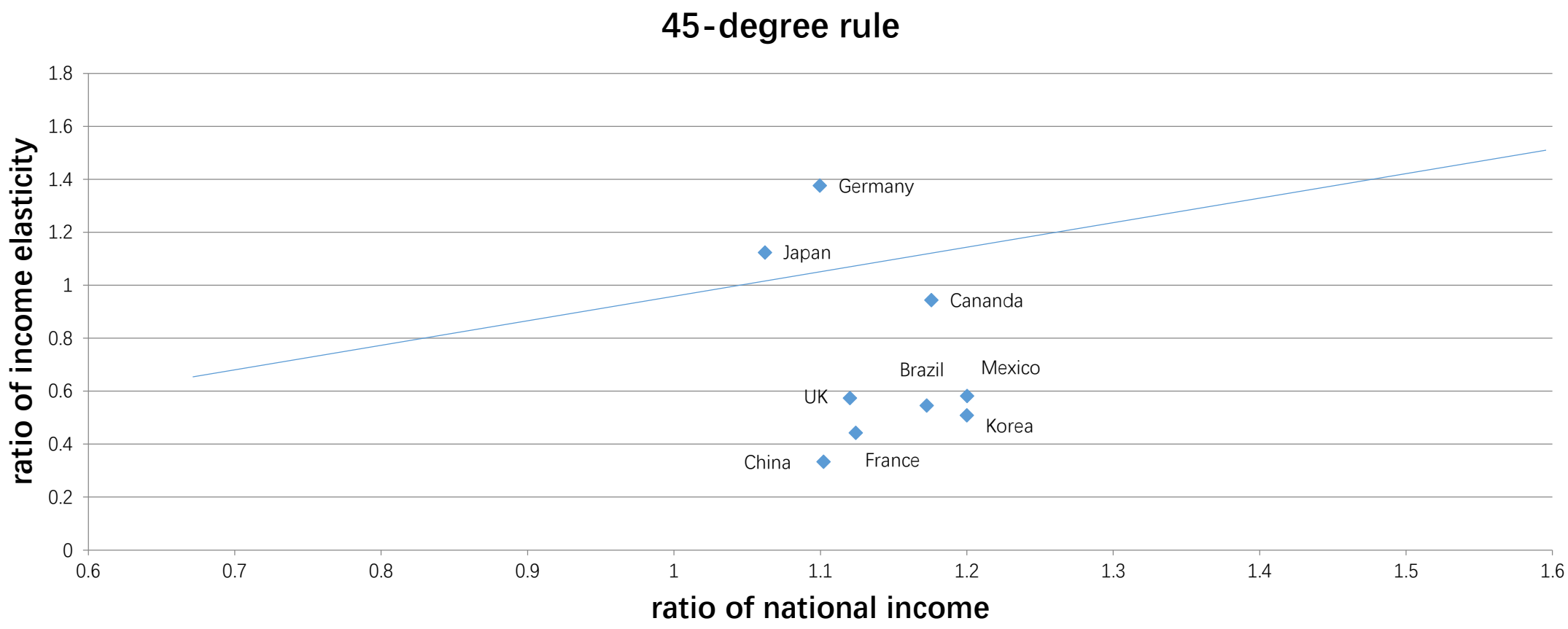
- 5.1 Inspection of the 45-degree rule
- 5.2 Verifying Hypothesis 2
- 5.3 Endogenous Problem

5.1 Inspection of the 45-degree rule

- **Table 2 Income Elasticity for United States with Its Trading Partners**

	Brazil	Canada	China	France	Germany	Japan	Korea	Mexico	UK
VARIABLES	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade
lngdp_f	0.983***	0.167***	0.481***	0.285***	0.796***	0.743***	1.214***	0.152*	-0.330**
	(0.045)	(0.052)	(0.071)	(0.103)	(0.106)	(0.113)	(0.103)	(0.087)	(0.128)
lngdp_usa	-1.843***	0.177**	-1.437***	-0.610***	-0.537***	-0.481***	-2.302***	-0.318***	0.676***
	(0.098)	(0.081)	(0.257)	(0.111)	(0.098)	(0.051)	(0.163)	(0.110)	(0.124)
Constant	15.087***	-4.819***	14.498***	5.015***	-2.265***	-1.932	20.845***	3.529***	-5.338***
	(1.075)	(0.631)	(2.938)	(0.828)	(0.768)	(1.406)	(1.325)	(0.725)	(0.818)
Observations	5,513	5,984	5,750	5,679	5,763	5,738	5,521	5,809	5,759
R-squared	0.083	0.044	0.011	0.008	0.010	0.017	0.039	0.003	0.010
Number of industry	67	68	67	67	67	67	67	67	67

5.1 Inspection of the 45-degree rule



5.2 Verifying Hypothesis 2

- **Table 4 Income and Exchange rate Elasticity of United Stated and Sample Countries**

	Brazil	Canada	China	France	Germany	Japan	Korea	Mexico	UK
VARIABLES	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade
lngdp_f	1.514***	0.174	0.606***	0.290***	0.889***	0.489	2.175***	0.561***	3.094**
	(0.121)	(0.426)	(0.154)	(0.103)	(0.109)	(0.613)	(0.302)	(0.148)	(1.218)
lngdp_usa	-3.358***	0.169	-1.675***	-0.422***	-0.392***	-0.477***	-3.782***	-1.288***	-2.576**
	(0.335)	(0.452)	(0.368)	(0.124)	(0.105)	(0.052)	(0.467)	(0.304)	(1.157)
lnnoex	0.696***	0.008	0.506	0.102***	0.271***	-0.216	1.055***	0.568***	3.468***
	(0.147)	(0.461)	(0.558)	(0.030)	(0.073)	(0.512)	(0.312)	(0.166)	(1.226)
Constant	27.807***	-4.834***	13.998***	1.612	-6.989***	2.597	26.446***	10.509***	-17.734***
	(2.894)	(1.051)	(2.989)	(1.308)	(1.488)	(10.855)	(2.122)	(2.165)	(4.459)
Observations	5,513	5,984	5,750	5,679	5,763	5,738	5,521	5,809	5,759
R-squared	0.086	0.044	0.011	0.010	0.013	0.017	0.041	0.005	0.011
Number of industry	67	68	67	67	67	67	67	67	67

Table 6 verifying Hypothesis 2

	income elasticity of exports	income elasticity of imports	ratio of income elasticity	ratio if income	location to 45-degree line	deduced exchange rate elasticity	regression result
Brazil	1.023	-1.875	0.546	1.173	below	positive	0.696
Canada	0.167	-0.177	0.944	1.176	below	positive	0.008
China	0.44	-1.32	0.333	1.102	below	positive	0.506
France	0.265	-0.599	0.442	1.124	below	positive	0.102
Germany	0.669	-0.486	1.377	1.1	above	negative	0.271
Japan	0.545	-0.485	1.124	1.062	above	negative	-0.216
Korea	1.163	-2.288	0.508	1.2	below	positive	1.055
Mexico	0.2	-0.344	0.581	1.2	below	positive	0.568
United Kingdom	-0.35	0.61	0.574	1.12	below	positive	3.468

5.3 Endogenous Problem

- in National Income Accounting System, net exports are an important part of national income
- Exchange Rate Determination Theory, trade deficit will reduce foreign exchange supply and increase foreign exchange demand, so that exchange rate of local currency will fall

- Two instrument variables:
- M2 ratio and lag term

5.3 Endogenous Problem

- **Table 7 Income and Exchange rate Elasticity (ratio of M2 as instrument variable)**

	Brazil	Canada	China	France	Germany	Japan	Korea	Mexico
VARIABLES	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade
lngdp_f	0.228***	-0.061	0.032	0.018	0.604***	0.536***	1.147***	0.053
	(0.084)	(0.067)	(0.159)	(0.152)	(0.128)	(0.118)	(0.128)	(0.113)
lngdp_usa	-4.240***	0.590***	-2.630***	-0.324*	-0.341***	-2.264***	-1.931***	-0.578***
	(0.244)	(0.111)	(0.406)	(0.166)	(0.121)	(0.312)	(0.459)	(0.173)
lnm2ratio	2.052***	1.155***	1.243***	0.893**	0.691**	-2.017***	-0.176	0.251*
	(0.193)	(0.171)	(0.289)	(0.373)	(0.285)	(0.351)	(0.211)	(0.138)
Constant	51.921***	-13.395***	34.240***	0.197	-5.745***	37.253***	16.867***	7.563***
	(3.600)	(1.501)	(5.545)	(2.190)	(1.544)	(6.954)	(4.774)	(2.231)
Observations	5,328	5,780	4,865	5,483	5,567	5,480	5,332	5,611
R-squared	0.104	0.050	0.017	0.009	0.012	0.023	0.038	0.004
Number of industry	67	68	67	67	67	67	67	67

5.3 Endogenous Problem

- **Table 8 Income and Exchange rate Elasticity(lag term as instrument variable)**

	Brazil	Canada	China	France	Germany	Japan	Korea	Mexico	UK
	2sls	2sls	2sls	2sls	2sls	2sls	2sls	2sls	2sls
VARIABLES	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade	Intrade
lngdp_f	1.806***	0.644	2.538**	0.366*	1.038***	1.332	1.635*	0.407	6.556*
	(0.432)	(1.188)	(1.254)	(0.198)	(0.245)	(2.412)	(0.910)	(0.468)	(3.640)
lngdp_usa	-4.101***	-0.331	-5.766**	-0.500**	-0.466*	-0.567***	-2.798**	-1.129	-5.827*
	(1.209)	(1.262)	(2.806)	(0.238)	(0.240)	(0.178)	(1.411)	(0.950)	(3.466)
Innoex	0.993*	0.492	6.949*	0.098	0.279*	0.383	0.641	0.620	6.945*
	(0.534)	(1.289)	(4.150)	(0.061)	(0.166)	(1.957)	(0.934)	(0.524)	(3.671)
Constant	33.857***	-5.548**	18.853**	1.791	-7.924**	-10.737	20.195***	9.774	-30.692**
	(10.314)	(2.747)	(9.226)	(2.501)	(3.275)	(42.172)	(6.535)	(6.676)	(13.084)
Observations	5,452	5,916	5,688	5,616	5,698	5,671	5,461	5,742	5,693
R-squared	0.014	0.009	0.012	0.003	0.004	0.002	0.003	0.001	0.003

6 Explaining the Difference of income elasticity

- A necessity product mainly has low income elasticity, and a luxury product often has high income elasticity

- The income elasticity of US exports is less than that of imports, indicating that US export commodities are relatively more essential goods.

- Is that true? And why?

6 Explaining from the Perspective of Trade Structure

- We further examine the income elasticity and exchange rate elasticity of different industry in HS 2-digit classification

- Cereals/ Raw hide and leather/ Wool and Animal Fine Hair

- Inorganic chemicals/ Vehicles and accessories/ Optics and photography

- **Table 7 Income and Exchange rate Elasticity of different industry**

	Cereals	Cereals	Raw hide and leather	Raw hide and leather	Wool and Animal Fine Hair	Wool and Animal Fine Hair
VARIABLES	lnexp	lnimp	lnexp	lnimp	lnexp	lnimp
lngdp_f	2.542***		1.665***		-1.161***	
	(0.786)		(0.418)		(0.363)	
lngdp_usa		1.709*		1.192**		-1.126**
		(0.902)		(0.475)		(0.506)
lnreex	-0.639	2.075**	0.769	-0.474	0.388	-0.282
	(1.110)	(1.012)	(0.581)	(0.541)	(0.512)	(0.562)
Constant	-24.182	-1.321	-8.625	-2.039	31.872***	34.843***
	(16.399)	(17.169)	(8.672)	(9.038)	(7.591)	(9.636)
Observations	232	232	1,072	1,274	750	750
R-squared	0.068	0.059	0.124	0.395	0.383	0.455

• Continued Table 7

	Inorganic chemicals	Inorganic chemicals	Vehicles and accessories	Vehicles and accessories	Optics and photography	Optics and photography
VARIABLES	lnexp	lnimp	lnexp	lnimp	lnexp	lnimp
lngdp_f	1.733***		2.069***		1.580***	
	(0.174)		(0.252)		(0.189)	
lngdp_usa		2.474***		2.926***		2.509***
		(0.226)		(0.414)		(0.211)
lnreex	-1.018***	-1.199***	1.193***	-0.004	0.515**	-0.142
	(0.243)	(0.253)	(0.349)	(0.462)	(0.232)	(0.235)
Constant	-8.501**	-17.942***	-9.971*	-28.603***	-5.578	-22.091***
	(3.637)	(4.305)	(5.235)	(7.890)	(3.865)	(4.012)
Observations	3,582	3,659	1,509	1,571	2,164	3,211
R-squared	0.276	0.329	0.518	0.323	0.571	0.406

Further consideration

- On one hand, large-scale manufacturing and high-tech enterprises of United States have chosen to relocate to other countries, So export income elasticity of US is relatively low.

- On the other hand, the advanced financial markets provide sufficient liquidity so that leads to greater import income elasticity.

7 Conclusion

- First, the ratio of income elasticity is positively related to the ratio of income in bilateral trade

- Second, when income elasticity ratio is greater than the ratio of income, currency depreciation can improve balance of payments; otherwise, currency appreciation can handle this work.

- Thanks for listening!