Green Havens and Trade in Environmental Goods

Trang My Tran

Deakin University
trantra@deakin.edu.au

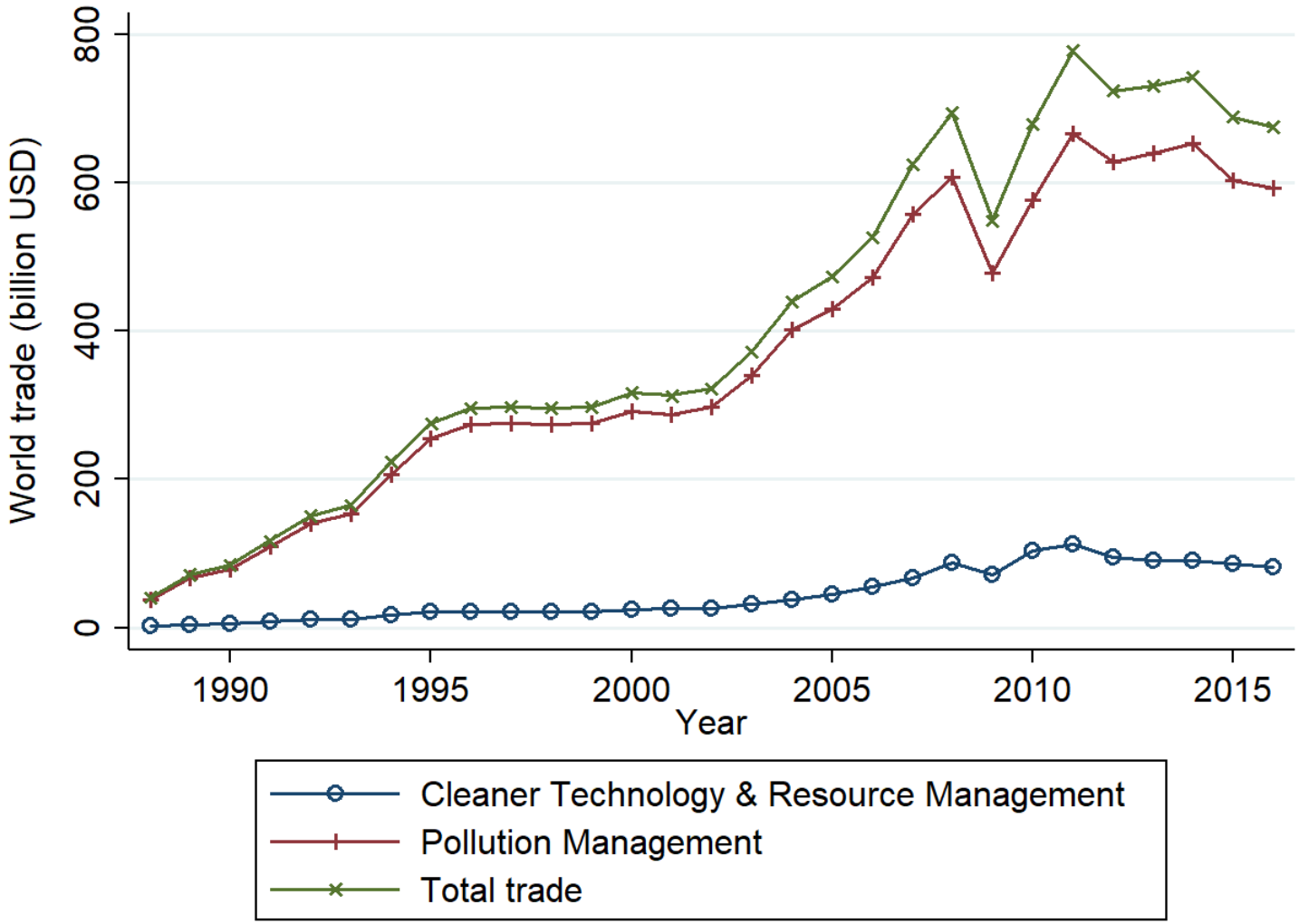
The Australian Conference of Economists 2019

16^{th} July, 2019

Environmental Goods and Services Industry

- Activities which produce goods and services to **measure, prevent, limit, minimize** or **correct** environmental damage to water, air, and soil as well as problems related to waste noise and eco-systems (OECD/Eurostat, 1999) Example
- Categorized into 3 groups
  - Pollution Management
  - Cleaner Technology and Products
  - Resource Management
- Importance of facilitating trade in environmental goods and services has been recognized by international communities
  - The Ministerial Declaration of the WTO Doha Round in 2001
  - 2012 Rio +20 outcome document "The Future We Want"

World trade of EGs during 1988 - 2016



Source: Author's calculation based on UN COMTRADE data

Top exporters

Five largest exporters	Value of trade (billion USD)	% of world trade
United States	2,010	16.0
Germany	1,860	14.8
Japan	1,380	11.0
China	1,170	9.3
Italy	625	5.0
Total	7,045	56.1
Top 5 developing country exporters	Value of trade (billion USD)	% of world trade
China	1,170	9.3
Mexico	284	2.3
Malaysia	162	1.3
Brazil	96.9	0.77
Thailand	95	0.75
Total	1,864	14.42

Source: Author's calculation based on UN COMTRADE data

Top importers

Five largest importers	Value of trade (billion USD)	% of world trade
United States	1,710	13.6
Germany	1,020	8.1
China	964	7.7
Japan	501	4.0
South Korea	498	4.0
Total	4,696	37.4
Top 5 developing country importers	Value of trade (billion USD)	% of world trade
China	964	7.7
Mexico	419	5.3
Thailand	208	1.7
Malaysia	177	1.4
Brazil	170	1.3
Total	1,938	17.4

Source: Author's calculation based on UN COMTRADE data

Research question

To what extent does the environmental regulation stringency affect

- the **bilateral trade** of environmental goods?
- the **export** and **import** of environmental goods?

Literature Review

- The most relevant studies: Sauvage (2014) & Cantore and Cheng (2018)
  1. Sauvage (2014)
     - Approach: use revealed comparative advantage (RCA)
     - No control for the endogeneity of environmental policy and trade of EGs
  2. Cantore and Cheng (2018)
     - Gravity approach
     - Concentration on the import flow of EG
     - Control for the endogeneity of GDP and technological innovation with trade
- Pollution haven and waste haven studies
  - Recent evidences on pollution haven effects (Milliment & Roy, 2016)
  - Waste haven effect (Kellenberg, 2010; Kellenberg, 2012)
  - Limited focus on green haven: Poelhekke & Ploeg (2015)

Contributions

1. The first paper to use the trade data at the product level
2. It examines the export and import flow separately
3. It pays close attention to the endogeneity issue
4. It fills the gap of the green haven literature

Data

Variables	Details	Source	No. countries
Trade data			
EG trade	Bilateral trade at HS-6 product level (1990 - 2015)	UN Comtrade	182
Stringency measure			
Environmental policy stringency (EPS) index	Composite index based on market-based and non-market instruments (1990 - 2015)	OECD; Botta & Kozluk (2014)	33
Energy price index	Weighting fuel prices by the consumption of each fuel type in that country (1995 - 2015)	Sato et. al (2019)	42
Shadow price	Constructed based on economic theory and firms' choices (1995 - 2009)	Althammer & Hille (2016)	28

Correlation among stringency measures

Panel A: Correlation of three measures (No. observations = 310)			
	EPS index	Shadow price	Energy price index
EPS index	1.000		
Shadow price	0.603	1.000	
Energy price index	0.334	0.617	1.000
Panel B: Pairwise correlation among three measures			
	EPS index	Shadow price	Energy price index
EPS index	1.000		
	(781)		
Shadow price	0.611	1.000	
	(362)	(412)	
Energy price index	0.500	0.598	1.000
	(455)	(348)	(553)

Notes. Number of observations for each entry is in parentheses.

Summary Statistics

Variable	Obs.	Mean	S.D.	Min	Max
$Ln(TradeValue_{ijpt})$	8,239,657	10.070	3.073	-0.102	22.800
$Ln(EPS_{it})$	5,173,960	0.509	0.602	-1.561	1.418
$Ln(EPS_{jt})$	2,932,056	0.397	0.665	-1.561	1.418
$Ln(ShadowPrice_{it})$	2,817,781	-0.135	0.313	-1.092	0.605
$Ln(ShadowPrice_{jt})$	1,562,201	-0.171	0.321	-1.092	0.605
$FEPI_{it}$	5,343,078	6.233	0.494	4.524	7.231
$FEPI_{jt}$	3,339,791	6.169	0.518	4.524	7.231

More

Empirical Model

$$\begin{aligned} Ln(TradeValue_{ijpt}) =& \alpha_0 + \alpha_1 \mathbf{Ln(Stringency_{ijt})} + \alpha_2 Border_{ij} + \alpha_3 Currency_{ijt} \\ &+ \alpha_4 FTA_{ijt} + \alpha_5 Ln(Distance_{ij}) + \alpha_6 Language_{ij} \\ &+ \alpha_7 Colony_{ijt} + \alpha_{it} + \alpha_{jt} + \alpha_{pt} + \varepsilon_{ijpt} \end{aligned} \tag{1}$$

- $TradeValue_{ijpt}$: trade value of product p from exporter i to importer j in year t
- $Stringency_{ijt}$: measure of environmental policy stringency by exporter-importer pair in year t. It is constructed as

$$Ln(Stringency_{ijt}) = Ln(Stringency_{it} + Stringency_{jt}) \tag{2}$$

- $Border_{ij}$, $Distance_{ij}$, $Language_{ij}$: Bilateral time-invariant characteristics
- $Currency_{ijt}$, FTA_{ijt}, $Colony_{ijt}$: Bilateral time-variant characteristics
- α_{it}, α_{jt}, α_{pt}: fixed effects

Main Results

Table: Estimates of the impact of environmental policy stringency on bilateral EG trade

	EPS index	Shadow price	Energy price index
	(1)	(2)	(3)
$Ln(Stringency_{ijt})$	**0.901*** **	**-2.021**	**0.923*** **
	(0.192)	(1.253)	(0.276)
Exporter-Year FE	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Observations	1,933,613	927,963	2,366,911
No. exporter-importer pairs	1,056	756	1,721
R-squared	0.498	0.528	0.497

Notes. Robust standard errors, in parentheses, are clustered by exporter-importer pairs. ** & *** Significance at 5% and 1%

Empirical Model

Export supply determinants:

$$\begin{aligned} Ln(TradeValue_{ijpt}) =& \beta_0 + \beta_1 \mathbf{Ln(Stringency_{it})} + \beta_2 Border_{ij} + \beta_3 Currency_{ijt} \\ &+ \beta_4 FTA_{ijt} + \beta_5 Ln(Distance_{ij}) + \beta_6 Language_{ij} \\ &+ \beta_7 Colony_{ijt} + \beta_8 \mathbf{Ln(GDP_{it})} + \beta_9 \mathbf{Disaster_{it}} \\ &+ \alpha_{jt} + \alpha_{pt} + \epsilon_{3ijpt} \end{aligned} \tag{3}$$

Import demand determinants:

$$\begin{aligned} Ln(TradeValue_{ijpt}) =& \gamma_0 + \gamma_1 \mathbf{Ln(Stringency_{jt})} + \gamma_2 Border_{ij} + \gamma_3 Currency_{ijt} \\ &+ \gamma_4 FTA_{ijt} + \gamma_5 Ln(Distance_{ij}) + \gamma_6 Language_{ij} \\ &+ \gamma_7 Colony_{ijt} + \gamma_8 \mathbf{Ln(GDP_{jt})} + \gamma_9 \mathbf{Disaster_{jt}} \\ &+ \alpha_{it} + \alpha_{pt} + \epsilon_{4ijpt} \end{aligned} \tag{4}$$

Endogeneity

- Endogeneity sources
  1. Simultaneity
     - Public opinion shifting (Anderson et al, 2017)
     - Domestic EG producer support
  2. Omitted variable bias

- Solving endogeneity
  - Use importer-year and exporter-year FE for Eq. (1)
  - Use IV for Eq. (3) - (4)
    - Absence of conventional IVs
    - Lewbel (2012) approach

Lewbel (2012) Approach

Consider model (3) - (4) with the corresponding first-stage equations

$$Ln(Stringency_{it}) = \beta_S Z_{it} + \delta_{3it} \tag{5}$$

$$Ln(Stringency_{jt}) = \gamma_S Z_{jt} + \delta_{4jt} \tag{6}$$

where Z_{it} and Z_{jt} are the set of exogenous variables used to generate the instruments
Now consider model (3) with Eq. (5)

$$Cov(Z_{it}, \epsilon_{3ijpt}\delta_{3it}) = 0 \tag{7}$$

$$Cov(Z_{it}, \delta_{3it}) \neq 0 \tag{8}$$

If these conditions are satisfied, then the instruments $[Z_{it} - \mathbf{E}(Z_{it})]\delta_{3it}$ are valid as they are not correlated with the second-stage error given in Eq. (5).

Main Results

Table: Determinants of EG exports

	EPS index		Shadow price		Energy price index
	OLS	2SLS	OLS	2SLS	OLS
$Ln(Stringency_{it})$	**0.557*** **	**0.986*** **	**0.769*** **	**0.608** **	**0.243**
	(0.135)	(0.270)	(0.248)	(0.254)	(0.160)
$Disaster_{it}$	0.026**	0.039***	0.002	-0.001	0.007
	(0.010)	(0.011)	(0.008)	(0.011)	(0.011)
$Ln(GDP_{it})$	0.918***	0.880***	0.969***	0.972***	0.936***
	(0.061)	(0.077)	(0.074)	(0.074)	(0.066)
Under-id test		0.002		0.000	
F-stat		50.53		66.27	
Endog. test		0.000		0.000	
Observations	4,972,363	4,893,821	2,706,716	2,706,716	5,070,207
No. exporter	33	33	28	28	42

Assumption test | Robustness Check

Main Results

Table: Determinants of EG imports

	EPS index		Shadow price		Energy price index	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
$Ln(Stringency_{jt})$	**-0.056**	**0.267**	**-0.234**	**-0.354***	**-0.306*****	**-2.913**
	(0.082)	(0.482)	(0.195)	(0.193)	(0.084)	(8.526)
$Disaster_{jt}$	-0.004	0.006	0.012	0.009	-0.009	-0.124
	(0.005)	(0.019)	(0.010)	(0.010)	(0.007)	(0.386)
$Ln(GDP_{jt})$	0.820***	0.778***	0.834***	0.839***	0.817***	1.048
	(0.043)	(0.085)	(0.036)	(0.035)	(0.034)	(0.737)
Under-id test		0.293		0.001		0.729
F-stat		4.606		22.20		0.100
Endog. test		0.000		0.000		0.000
Observations	2,859,209	2,802,987	1,526,799	1,526,799	3,180,869	3,180,869
No. importers	33	33	28	28	42	42

Robustness Check

Why do countries with laxer regulation tend to import more EGs?

$$
\begin{aligned}
Ln(TradeValue_{ijpt}) =& \theta_0 + \theta_1 \mathbf{Ln(Stringency_{it})} * \mathbf{Pol_p} \\
&+ \theta_2 \mathbf{Ln(Stringency_{jt})} * \mathbf{Pol_p} \\
&+ \theta_3 Border_{ij} + \theta_4 Currency_{ijt} + \theta_5 FTA_{ijt} \\
&+ \theta_6 Ln(Distance_{ij}) + \theta_7 Language_{ij} + \theta_8 Colony_{ijt} \\
&+ \alpha_{it} + \alpha_{jt} + \alpha_{pt} + \theta_{ijpt}
\end{aligned} \tag{9}
$$

where
$Ln(Stringency_{it}) * Pol_p$ is interaction term between $Ln(Stringency_{it})$ and Pol_p;
$Ln(Stringency_{jt}) * Pol_p$ is interaction term between $Ln(Stringency_{jt})$ and Pol_p;
Pol_p is a binary indicator whether the product is in the Pollution Management group.

Why do countries with laxer regulation tend to import more EGs?

Table: Exporter and Importer Regulation Stringency & Pollution Management product trade

	EPS index	Shadow price	Energy price index
$Ln(Stringency_{it}) * Pol_p$	0.368***	-0.096	0.133***
	(0.045)	(0.108)	(0.045)
$Ln(Stringency_{jt}) * Pol_p$	-0.237***	-0.268***	-0.280***
	(0.038)	(0.101)	(0.038)
Exporter-Year FE	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes
Product-Year FE	Yes	Yes	Yes
Observations	1,933,613	927,963	2,366,911
No. exporter-importer pairs	1,056	756	1,721

Notes. Robust standard errors, in parentheses, are clustered by exporter-importer pairs.

Conclusion

1. Finding summary
   - Regulatory stringency is a key determinant of EG trade
   - Evidence for the green haven effect is found
   - An increase in stringency level also leads to a shift toward exporting more and importing less Pollution Management products.
2. Implication
   - Lax environmental regulation is a challenge for the development of EG industry in developing countries
   - The results bring positive view on the role of environmental regulation

Thank you

Comments? Questions?

trantra@deakin.edu.au

Example

Example of EGs

Source: Internet MAIN

Summary Statistics

Table: Descriptive statistics of stringency measures

VARIABLES	N	mean	sd	min	max
EPS index	781	1.589	0.961	0.210	4.130
Shadow price	412	0.870	0.282	0.335	1.831
Energy price index	866	6.127	0.520	4.524	7.231

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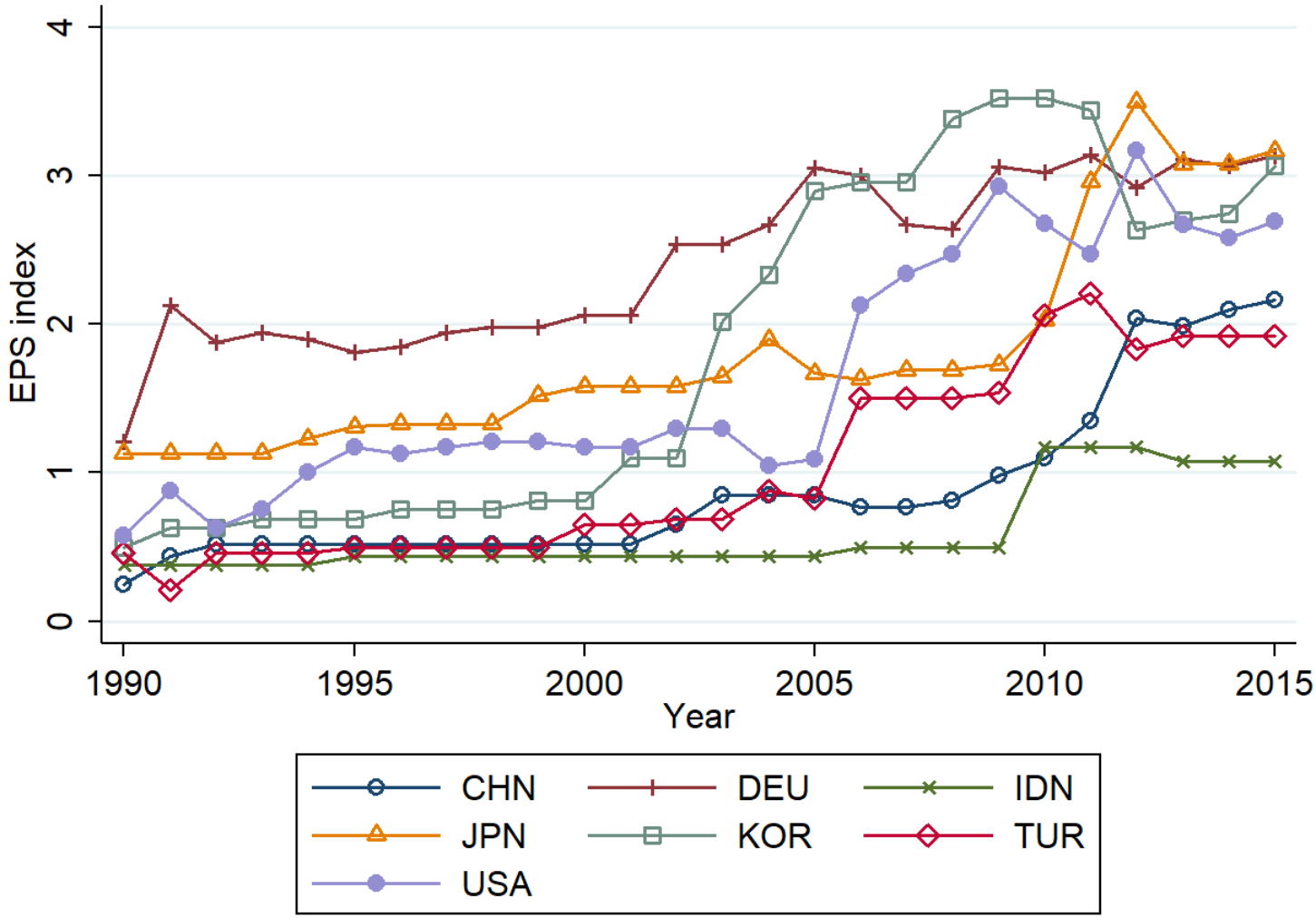
Change of the EPS index during 1990 - 2015



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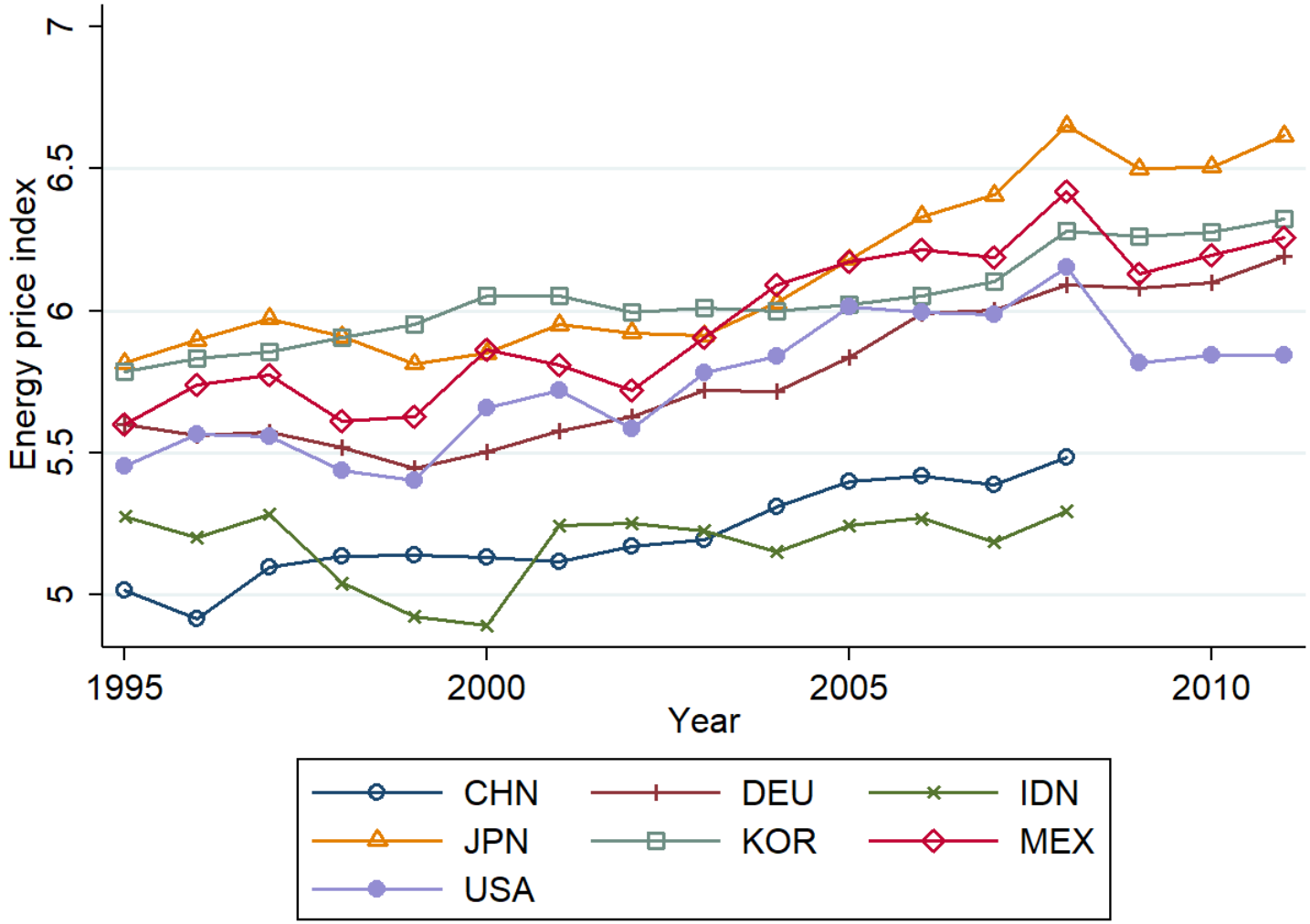
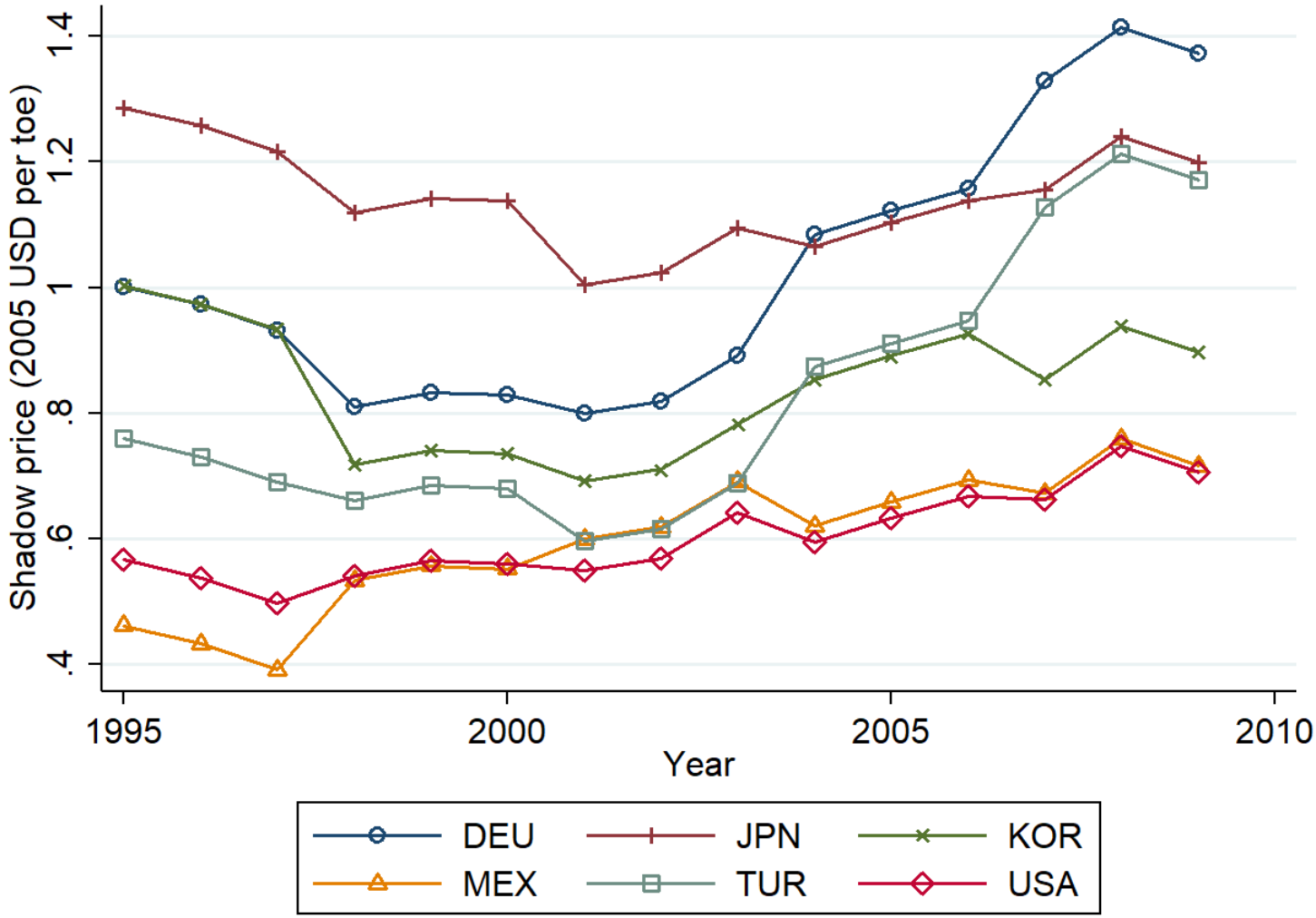
Change of the EP during 1995 - 2011



Change of the shadow price during 1995 - 2009



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Testing heteroskedasticity assumption

Use Breusch-Pagan test for heteroskedasticity

- EPS index
  - Export side: 3.18 (p-value: 0.075)
  - Import side: 3.45 (p-value: 0.063)
- Shadow price
  - Export side: 4.51 (p-value: 0.034)
  - Import side: same as above
- Energy price index
  - Export side: no evidence
  - Import side: 3.36 (p-value: 0.067)

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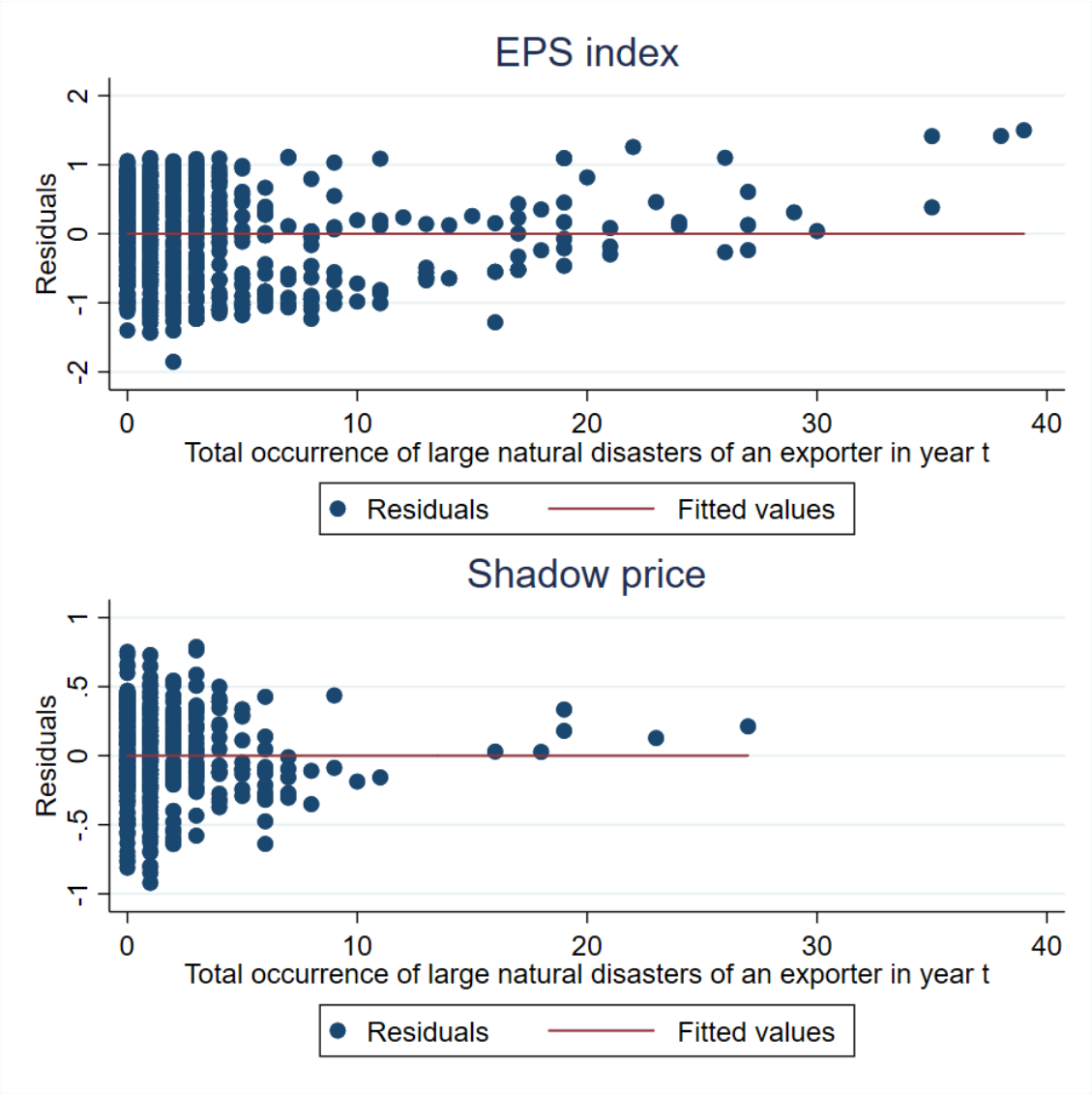
Testing heteroskedasticity assumption



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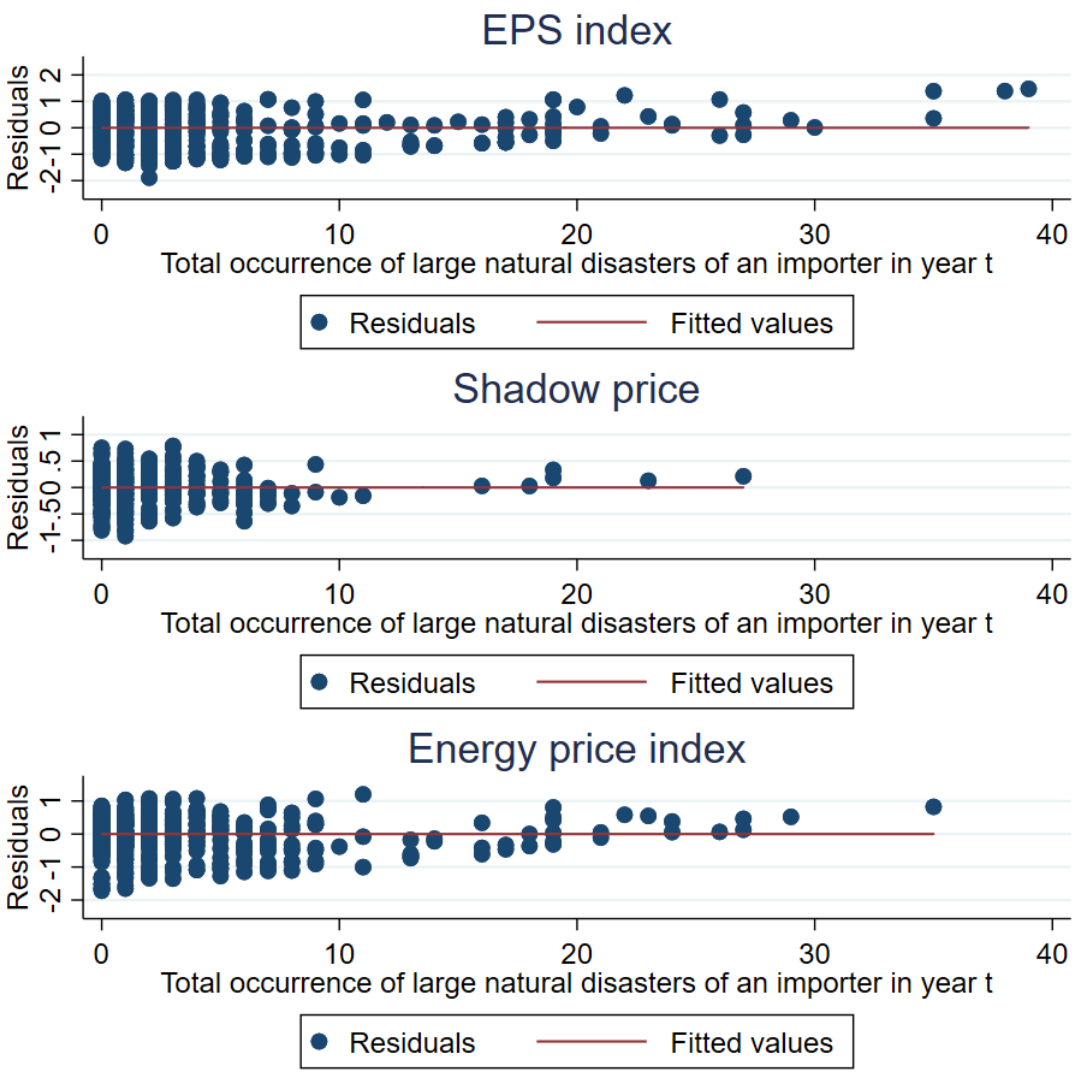
Testing heteroskedasticity assumption



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Robustness Check

Table: Using a different measure of natural disasters - Determinants of EG exports

	EPS index	Shadow price		Energy price index
	OLS	OLS	2SLS	OLS
$Ln(Stringency_{it})$	0.542***	0.818***	0.835***	0.261‡
	(0.131)	(0.235)	(0.250)	(0.165)
$Disaster_{it}$	0.023*	0.008	0.008	0.008
	(0.012)	(0.013)	(0.016)	(0.013)
$Ln(GDP_{it})$	0.896***	0.953***	0.952***	0.926***
	(0.076)	(0.083)	(0.088)	(0.078)
Under-id test			0.005	
F-stat			15.37	
Endog. test			0.000	
Observations	4,972,363	2,706,716	2,706,716	5,070,207
No. exporters	33	28	28	42

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Robustness Check

Table: Using a different measure of natural disasters - Determinants of EG imports

	EPS index	Shadow price		Energy price index
	OLS	OLS	2SLS	OLS
$Ln(Stringency_{jt})$	-0.038	-0.210	-0.306	-0.280***
	(0.078)	(0.219)	(0.229)	(0.084)
$Disaster_{jt}$	0.002	0.011	0.009	-0.001
	(0.008)	(0.012)	(0.013)	(0.010)
$Ln(GDP_{jt})$	0.806***	0.825***	0.832***	0.808***
	(0.039)	(0.043)	(0.043)	(0.037)
Under-id test			0.003	
F-stat			22.87	
Endog. test			0.000	
Observations	2,859,209	1,526,799	1,526,799	3,180,869
No. importers	33	28	28	42

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