Trade Collapse and Time Sensitivity

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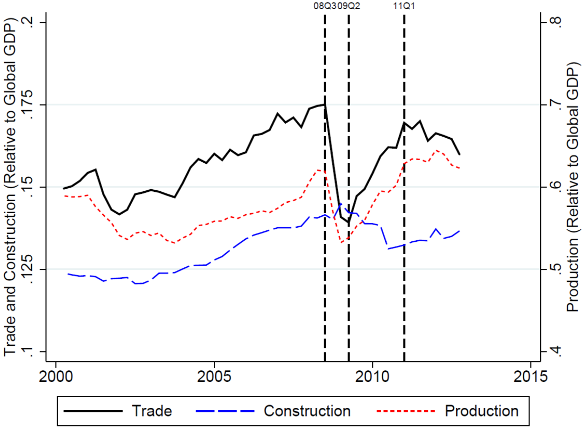
Motivation

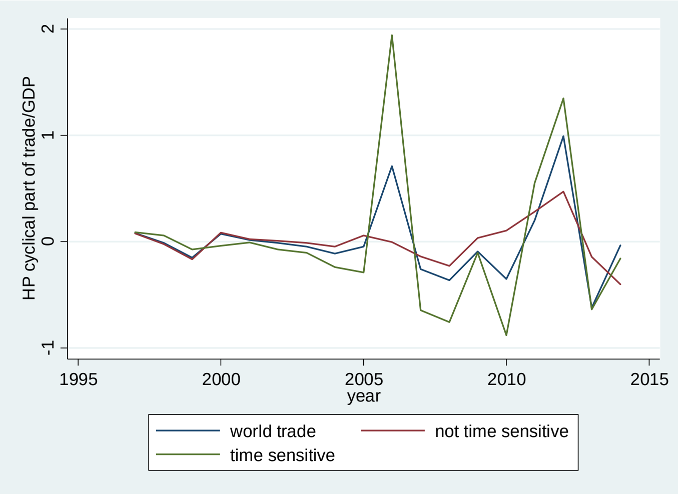
Trade collapse



Source: Eaton, Kortum, Neiman and Romalis (AER, 2016)

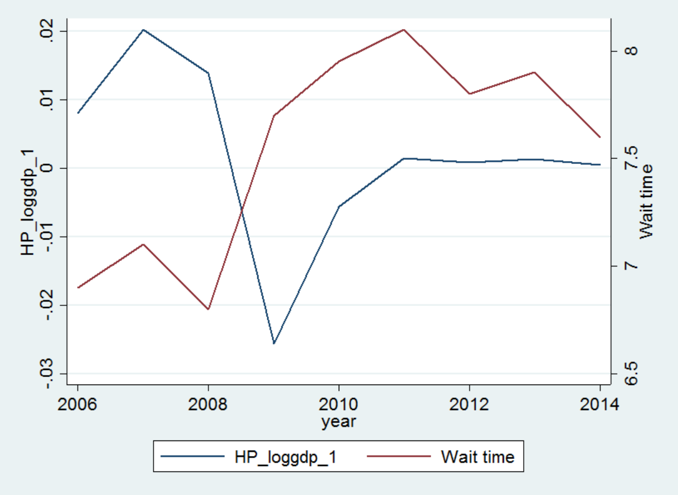
Motivation

Cyclicality of time-sensitive vs insensitive industries



Motivation

Wait time in LA (MarineTraffic)



Motivation

Search frictions: ships and exporters

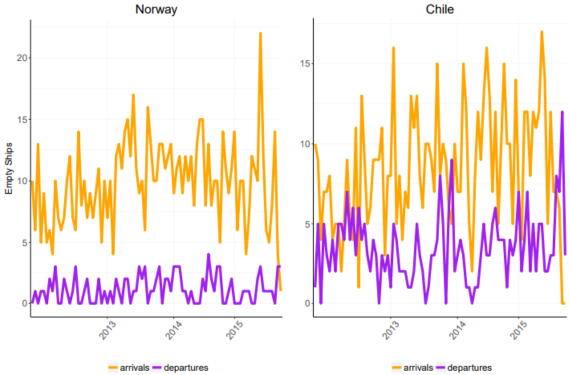
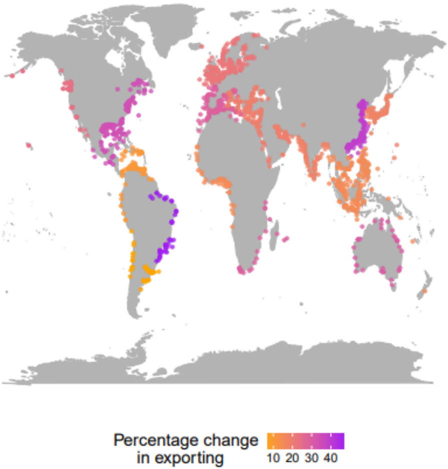


Figure 3: Flow of ships arriving empty and loading, and ships leaving empty in 2 week intervals.

Source: Brancaccio, Kalouptsidi and Papageorgiou (2017)

Motivation

The shipping market friction as a factor of trade pattern



Source: Brancaccio, Kalouptsidi and Papageorgiou (2017)

Motivation

Summary

- Trade collapsed more for time-sensitive industries;
- Waiting time of ships increased during the great recession;
- There exists shipping market friction worldwide;
- The shipping market may play a large role to determine the trade pattern in business cycle.

Literature

- Shipping time as a trade cost
  - Hummels and Schaur (2013), Harrigan (2010), Djankov, Freund and Pham (2010), Brancaccio, Kalouptsidi and Papageorgiou (2017)
- Trade collapse and the global recession
  - Eaton, Kortum, Neiman and Romalis (2016), Alessandria, Kaboski and Midrigan (2010), Ahn, Amiti and Weinstein (2011), Chor and Manova (2012)
- Time and business cycle
  - Meier (2018), Novy and Taylor (2014)

Roadmap

1. Empirical methodology and data
2. Empirical findings
3. Search model
4. Preliminary results
5. Conclude

Methodology

$$ExGrowth_{c,i,t} = \delta_{i,c} + \delta_{i,t} + \delta_{c,t} + \beta_1(REC_{c,t} \times SEN_i) + \beta_2 Controls_{i,c,t} + \epsilon_{c,i,t}$$

- $REC_{c,t}$ is a country- and year-specific indicator, which equals one if country c is in a recession in year t, and zero otherwise.
- β_1 captures the difference in industry export growth in recessions relative to normal times for industries with different levels of sensitivity.
  - $\beta_1 < 0$ indicates that export growth in industries with high sensitivity is more seriously affected by recession;
  - $\beta_1 > 0$ indicate that such industries grow particularly fast when there is recession.
- $Controls_{i,c,t}$: $share_{i,c,t-1}$ and $REC_{c,t} \times X_i$

Data

- Export growth: Exporter Dynamics Database $HS2$ level, $1997-2014$.
- Recession: peak-to-trough criterion
  - Troughs are identified as years when the logarithm of annual real GDP falls one standard deviation of the cyclical GDP below its trend using the Hodrick-Prescott filter. (WDI)
  - The peak year is identified as the nearest proceeding year of the trough year, with its cyclical GDP higher than that of its previous and posterior year.
  - The period from the peak to the trough is defined as a contraction.
  - The dummy variable $REC_{c,t}$ is equal to 1 if the year is in a contraction, and 0 if otherwise.

Data

- **Time sensitivity**: Hummels and Schaur (2013), Hummels (2011)
  - probability of people choosing air transportation with 1 day of delay in transportation.

	10 most sensitive industries	10 least sensitive industries
1	Vegetable Fats	Iron And Steel
2	Meat And Meat Products	Metalliferous Ores
3	Animal Or Veget fats	Textile Yarn
4	Dairy Products	Fertilizers
5	Organic Chemical	Misc food products
6	Travel Goods	Nonmetallic Manufactures
7	Coal Coke	Cork And Wood Manufactures
8	Photographic Equipment	Furniture
9	Plastics In Nonprimary	Petroleum
10	Oil Seeds	Cork And Wood

Data

- Industry Technological Measures X_i: Samaniego and Sun, 2016
  - **Investment lumpiness**: the average number of investment spikes per firm during a decade in a given industry
    - Alessandria, Kaboski and Midrigan (2010)
  - **Intermediate intensity**: dividing gross output by the difference between gross output and value added
    - Bems, Johnson and Yi (2011)
  - **External finance dependence**: the share of capital expenditures not financed internally.
    - Chor and Manova (2012)

Data

Industry	ISTC	EFD	LMP	INT
Food products	311	-0.039	1.195	0.658
Beverages	313	-0.048	1.29	0.549
Tobacco	314	-0.801	0.815	0.357
Textiles	321	0.029	1.232	0.586
Apparel	322	0.075	1.998	0.493
Leather	323	-0.959	1.927	0.55
Footwear	324	-0.45	2.239	0.483
Wood products	331	0.052	1.72	0.596
Furniture, except metal	332	0.015	1.381	0.484
Paper and products	341	-0.062	0.902	0.551
Printing and publishing	342	-0.222	1.67	0.35
Industrial chemicals	351	0.028	1.34	0.558
Other chemicals	352	1.654	2.13	0.393
Petroleum refineries	353	-0.055	0.763	0.833
Misc. pet. and coal products	354	-0.059	1.042	0.648
Rubber products	355	-0.064	1.098	0.482
Plastic products	356	0.088	1.557	0.494
Pottery, china, earthenware	361	-0.107	1.292	0.311
Glass and products	362	0.289	1.755	0.409
Other non-met. Min. prod.	369	0.021	0.99	0.478
Iron and steel	371	-0.004	0.951	0.578
Non-ferrous metals	372	0.037	1.245	0.681
Fabricated metal products	381	-0.052	1.365	0.488
Machinery, except electrical	382	0.542	2.694	0.479
Machinery, electric	383	0.543	2.704	0.443
Transport equipment	384	0.041	1.614	0.598
Prof. & sci. equip.	385	0.942	2.79	0.344
Other manufactured prod.	390	0.404	2.006	0.46

Findings: main results

	Export growth			
Rec × *SEN*	-1.325***	-0.970***	-1.225***	-0.875***
	(0.148)	(0.158)	(0.230)	(0.232)
Rec × *EFD*		-0.174***		
		(0.0300)		
Rec × *INT*			-0.00586	
			(0.0105)	
Rec × *LMP*				-0.00958**
				(0.00386)
Obs	175, 067	173, 698	173, 698	173, 698

Findings: alternative measure

	Export growth			
$Rec \times SEN$	-0.399***	-0.349***	-0.535***	-0.509***
	(0.0887)	(0.0868)	(0.0880)	(0.0873)
$Rec \times EFD$		-0.237***		
		(0.0277)		
$Rec \times INT$			-0.0563***	
			(0.00674)	
$Rec \times LMP$				-0.0228***
				(0.00244)
Obs	$175,067$	$173,698$	$173,698$	$173,698$

Model: Environment

- Aggregate state s follows a Markovian process $P(s'|s)$
- Domestic producers need to search a ship to export. A ship announce contracts to attract exporters.
- Each contract is sufficiently to denote with the expected value x that the producers can get. All the contracts that offer the same expected value are pooled as one market segment.
- Producers direct their search to a market segment x, and meet the ships randomly
  - market tightness on market x as $\theta(x, s)$
  - $\eta(\theta)$: prob a good producer meets a ship
  - $\mu(\theta) = \eta(\theta)/\theta$: prob a ship meets a producer
- The ship is heterogeneous in terms of the fixed transportation cost z

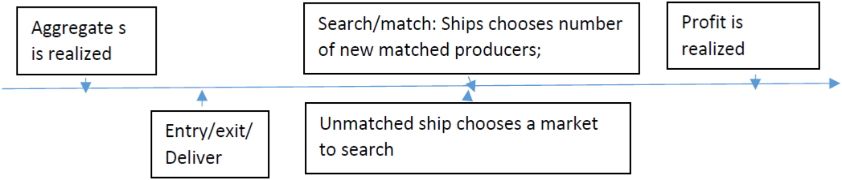
Model: Environment (cont')

- A contract of the ship specifies $\{d_t, p_t, x_t\}_{t=0}^{\infty}$
  - $d_t = 1$ if the ship will leave the habour and 0 otherwise
  - p_t is the transportation fee charged by the ship
  - x_t is the market that the ship posts the contract
- Or in a recursive way
  $\{d(n, z', s'), p(n, z', s'), x(n, z', s'), W(n, z', s')\}$
  - n: orders received
  - W: the future promised value to the exporter

Model: Producer prob

- Discount rate $\beta < 1$
- Profit only selling in domestic market $\pi(s)$; profit serving export market $\pi^*(s)$
- To export, pays a random search cost h, h draws from $H(h)$
- The good producer has four possible states:
  1. only sells on domestic market and is searching on ship now;
  2. only sells on domestic market now and does not search a ship;
  3. only sells on domestic market but has been matched to a ship and is waiting to deliver;
  4. exports now.

Timeline


Aggregate s
is realized
Entry/exit/
Deliver
Search/match: Ships chooses number
of new matched producers;
Unmatched ship chooses a market
to search
Profit is
realized

Model: Producer prob (cont')

- Expected value of the producer if it does not match with a ship

$$\begin{aligned} U(s) &= \max_{x_u} \pi(s) + \beta E_{s',h'} \max[-h' + \eta(\theta(x_u(s'), s')) x_u(s') \\ &+ (1 - \eta(\theta(x_u(s'), s'))) U(s'), U^D(s')] \end{aligned}$$

- Expected value if the producer does not want to search the ship

$$U^D(s) = \pi(s) + \beta E_{s'} U(s')$$

- If the good producer is matched to a ship with order n and productivity z, τ periods ago. The value of the producer is

$$\begin{aligned} \mathcal{W}(n, z, \tau, s; \omega) &= \pi(s) + \beta E_{z',s'}[d(n, z', s') U^E(s', \tau + 1) \\ &+ (1 - d(n, z', s')) W(n, z', s')] \end{aligned}$$

- Value of export is

$$U^E(s, \tau) = \pi(s) + \max(\pi^*(s) - \rho\tau, 0) + \beta E_{s'} U(s')$$

where ρ captures the time sensitivity of the goods when export.

Model: Ship Prob

- An empty ship starts with space $\bar{n}$ (same across all firms) and gradually receives orders.
- Suppose the number of exporters that have been matched with the ship is n
- The promised value and waiting time of each exporter j is W_j and τ_j for $j \in [0, n]$
- Wait in the habour, the cost is $c(n)$; leave the habour, fixed cost z
- Two states of the ship: choose to wait in the habour; choose to deliver

Model: Ship Prob (cont')

- Wait in the habour

$$
\begin{aligned}
J^N\left(n, z', s', \{W_j', \tau_j'\}_{j\in[0,n]}\right) &= \max_{p,k,x_s,W_j'} pq - w\left(s'\right)\frac{q}{\mu\left(\theta\left(x_s, s'\right)\right)} \\
&+ J\left(n', z', s', \{W_j', \tau_j'\}_{j\in[0,n']}\right)
\end{aligned}
$$

$$
\begin{aligned}
s.t. \quad n' &= n + q, \quad n' \leq \bar{n} \\
k &= \frac{q}{\mu\left(\theta\left(x_s, s'\right)\right)}
\end{aligned}
$$

$$
\begin{aligned}
W_j &= \pi\left(s\right) + \beta E_{z',s'}\left[dU^E\left(s', \tau_j'\right) + \left(1-d\right)W_j'\right] \text{ if } j \in [0, n] \\
\tau_j' &= \tau_j + 1 \text{ if } j \in [0, n] \\
W_j' &= x_s + p \quad \text{if } j \in (n, n'] \\
\tau_j' &= 0 \quad \text{if } j \in (n, n']
\end{aligned}
$$

Model: Ship Prob (cont')

- Leave the habour

$$J^A(z', s') = -z + \beta J^e(z', s')$$

- $J^e(z, s)$ is the value of an empty ship and defines as

$$\begin{aligned} J^e(z, s) &= \max_{p^e, q^e, x_s^e} \left[p^e(z, s) q^e(z, s) - w(s) \frac{q^e(z, s)}{\mu(\theta(x_s^e, s))} \right. \\ &\quad \left. + J(q^e(z, s), z, s) \right]^+ \end{aligned}$$

- Value of the ship

$$\begin{aligned} & J\left(n, z, s, \{W_j, \tau_j\}_{j \in [0, n]}\right) \\ = \; & -c(n) + \beta E_{z', s'} \left[\begin{array}{c} \max_d \left(J^A(z', s'), \right. \\ \left. J^N\left(n, z', s', \{W'_j, , \tau'_j\}_{j \in [0, n']}\right)\right) \end{array} \right] \end{aligned}$$

Joint Surplus

- $V(n, z, T, s)$ is the joint surplus if a ship is matched with n exporters.

$$V(n, z, T, s) = \max_{q, x_s} n\pi(s) - c(n) +$$

$$\beta E_{z',s'}\{\max_{d'} \begin{bmatrix} -\left(x_s(n, z', T', s') + \frac{w(s')}{\mu(\theta(x_s, s'))}\right) q(n, z', T', s') \\ +V(n+q, z', T', s'), \\ -z' + \beta V^e(z', s') + U^E(s', T')\, n \end{bmatrix}$$

$$s.t. \quad n + q \leq \bar{n}$$

$$T' = \frac{n}{n+q}(T+1)$$

- The value $V^e(z, s)$ is the joint surplus of an empty ship which is defined as

$$V^e(z, s) = \max_{q^e, d^e} \left\{ \begin{array}{c} -\left(x_s^e(z, s) + \frac{w(s)}{\mu(\theta(x_s^e, s))}\right) q^e(z, s) \\ +V(q^e, z, 0, s) \end{array} \right\}^+$$

Proposition

The ship's and the producer's problem and the joint surplus problem are equivalent in the following sense:
(i) $V(n, z, T, s) = J\left(n, z, s, \{W_j, \tau_j\}_{j\in[0,n]}\right) + \sum_{j=0}^{n} W_j$;
(ii) the firm's policy functions maximize the joint surplus;
(iii) the policy functions in the joint-surplus functions maximize the firm's problem.

Calibration

- The matching technology is assumed to be

$$\begin{aligned}\eta(\theta) &= \zeta\theta^{1-\varepsilon} \\ \mu(\theta) &= \zeta\theta^{-\varepsilon}\end{aligned}$$

- The cost of holding inventory is

$$c(n) = \gamma_0 n^{\gamma_1}$$

- The profit function $\pi(s)$ is assumed to

$$\pi(s) = s^{\alpha}$$

- We choose the $\pi^*(s)$ as

$$\pi^*(s) = A\pi(s)$$

Parameter Values

Parameter	Value	Source
ζ	1.2	Schaal(2015)
ϵ	0.6	Schaal(2015)
γ_0	3.4	Haltiwanger net al.(2005)
γ_1	2	Haltiwanger et al. (2005)
α	0.75	Lucas(1988)
A	1.1	Data export sales/domestic sales
ρ	0.2	Hummels and Schaur (2013)

Numerical Methods

1. We can first guess $V(n, z, s)$ and solve $\kappa(s)$ from the free entry condition. This step is monotonistic and we can use the bisect to solve it.

$$\int \max_{q^e(z,s)} \left[-\kappa(s) q^e + V(q^e, z, s)\right]^+ dG(z) = k_e$$

2. Then we solve $\theta(x, s)$ and the exporters problem to get $U^E(s)$

$$x + \frac{w(s)}{\mu(\theta(x, s))} = \kappa(s)$$

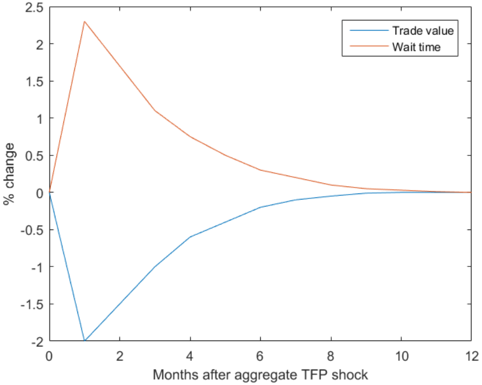
for each $x < \kappa(s)$; otherwise $\theta(x, s) = 0$ if $x \geq \kappa(s)$

The value function of U should be standard.

3. Finally, we can solve $V(n, z, s)$ and check for convergence.

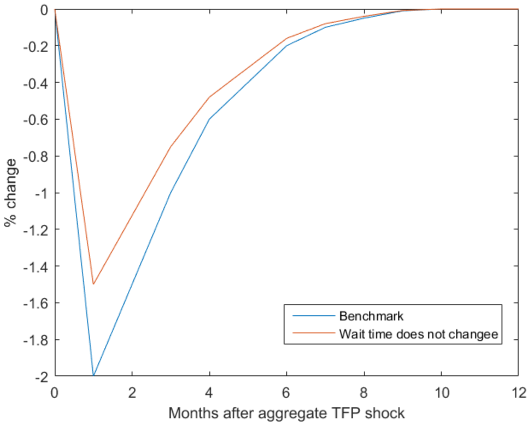
Results

Impulse response of 1% negative TFP shock



Results

Counter-factual Analysis



Conclusion

- We find that industries which are sensitive to shipping time experienced more decline in their trade growth rates.
- The dynamic search model featuring heterogenous producers and ships is able to generate the sensitivity of trade to waiting time.
- Future work?