Trade Disruptions and the Organization of Supply Chains

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Motivation

- Global value chains have ↑ world trade and rich-poor country convergence
- Recent events put these supply chains at risk
- Understanding how firms respond to potential disruption is important for many reasons
- We highlight a novel aspect of importer-supplier interactions: choice of procurement system
- Specifically, buyers' choice of two different systems for assuring high-quality inputs
  - Firms buy on the spot market, perform inspections to verify quality
  - Firms form long-term relationships, pay incentive premia to deter cheating

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- We highlight a novel aspect of importer-supplier interactions: choice of procurement system
- Specifically, buyers' choice of two different systems for assuring high-quality inputs
  - Firms buy on the spot market, perform inspections to verify quality – "A" system
  - Firms form long-term relationships, pay incentive premia to deter cheating – "J" system

What Do We Do?

- Theory
  - Start with Taylor & Wiggins (1997)'s model of domestic procurement
  - TW show that A and J procurement are optimal solutions to a quality control problem
  - We extend to TW to international procurement; add probability of trade disruption (e.g., trade war)

- Data
  - Develop indicator of A vs J procurement using transaction-level trade data
  - Use this indicator to examine whether buyers and transactions behave as predicted
  - Analyze US importers' reactions to sizeable reduction in tariff uncertainty with China in 2000

- Quantitative simulations
  - Embed our model in Eaton & Kortum (2002) to analyze GE implications
  - What to expect if the probability of trade disruption rises for all US trade partners?

Agenda

- Introduction
- Model overview
- Data
- Quantitative simulations

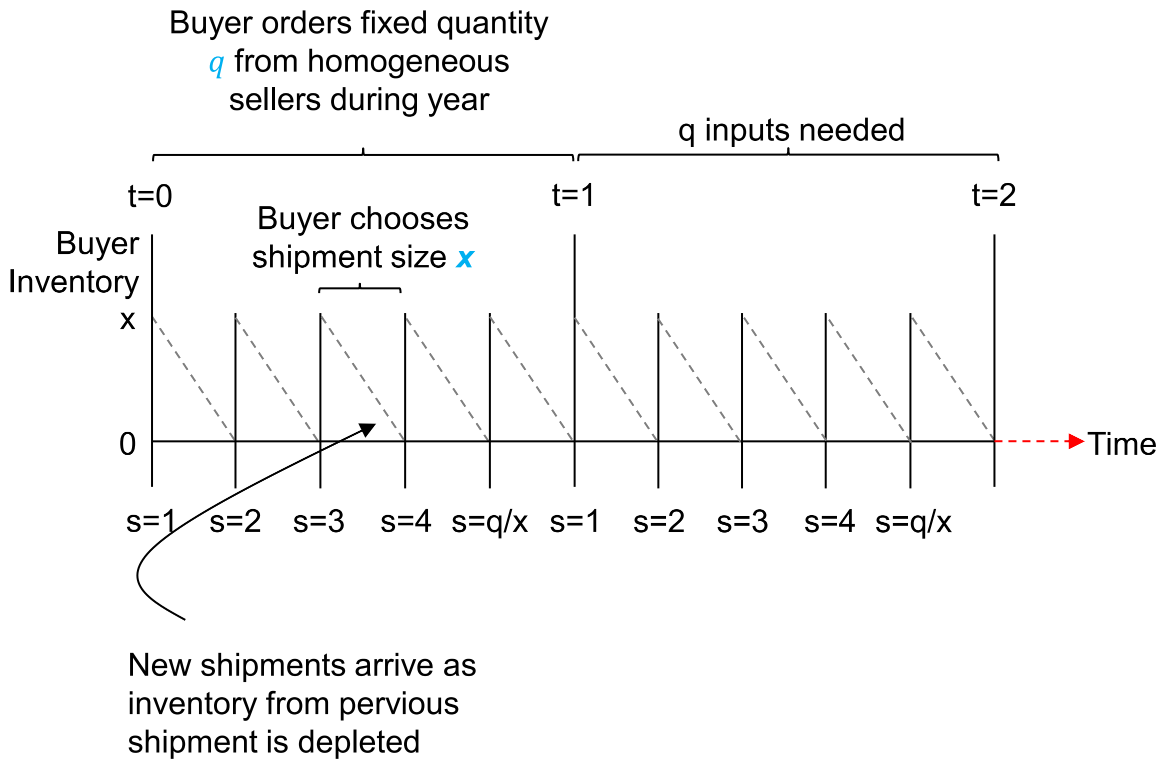
Model Overview

- We start with Taylor and Wiggins' (1997) model of *domestic* procurement
  - Buyer orders inputs from supplier without observing quality
  - Buyer chooses optimal order pattern, payments, and inspections

- TW show that the optimal contract is one of two strategies:
  - A (“American” in TW)
    - Buyer chooses lowest cost bidder in spot market
    - Pays fixed inspection cost with some probability (we simplify to 1) to deter cheating
    - Sellers have no bargaining power; thus receive marginal cost
  - J (“Japanese” in TW)
    - No inspection; buyer deters cheating via payment of incentive premium in long-term contract

- Our modeling contribution
  - Generalize to int’l procurement, where disruption (e.g., trade war) may break relationships
  - Embed the model into GE (last part of presentation)

Buyer (US Importer) Problem



- Buyer chooses x to minimize the present discounted value of each system

- Cost per order c_i under each system $i \in \{A, J\}$ is

$$c_A(x,q) = \bar{\theta}x + f + Fixed\ Inspection\ Cost$$

Cost per unit of high quality (↑ $\bar{\theta}x$, ↓ $\bar{\theta}x$)

Fixed order cost (↑ f, ↓ f)

$$c_J(x,q) = \bar{\theta}x + f + Incentive\ Premium$$

Per order payment needed to deter seller from cheating; rises with probability of trade disruption (↑ Incentive Premium)

- $\{A, J\}$ choice is trade-off between inspection cost and incentive premium

- Buyer chooses system with lower average costs

Model Implications: Distinguishing Systems

- Order size: $x_A^* > x_J^*$
  - Fixed inspection cost under A implies less frequent orders, so higher order size x
  - Incentive provision under J implies more frequent ordering

- Price: $p_A^* < p_J^*$
  - Incentive premium under J raises the price above marginal costs

- These results also present in TW's domestic procurement
  - Our paper provides the first empirical examination of these predictions

Model Implications: Trade Policy

- Cost of J procurement depends on probability of trade disruption
  - Sellers demand higher incentive not to cheat on quality if disruption is more likely

- Cost of A procurement is independent of trade policy

- Lower probability of trade wars → lower incentive premium → J becomes less costly

- There exists a unique probability above which A is less costly and below which J less costly

- If the probability of a trade war falls sufficiently, optimal system switches from A→J
  - Order size falls, since $x_A^* > x_J^*$
  - Price rises, since $p_A^* < p_J^*$

We will see this in US-China trade shortly

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- Introduction
- Model
- Data
  - Data sources
  - Classify importers as A vs J according to number of suppliers
  - Is inferred A vs J buyer procurement consistent with model?
  - Procurement switching after reduction in US-China uncertainty?
- Quantitative simulations

Data Sources

- Transaction-level US import data from 1992 to 2016
  - Observe buyer, seller, value, quantity, departure, arrival
  - Focus on arm's-length transactions
  - Focus on shipments within narrow $mhcz$ “buyer” quadruples to isolate variation in price, quantity

importer * product * country * mode of transportation

- Longitudinal Business Database (LBD) and Economic Censuses (ECs)
  - Track various attributes of firms over time, e.g,. inventories

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Classifying Importers as A vs J Using the Model

- Model
  - Under A, buyers receive shipments from many sellers
  - Under J, buyers receive shipments from a single seller

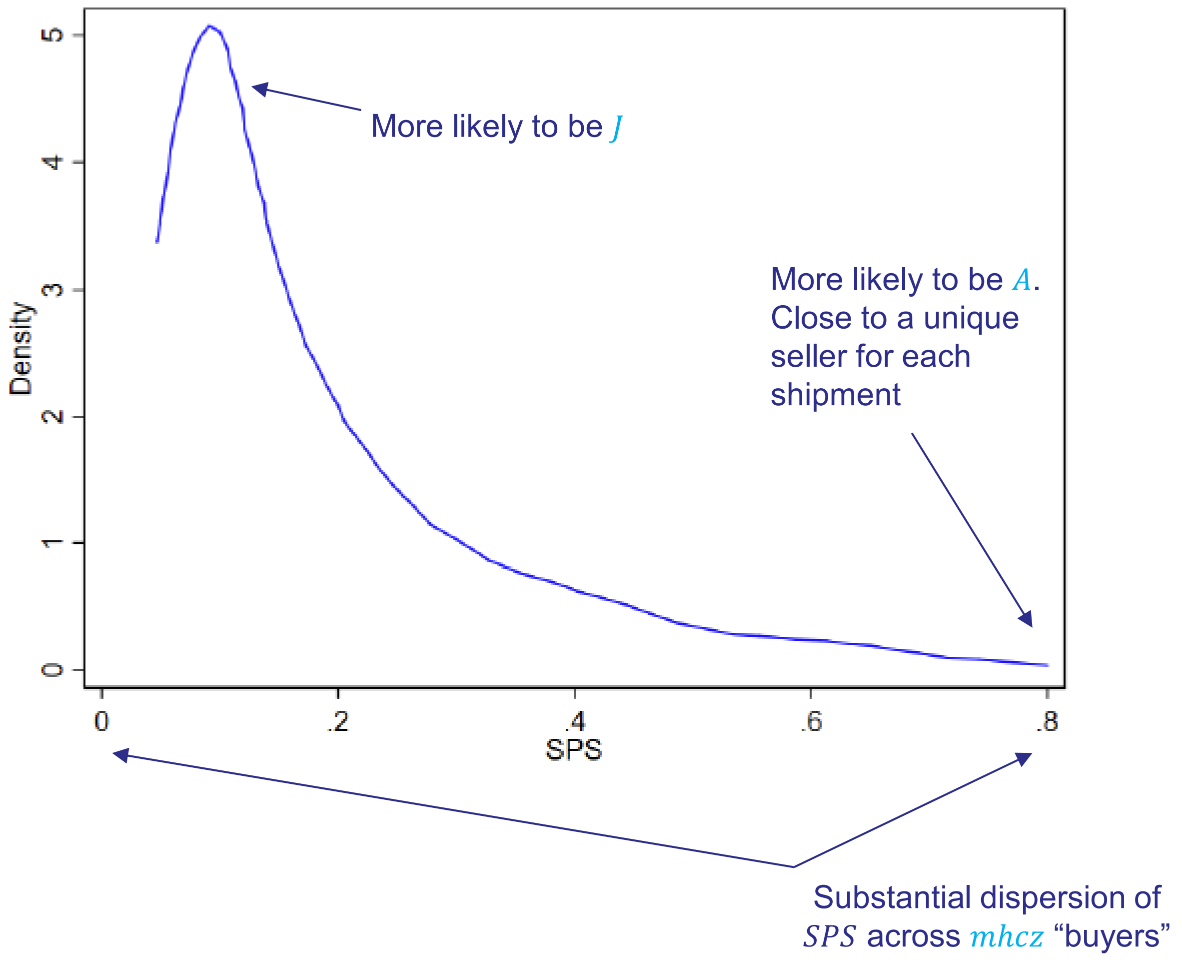
- Data
  - For each $mhcz$ "buyer", compute sellers per shipment (SPS) over some period

$$SPS_{mhcz}^{beg-end} = \frac{Number\ of\ Suppliers_{mhcz}^{beg-end}}{Number\ of\ Transactions_{mhcz}^{beg-end}}$$

  - Bounded (0,1]
  - $SPS_{mhcz} = 1$ means different seller for each shipment
  - $SPS_{mhcz} \rightarrow 0$ means many shipments from a given seller
  - Higher SPS_{mhcz}, more likely to be A procurement

Classifying Importers as A vs J Using the Model

Distribution of $SPS_{mhcz}^{1996-2016}$



- Average SPS across countries or products to ask:
  - Which countries imports look most J?
  - Which products look most J?

Mean SPS_{mhcz} Across Countries and Sectors

1992-2000 vs 2002-2007

Average $SPS_{mhcz}^{beg-end}$ Across c

Country	1995-2000	2002-2007
Mexico	0.095	0.068
Japan	0.107	0.123
Taiwan	0.132	0.114
Canada	0.141	0.120
United Kingdom	0.146	0.225
South Korea	0.156	0.135
France	0.177	0.158
Rest of the World	*0.180*	*0.156*
Germany	0.184	0.163
China	0.185	0.147
Brazil	0.190	0.151

Average $SPS_{mhcz}^{beg-end}$ Across h

Product code (HS chapter)	1995-2000	2002-2007
Transportation (86-89)	0.107	0.081
Machinery (84-85)	0.130	0.133
Plastics (39-40)	0.130	0.096
Optical products (90-92)	0.137	0.127
Footwear (64-67)	0.142	0.117
Other products (93-99)	*0.151*	*0.124*
Metals (72-83)	0.154	0.128
Food (16-24)	0.155	0.120
Chemicals (28-38)	0.156	0.121
Stones & Jewelry (68-71)	0.159	0.141
Animal products & vegetables (01-15)	0.166	0.132
Minerals (25-27)	0.182	0.203
Leather and wood products (41-49)	0.188	0.153
Textiles (50-63)	0.224	0.177

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Is Inferred A vs J Buyer Procurement Consistent with Model?

- Model
  - A buyers receive larger shipments, less frequently, at lower price

- Data
  - Use SPS_{mhcz} to compare A and J shipment attributes via OLS

$$\ln(\bar{Y}_{mhcz}) = \beta_1 \ln(SPS_{mhcz}) + \beta_2 \ln(QPW_{mhcz}) + \beta_3\, beg_{mhcz} + \beta_4\, end_{mhcz} + \lambda_{hcz} + \epsilon_{mhcz}$$

Shipment size, frequency or unit value

Sellers per shipment (Higher SPS, more likely to be A)

Quantity per week (hold q fixed as in model)

Controls for first and last week of $mhcz$, and product bin

Procurement Varies with Inferred A, J System as Predicted

	(1) ln(QPS_{mhcz})	(2) ln(WBS_{mhcz})	(3) ln(UV_{mhcz})
ln(SPS_{mhcz})	0.418***	0.452***	-0.123***
	(0.017)	(0.017)	(0.021)
ln(QPW_{mhcz})	0.701***	-0.308***	-0.287***
	(0.014)	(0.014)	(0.020)
Obs	2,966,000	2,966,000	2,966,000
R-squared	0.947	0.674	0.845
Fixed effects	hcz	hcz	hcz
Controls	beg, end	beg, end	beg, end

Note: Standard errors two-way clustered by county and HS chapter.

- Higher buyer SPS_{mhcz} associated with
  - Bigger shipments (QPS_{mhcz})
  - More time between shipments (WBS_{mhcz})
  - Lower unit value (UV_{mhcz})
- First empirical support for Taylor Wiggins (1997)
- In other results, we find that higher buyer SPS_{mhcz} also associated with higher inventories

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US-China Sourcing After Substantial ↘ in Tariff Uncertainty

- US grants China "permanent" access to MFN tariffs in 2000
- Exposure to this decline in tariff uncertainty varied by product
- Triple DID empirical strategy
- How did buyers' shipment size, frequency and unit value respond
  - After versus before PNTR?
  - For US buyer relationships with China vs other countries?
  - In products more vs less exposed to PNTR?

$$\ln(\bar{Y}_{mxhczt}) = \beta_1 Post_t * China_c * Exposure_h + \beta_2 X_{mxhczt} + \beta_3 \ln(QPW_{mxhczt}) + \lambda_{mxhcz} + \lambda_t + \epsilon_{mxhczt}$$

Shipment size, frequency or unit value

Triple interaction of Post and China dummies with exposure to PNTR

Interactions needed to identify β_1

Quantity per week (hold q fixed as in model)

US-China Sourcing After ↓ in Tariff Uncertainty

	(1) $\ln(QPS_{mxhczt})$	(2) $\ln(WBS_{mxhczt})$	(3) $\ln(UV_{mxhczt})$
$\text{Post}_t \times \text{China}_c \times \text{Exposure}_h$	-0.197***	-0.168***	0.092***
	(0.009)	(0.009)	(0.023)
$\ln(QPW_{mxhczt})$	0.368***	-0.632***	-0.124***
	(0.009)	(0.008)	(0.013)
Obs	439,000	439,000	439,000
R-squared	0.98	0.89	0.99
Fixed effects	mxhcz, t	mxhcz, t	mxhcz, t
Controls	Y	Y	Y

- After PNTR, more exposed $mxhcz$ "buyer-seller" quintuples exhibit relative
  - ↓ quantity per shipment (QPS_{mhcz})
  - ↓ weeks between shipments (WBS_{mhcz})
  - ↑ unit value (UV_{mhcz})
- These results suggest a transition from $A \rightarrow J$
- Consistent with ↓ in probability of disruption
- Paper contains further evidence

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Quantitative Framework

- We embed our model into a standard EK (2002) model of comparative advantage
  - Quantity traded q is now endogenous

- Challenge: average (and marginal) costs are ↓ sloping in q due to fixed cost of shipments
  - Standard competitive markets as in EK do not apply
  - So, use Baumol et al. (1982) contestable markets: Bertrand competition for markets with IRS

- New sources of heterogeneity
  - Productivity (Also in EK)
  - Bilateral trade peace probabilities (New)
  - Country quality inspection costs (New)

- Comparative advantage now depends on productivity and policy uncertainty

Quantitative Exercise

- Estimate model with 3 countries for 1992-2016
- US, China, rest of world (ROW)
- Parameterization using mix of calibration and moment matching

Baseline Estimation Results

		Baseline Equilibrium
(1)	Share of consumption from China (%)	6.6%
(2)	- of which, "Japanese"	9.5%
(3)	Share of consumption from ROW (%)	27.6%
(4)	- of which, "Japanese"	52.1%
(5)	Share of consumption from U.S. (%)	65.8%
(6)	Avg. inspection costs	0.4%
(7)	Avg. fixed costs (imports)	4.5%
(8)	Manufacturing price index	1.000
(9)	Utility	1.000

- 9.5 percent of imports from China are J vs 52.1 percent for ROW
- ROW share larger due to lower trade war probability and lower fixed costs

Three Counterfactuals We Examine

- Symmetric increase in the probability of a trade war between the US and all trading partners
- Adoption of trade facilitation policies
- Increased automation

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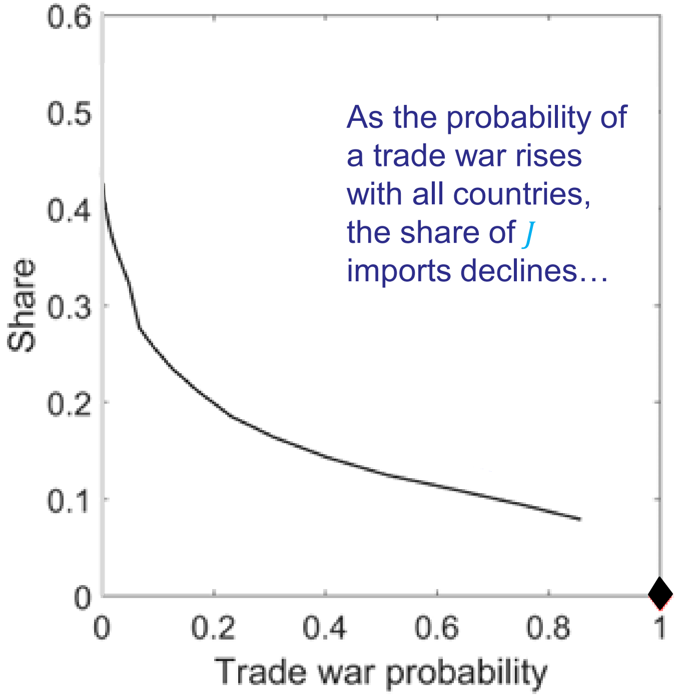
What if Probability of Trade War Rises Symmetrically For All US Partners?



Share of *J* imports

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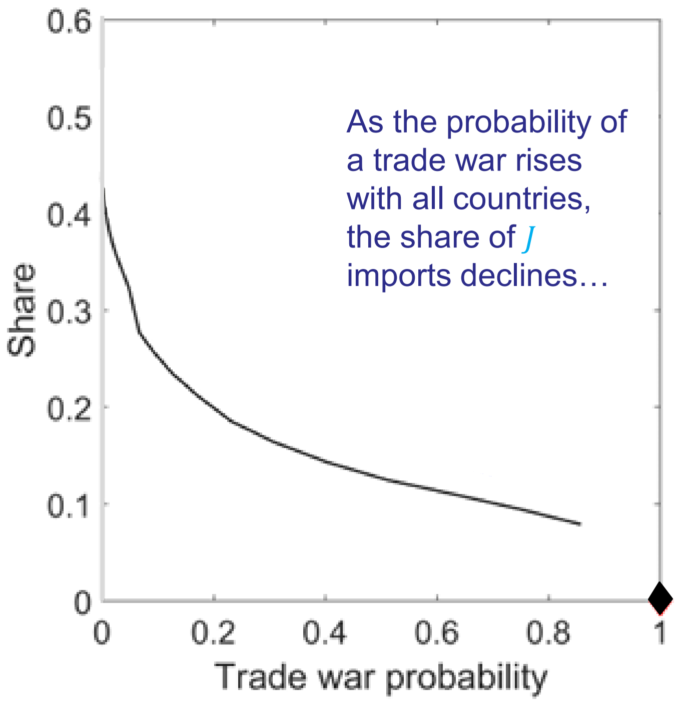
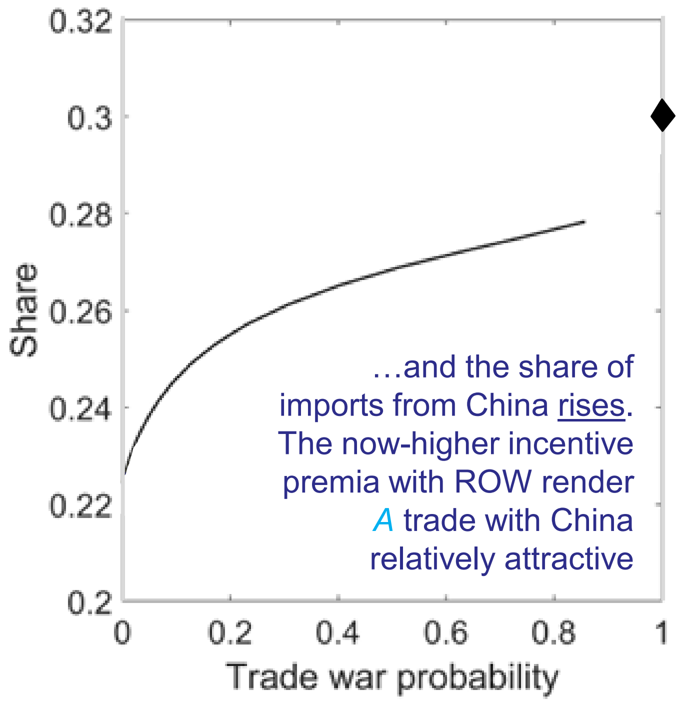


Share of *J* imports



Share of imports from China

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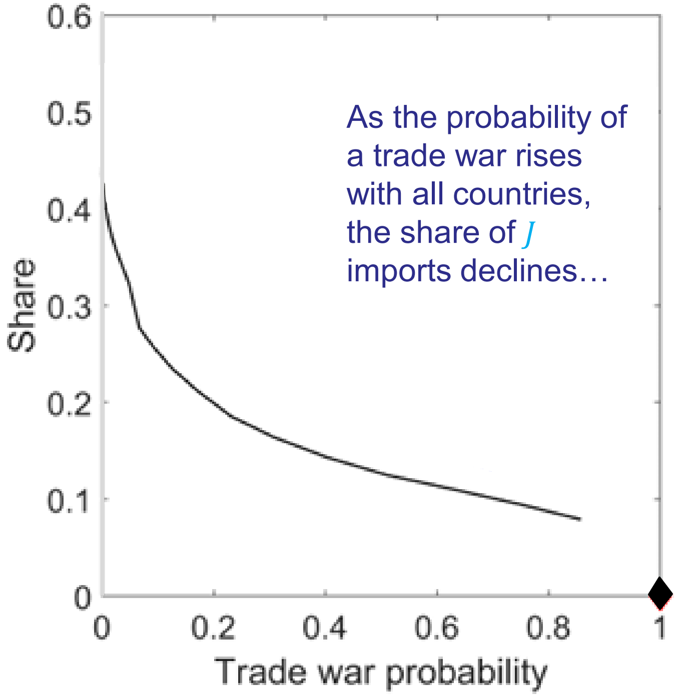
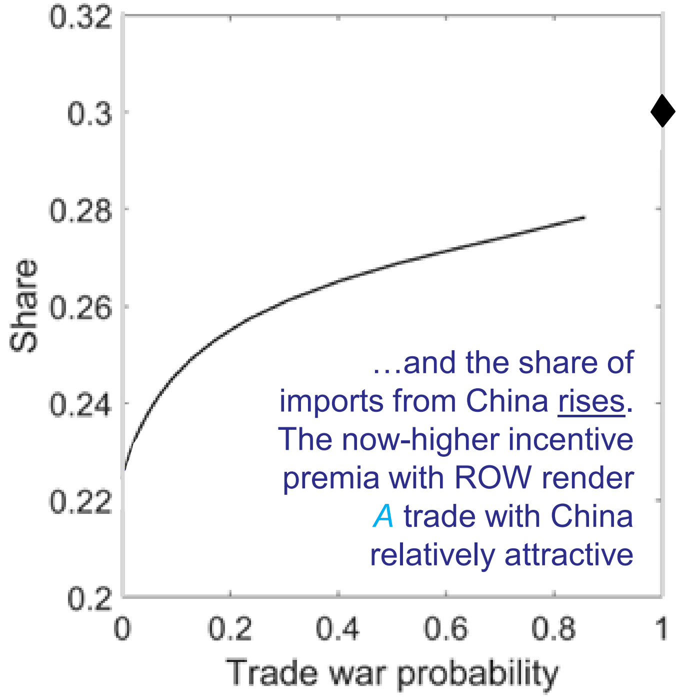
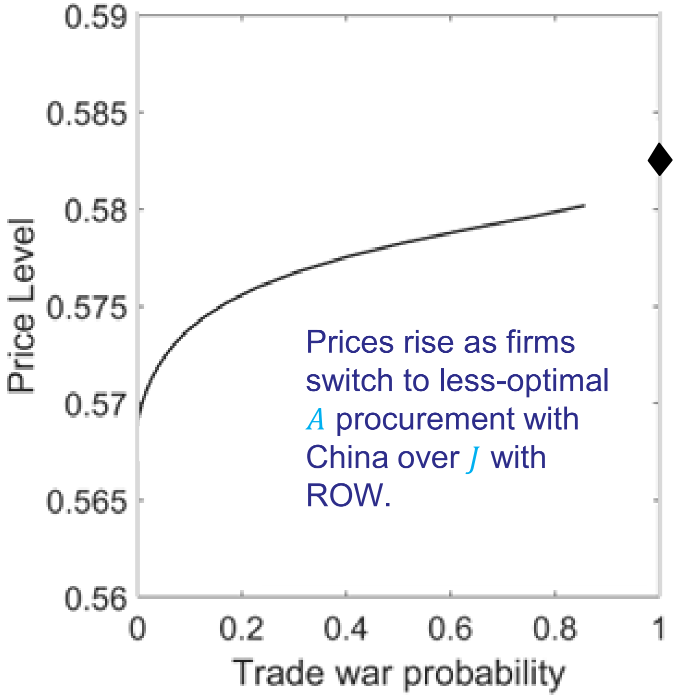


Share of J imports



Share of imports from China



Price Level

Conclusion

- We develop a model linking procurement patterns to trade policy uncertainty
- As the probability of trade peace declines, importer-exporter pairs are less likely to form longer-term, “just-in-time“ relationships
- Quantitative simulations reveal broad increases in uncertainty can lead to unexpected outcomes

Thanks!