An Unhealthy Trade Surplus

Jungho Lee, Shang-Jin Wei, and Jianhuan Xu

August 21, 2019

Introduction

Wefare cost of current account

- Exisiting view: In the absence of distortions to savings or investment, current account surplus does not produce a welfare loss
- This paper: Even without distortions to savings or investment, a current account surplus may produce a welfare loss.
- Trade surplus is usually the largest component of current account surplus. Trade surplus
  - reduces shipping cost of inbound cargos
  - increases imports of heavy goods (such as scrap metals and other industrial waste)
  - additional pollution and cause significant welfare loss, especially in countries with low pollution control standard or weak enforcement

Motivation

- China is the largest heavy goods import country in the world

Table 1: China and World's Heavy Goods Imports

	China	World
Ave weight (kg) per dollar import	0.46	0.22
Waste imports value(mil $)	1,610	6,450
Waste imports weight(mil ton)	313	1,260

Note: Waste goods = "waste" or "scrap" in hs6 goods description.

- China's waste imports are about $1 or 250kg per person per year.
- Why does China import so much heavy goods, such as scraps? Is there any consequence of this import pattern?

What we do

- Our story:
  - Trade surplus reduces the shipping cost of relatively heavy goods - those with a high weight to value ratio.
  - Waste goods are among the heavy goods.
- Estimation suggests:
  - a 10% increase in the trade surplus is associated with an increase in heavy goods imports by 1.2% ...
  - and an increase in the waste goods imports by 4.5%
- Welfare consequence:
  - The industries which use more heavy goods are more polluting industries.
  - Trade surplus gives these industries cheaper intermediate inputs. The pollution will increase.
  - Welfare loss: 0.4%

Literature

- Non-iceberg trade cost: Hummels and Skiba (2004), Lashkaripour (2015) and Wong (2017) and Brancaccio et al. (2017). Do not highlight the trade surplus and heavy goods shipping cost relation.
- Welfare cost of trade imbalance: Dekle et al. (2007) and Epifani and Gancia (2017). Only focus on terms of trade.
- Pollution and trade: Frankel(2009), Kellenberg (2009, 2012), Lan et al. (2012) Bombardini and Li (2016). Focus on "pollution heaven hypothesis".

Model

- Let λ be the Lagrangian multiplier of the back-haul capacity (price per weight). Assume λ is smaller when surplus is larger
- Shipping cost per unit is

  $$c_i \propto \lambda w_i$$

  where w is the weight per unit of good i
- The trade cost **per value** (iceberg cost) is τ_i

  $$\tau_i \propto t_i + \frac{c_i}{p_i} \propto t_i + \lambda \frac{w_i}{p_i}$$

  where t_i is the ad-valorem trade tariff; p_i is the price per unit.
- Hypothesis to test:
  - The trade surplus pushes the cost per weight lower
  - A country imports more heavy (per value) goods if the cost per weight is low.
  - A country tends to import more heavy goods if it runs a larger trade surplus.

Data

- Container freight cost (64 country-pairs) + UN goods trade data (2010-2017)
  - Use the container freight cost as the proxy of λ. The container usually has a maximum weight.
- Weight-value ratio: Columbia custom data (2007-2013).
  - The weight-value ratio is quite persistent over time (0.91) and the correlation is about 0.8 with Chinese weight-value ratio.

Empirical Specification: Shipping cost

- We consider the following regression equation:

$$\ln \lambda_{ndt} = \alpha_0 + \alpha_1 \ln(\text{Imbalance})_{ndt} + \Omega_{\overleftrightarrow{nd}\,t} + e_{ndt} \tag{1}$$

$$\tag{2}$$

- n and d = the origin and destination; *Imbalance* = *export*/*import* of country d
- $\Omega_{\overleftrightarrow{nd}\,t}$ is the country pair-year FE (no direction)
- Recognizing that the trade imbalance may be endogenous, we use the gov expenditure as the IV for trade imbalance.

$$\left\{ \left(\frac{\text{Import}_{dn2000}}{\text{Import}_{d2000}} \right) \times \text{Gov}_{dt} \right\} \Big/ \left\{ \left(\frac{\text{Import}_{nd2000}}{\text{Import}_{n2000}} \right) \times \text{Gov}_{nt} \right\}, \tag{3}$$

- We will further handle the endogeneity problems using some case studies.

Estimates for the Main Regressions: Shipping Cost

Table 2: Estimates for the Main Regressions: Shipping Cost

	(1) $\ln \lambda_{ndt}$	(2) $\ln \lambda_{ndt}$	(3) $\ln \lambda_{ndt}$	(4) $\ln \lambda_{ndt}$
$\ln(\text{Imbalance})_{ndt}$	-0.071***	-0.126***	-0.027	-0.082**
	(0.024)	(0.0349)	(0.025)	(0.039)
$\ln(\text{Imbalance})_{ndt} \times$ Pervasive-route			-0.279***	-0.192**
			(0.063)	(0.082)
Country-pair-year FE	Y	Y	Y	Y
IV		Y		Y
Obs.	596	434	596	434
R-squared	0.82	0.83	0.83	0.83

Notes: Pervasive route=1 if the destination country runs an aggregate trade surplus and the origin country runs an aggregate trade deficit.

Empirical Specification: Import Composition

- We test whether the low shipping cost will involve heavier goods import

$$\ln I_{i,ndt} = \beta_0 \ln \lambda_{ndt} + \beta_1 \ln \lambda_{ndt} \times \ln \left(\frac{w_i}{p_i} \right) + \eta_{i,nt} + \eta_{i,dt} + \epsilon_{i,ndt}, \quad (4)$$

- $I_{i,ndt}$ is the import good i from country n to country d in year t
- To address the endogeneity problem, we use the gov expenditure as the IV.

Estimates for the Main Regressions: Log Import Value

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln \lambda_{ndt}$	-1.210***	-1.493***	-1.189***		-1.213***	
	(0.029)	(0.034)	(0.029)		(0.029)	
$\ln \lambda_{ndt} \times \ln\left(\frac{w_i}{p_i}\right)$	-0.127***	-0.169***	-0.120***	-0.117***	-0.135***	
	(0.011)	(0.013)	(0.011)	(0.011)	(0.011)	
$\ln \lambda_{ndt} \times \ln\left(\frac{w_i}{p_i}\right)$					-0.020***	
$\times$Persist					(0.001)	
$\ln(\text{Imbalance}_{ndt})$						0.0147***
$\times \ln\left(\frac{w_i}{p_i}\right)$						(0.005)
O-g-y FE	Y	Y	Y	Y	Y	Y
D-g-y FE	Y	Y	Y	Y	Y	Y
D-o-Y FE				Y		Y
IV		Y				
W/o bulky goods			Y			
Obs.	873,074	873,074	861,216	873,074	873,074	873,074
R-squared	0.82	0.82	0.82	0.84	0.83	0.85

Further address the endogeneity issue

- We provide two more exercises besides the IV setup to address the endogeneity issue.
- Propose two exercises:
  - Mexico currency crisis as an exogenous shock to trade imbalance but not to the heavy goods import
  - China port import data: different ports in the same country so that unobserved country-pair component can be controlled

Evidence from Mexican Currency Crisis

- Look for an exogenous shock to the trade imbalance.
- Assuming that the currency crisis only changes the trade imbalance, but is not directly correlated with the composition of goods imports (Aguiar, 2004).
- Estimate the following equation

$$\ln\left(\frac{\text{Imports}_{i,nt}}{\text{Imports}_{i,nt-1}}\right) = \beta \ln \frac{\text{Imbalance}_{nt}}{\text{Imbalance}_{nt-1}} \times \ln\left(\frac{w_i}{p_i}\right) + \eta_{it} + \eta_{nt} + \varepsilon_{i,nt}$$

- We use a 5-years window.

Estimates for the Mexican data

	(1) $\ln I_{i,nt}$	(2) $\Delta \ln I_{i,nt}$
$\ln(\text{Imbalance})_{nt} \times \ln\left(\frac{w_i}{p_i}\right)$	0.0595***	
	(0.003)	
$\Delta \ln(\text{Imbalance})_{nt} \times \ln\left(\frac{w_i}{p_i}\right)$		0.0145***
		(0.005)
Product-Year FE	Y	Y
Origin-Year FE	Y	Y
Obs.	192,356	133,459
R-squared	0.50	0.20

Evidence from Chinese Ports Data

- From the Chinese custom data (2000-2006), we can compute the port-country bilateral trade volumes.
- If a carrier must return to its home port, our story should hold as well (spoke-hub).
- Use Chinese ports data, estimate the following equation

$$\ln \text{Imports}_{i,mnt} = \beta \ln \text{Imbalance}_{mnt} \times \ln\left(\frac{w_i}{p_i}\right) + \eta_{imt} + \eta_{int} + \eta_{mn} + \varepsilon_{i,mnt}$$

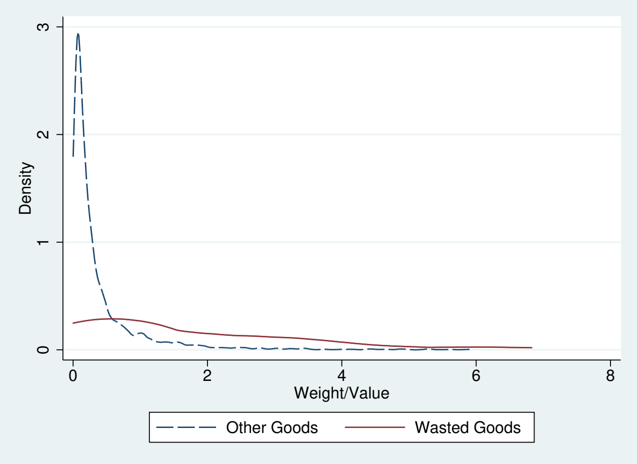
where m is a port, n is an origin country

Estimates for the Chinese Port data

	(1) $\ln I_{i,nmt}$	(2) $\ln I_{i,nmt}$
$\ln(\text{Imbalance})_{nmt}$	0.051***	
	(0.002)	
$\ln(\text{Imbalance})_{nmt} \times \ln\left(\frac{w_i}{p_i}\right)$	0.0098***	0.0057***
	(0.001)	(0.001)
Port-Product-Year FE	Y	Y
Origin-Product-Year FE	Y	Y
Port-Origin-year FE		Y
Obs.	4,970,457	4,970,457
R-squared	0.79	0.81

Application 1: Waste Goods Imports

Figure 1: The Density of Weight to Value (kg/usd) Ratio



NOTE: This figure shows the density of the weight to value ratio.

Waste Imports across Countries

Table 3: Estimates for Waste-Goods Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln \lambda_{ndt}$	-0.943***	-1.206***	-1.136***	-1.484***	-1.814***	-2.846***
	(0.015)	(0.017)	(0.018)	(0.029)	(0.097)	(0.135)
$\ln \lambda_{ndt} \times$ Waste	-0.454***	-0.298	-0.718***	-0.511*	-0.452**	-0.720***
	(0.179)	(0.179)	(0.203)	(0.304)	(0.179)	(0.205)
$\ln \lambda_{ndt} \times \ln \left(\frac{w_i}{p_i}\right)$		-0.125***		-0.166***		
		(0.011)		(0.0133)		
$\ln \lambda_{ndt} \times$ Waste$\times$ $\ln(\text{GDP}_d)$					0.090***	0.174***
					(0.010)	(0.014)
O-g-y	Y	Y	Y	Y	Y	Y
D-g-y	Y	Y	Y	Y	Y	Y
IV			Y	Y		Y
Obs.	870,119	870,044	870,119	870,044	870,119	870,119
R-squared	0.82	0.82	0.82	0.82	0.82	0.82

Application 2: Trade Surplus and Pollution

- Construct the weight per input value using the China 2012 I-O table.
- The pollution intensity per dollar value of output for each industry is obtained from the data by the World Bank's Industrial Projection System (IPPS).

Table 4: The Correlation Between Pollution Intensity and Input's Weight across Chinese Industries

	ln(SO2)	ln(NO2)	ln(TSP)
Weight-per-input-value	2.424**	1.845*	1.974*
	(1.273)	(1.128)	(1.178)
Obs.	74	74	74
R-square	0.05	0.04	0.04

Notes: This table shows the correlation between three pollution intensities and the weight-per-input-value across Chinese industries. *** p<0.01, ** p<0.05, * p<0.1.

Polluting Sectors and Trade Surplus

- We want to test whether the increase of trade surplus would make polluting industries dis-proportionally expand through our mechanism.
- We take China as an example.

$$\ln Y_{i,t} = \beta_0 \ln imbalance_t * PollutingSector_i + \epsilon_{i,t}, \tag{5}$$

where i is a 4-digit industry and t is from 1999-2017.

- Use Chinese biggest 3 trading partners' gov expenditures (Japan, Korea and US) as an IV for trade imbalance.
- $Y_{i,t}$ is the domestic sales of industry i in year t.

Table 5: Estimates for the Industry Output and Trade Imbalance

	(1) $\ln(\text{Output}_{i,t})$	(2) $\ln(\text{Output}_{i,t})$	(3) $\ln(\text{Output}_{i,t})$
$\ln(\text{Imbalance}_t)\times$ Heavy-sector$_i$			0.921**
			(0.374)
$\ln(\text{Imbalance}_t)\times$ Polluting-sector$_i$	0.905***	0.983**	0.666
	(0.421)	(0.500)	(0.410)
Year FE	Y	Y	Y
Industry FE	Y	Y	Y
IV		Y	
Obs.	6,630	6,630	6,630
R-square	0.98	0.98	0.98

Notes: Output$_i$ means a Chinese industry domestic output in year t. Imbalance$_t$ is Chinese trade imbalance measured by export-import ratio in year t. Heavy-sector$_i$ and Polluting-sector$_i$ are dummy variables defined in section **??**. We use the government

Discussion

- If the gov can collects tax to correct the pollution effect from the trade surplus, there is no welfare loss.
- However, we find that there is no correlation between the environmental regulation and trade surplus or heavy goods import.

Welfare loss of trade surplus: A quantitative analysis

Consumer

- A small open economy; two periods; complete capital market
- Final consumption comes from two sectors output: polluting sector q_t and output from the green sector y_t.
- Three trade-able materials: heavy material (H), light material(M) and scrap (K)
- One period utility: $\ln c - \eta x$, c=consumption, x =pollution emission

$$c_t = \alpha^{-\alpha} (1-\alpha)^{-(1-\alpha)} y_t^{\alpha} q_t^{1-\alpha} \tag{6}$$

- ϕ share of final consumption converts to scrap goods

$$K_t = \phi c_t \tag{7}$$

- Consumer are endowed with H and M every period.

Firm

- The green sector uses labor and light materials to produce

$$y_t = A_{y,t} \left(m_t^{\omega} m_t^{*(1-\omega)} \right)^{\theta} L_{y,t}^{1-\theta}$$

- All start variables denote the imports from foreign countries.
- The polluting sector uses scrap, heavy material and labor to produce. One unit of output will generate b ton pollutants.

$$q_t = A_{q,t} \left(h_t^{\beta} h_t^{*(1-\beta)} \right)^{\sigma} \left(k_t^{\gamma} k_t^{*(1-\gamma)} \right)^{\lambda} L_{q,t}^{1-\sigma-\lambda}$$

- The pollution abatement cost is $\frac{\xi}{2}\bar{x}_t^2$, $\bar{x}_t$ is the reduction of pollution
- Pollution emission $x_t = by_{gt} - \bar{x}_t$
- Pollution tax $T_t x_t$

Trade Cost

- The trade cost of light material is assumed to be exogenous.
- The trade cost of the heavy and scrap are endogenously determined by the trade surplus.

$$\tau^*_{h,t} = \bar{\tau}^*_{h,t} \left(1 + \frac{S_t}{w_t}\right)^{-v} I(S_t > 0)$$

$$\tau^*_{k,t} = \bar{\tau}^*_{k,t} \left(1 + \frac{S_t}{w_t}\right)^{-v} I(S_t > 0)$$

Calibration

Assume $T = 0$. Calibrate the model to match period 1 with 2012 Chinese economy.

Table 6: Parameters

Parameters	Value	Moments	Model	Data
L	0.897	wage per capita	1	1
ρ	1.021	surplus per capita/w per capita	0.045	0.045
ω	0.659	light import/total expenditure	0.092	0.092
σ	0.461	labor share in polluting industry	0.52	0.52
λ	0.019	scrap import/total expenditure	0.005	0.005
β	0.333	heavy import/total expenditure	0.123	0.123
M	0.616	light export/total expenditure	0.13	0.13
H	0.275	heavy export/total expenditure	0.117	0.117
ϕ	0.031	scrap export/total expenditure	0	0
b	2.73	SO2 ton emission/total expenditure	0.001	0.001
ξ	0.56	SO2 ton trade price	0.46	0.46

Results

Table 7: Calibration Results

	(1)	(2)	(3)	(4)	(5)
Pollution	100	97.90	74.00	97.57	49.83
Pollution intensity	100	98.88	85.26	98.71	68.99
Scrap imp t=1	100	96.92	0	0	50.62
Heavy imp t=1	100	96.92	99.97	98.93	60.84
Surplus/w %	4.50	4.50	4.51	5.38	3.31
Pc t=1	100	100.40	105.81	100.10	141.39
Utility change from c (%)	0	-4.51	-9.99	-4.61	-9.20
Utility change (%)	0	0.40	1.14	0.34	8.25

Notes: This table shows the model predictions in different counter-factual studies: (1) Benchmark model, (2) Symmetric trade cost ($v = 0$), (3) Banning scrap import, (4) Banning scrap import + high elasticity of substitution ($\omega_k = 10$) (5) Optimal environmental regulation.

Conclusion

- This is the first paper that explores how a trade imbalance may affect welfare by altering the composition of imports
- Consistent with our theory, we find that countries with a trade surplus tends to import more heavy goods, especially industrial waste.
- This suggests a concrete channel for a trade surplus to generate a welfare loss, especially in developing countries that have a lax environmental standard.

Most(Least) 10 Heavy Goods

Table 8: 10 Most Heavy and Light Goods

Heavy Goods	Light Goods
Bitumen and asphalt	Diamond
Limestone flux	Precious metal
Wasted slag from iron	Gold
Ceramic building bricks	Halogenated derivatives
Glass scrap	Watch
Pebbles and flint	Emeralds
Sea-iron products	Gold powder
Smelting steel waste	Cocaine esters
Tungsten-bearing waste	Lysergic acid
Gypsum	Alkaloids

Note: This table shows 10 goods which have the highest (lowest) weight-to-value ratio from the transaction level data on Colombian imports in 2007-2013 period.

Back density Back main results

Estimates for the Main Regressions: Shipping Cost (cont')

- Concern: Multinational shipment arrangement by shipping companies may mitigate the negative relationship between trade imbalance and the shipping cost differential.
- First, negative elasticity of trade imbalance suggests that this concern is not strong enough to over turn the sign.
- Second, if a country runs trade surplus against most of its trade partners (like China), it is difficult to find such a multinational shipment arrangement to full load the empty vessel.

Estimates for the Main Regressions: Shipping Cost (cont')

	(1)	(2)	(3)	(4)
	$\ln \lambda_{ndt}$	$\ln \lambda_{ndt}$	$\ln \lambda_{ndt}$	$\ln \lambda_{ndt}$
$\ln(\text{Imbalance})_{ndt}$	-0.088	-0.141**	-0.024	-0.042
	(0.06)	(0.067)	(0.073)	(0.084)
$\ln(\text{Imbalance})_{ndt} \times$ Sol.pair			-0.188	-0.237*
			(0.125)	(0.136)
Country-pair FE	Y	Y	Y	Y
IV		Y		Y
Obs.	84	84	84	84
R-squared	0.77	0.76	0.78	0.78

City-level evidence: Pollutant emission (cont')

VARIABLES	(1) ln(water pollutant)	(2) ln(so2)	(3) ln(dust)
ln(textile waste import)	0.543**	0.919***	0.382
	(0.237)	(0.299)	(0.321)
ln(metal waste import)	0.407*	-0.0717	-0.164
	(0.217)	(0.273)	(0.294)
ln(plastic waste import)	0.0328	0.0495	0.500
	(0.224)	(0.283)	(0.304)
GDP, Manufacture Y, Population	Y	Y	Y
Year FE	Y	Y	Y
City FE	Y	Y	Y
Observations	994	993	994
R-squared	0.966	0.954	0.947

All coefficients are scaled by 0.01.

Waste Imports and Pollution

- Lots of scientific evidence: Waste goods recycling might hurt people's health, e.g., increasing the cancer rate.
- Is the pollution externality generated by waste import properly corrected via government regulation?
  - OECD environmental regulation report (2002-2004)

Results of Regulation and Trade Imbalance

Table 9: Results of Regulation and Waste Imports

	(1) ERS	(2) Environment tax	(3) Regulation Standard
ln(Waste Import)	-0.011	-0.015	-0.017
	(0.013)	(0.042)	(0.012)
ln *GDP*	-0.199	-5.089	5.351***
	(1.311)	(4.243)	(1.184)
Corruption	-0.727**	-1.017	-0.098
	(0.339)	(1.069)	(0.306)
Regulation Quality	0.187	-1.005	0.451*
	(0.279)	(0.901)	(0.252)
Country FE	Y	Y	Y
Year FE	Y	Y	Y
Obs.	93	96	93
R-squared	0.94	0.85	0.96