Firm Heterogeneity and Costly Trade:

An Estimation Strategy and Policy Experiments

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Motivation

- USA, 2000: African Growth and Opportunity Act
  - Exporter - Madagascar
    - Duty free & Quota free
    - From 2000-2004: Exports to USA grew from $170 to $500 million
    - Exports to ROW: from $200 million to $ 500 million
- Europe, 2001: Everything but Arms Initiative
  - Exporter - Bangladesh
    - Duty free & Quota free
    - From 2000 to 2004, exports to EU grew from $1.3 to $3.0 billion
    - US Quotas: Exports to the USA increased by $30 million:
- Preferences increased trade to preference giver *and* to other markets

Motivation

- Widespread trade agreements
  - Preferential treatment (EBA, GSP (MFN), AGOA)
  - Intended to help LDCs
  - Complex eligibility restrictions: ROOs
- Limited work evaluating them
  - Back of the envelope calculations (No entry)
  - Limited information available (on fixed costs, market entry costs, documentation costs, parameters of distributions which are critical for evaluation)
- What determines their effectiveness?

In this paper...

- Tractable partial equilibrium model ‘a la Melitz with two dimensions of heterogeneity:
  - Productivity and Firm/Market specific demand shocks: hierarchy violations
  - Respects complexity of trade policy environment, suitable for policy counterfactuals
- Cross-section data based estimation: extends applicability
  - Cost: ignore dynamics and information therein
  - Maybe ways to incorporate some such information
- Estimation procedure to obtain all structural parameters:
  - Structure of fixed costs paid to enter industry or market, to produce, and documentation costs
  - Parameters of underlying distributions of demand shocks and productivity
  - Elasticities of substitution

The Application

- Woven Apparel producers in Bangladesh. US-EU over 90% of exports
- US has quotas so must meet ROOs, assembly needed, no preferences
- EU has preferences, tariffs 0 not 12-15%, no quotas, and “Yarn Forward” strict ROOs. Domestic cloth 20% price premium. Documentation costs.
- Size of US and EU potential market is similar

Overview of Results

- Exports
  * Large effects of preferences by EU on BD exports
  * Cross-market effects: Also raises BD exports to US by a lot, and welfare
  * Fixed cost subsidies and exports: 40-1 leverage roughly across all such cost subsidies.

- Welfare
  * Welfare results: “win-win” scenarios possible
  * Fixed cost subsidies differ in their welfare effects
  * Broader policy relevance: trade as aid, role of US quotas

Marginal Costs, Pricing and Revenue

- Profit of firm:

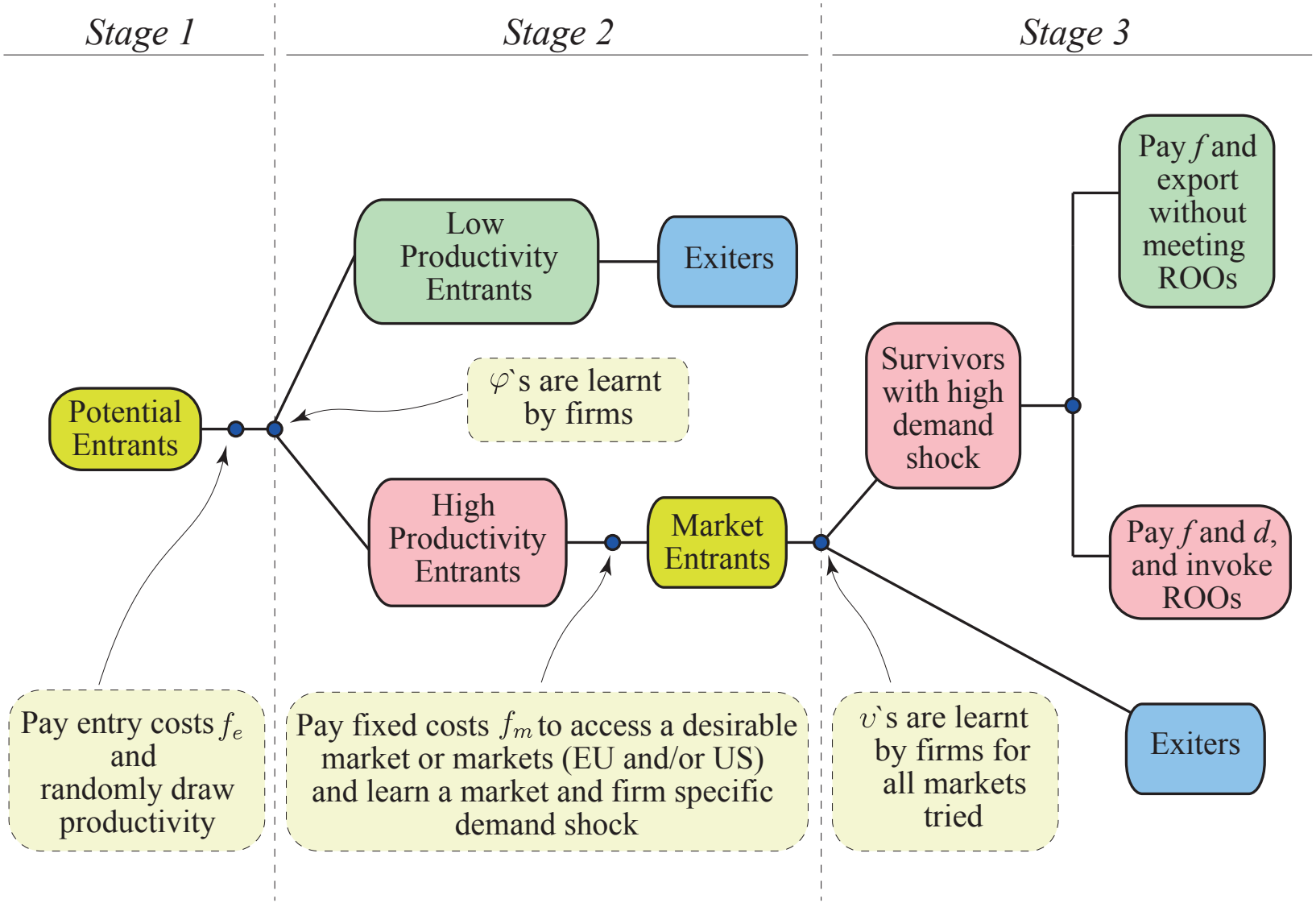
$$\pi_{ij}\left(\phi, v_{ij}, t_{ij}, \tau_{ij}\right) = \left(1 - t_{ij}\right)\left(p_{ij}\left(\phi\right) - \frac{1}{\left(1-t_{ij}\right)}\frac{1}{\rho_j}\frac{w\tau_{ij}}{\alpha\phi}\right) q_{ij}\left(\phi\right)$$

$$p_{ij}(\phi) = \frac{1}{\left(1 - t_{ij}\right)}\frac{\sigma_j}{\sigma_j - 1}\frac{\tau_{ij}}{\alpha\phi}$$

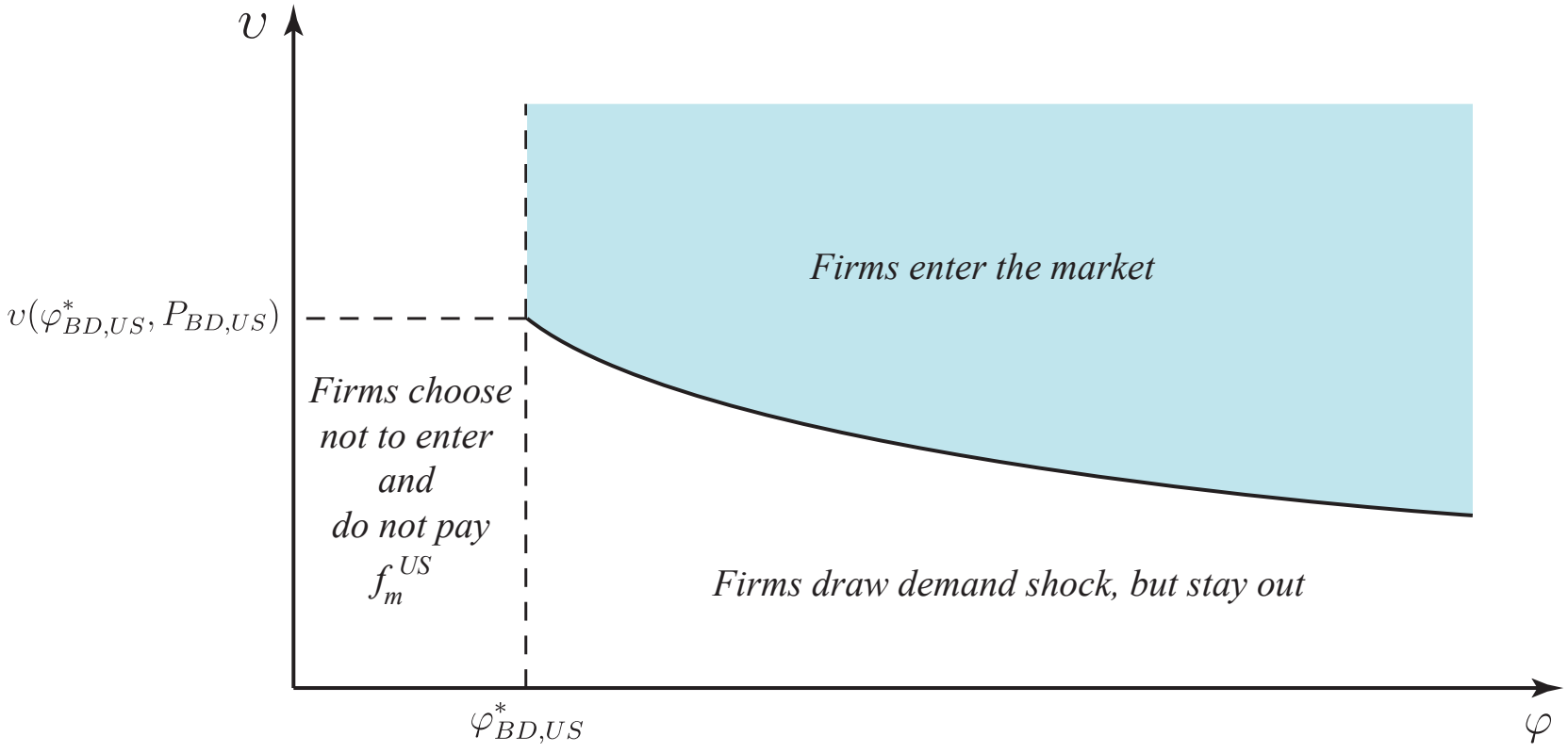
- t_{ij} is market specific tariff, τ_{ij} are market specific transportation costs, ϕ is firm specific productivity, $\alpha \leqslant 1$ is cost disadvantage

- Models ROO:
  - If meet ROOs, $\alpha < 1$, and $t_{ij} = 0$.
  - If do not meet ROOs, $\alpha = 1$, and $t_{ij} > 0$.

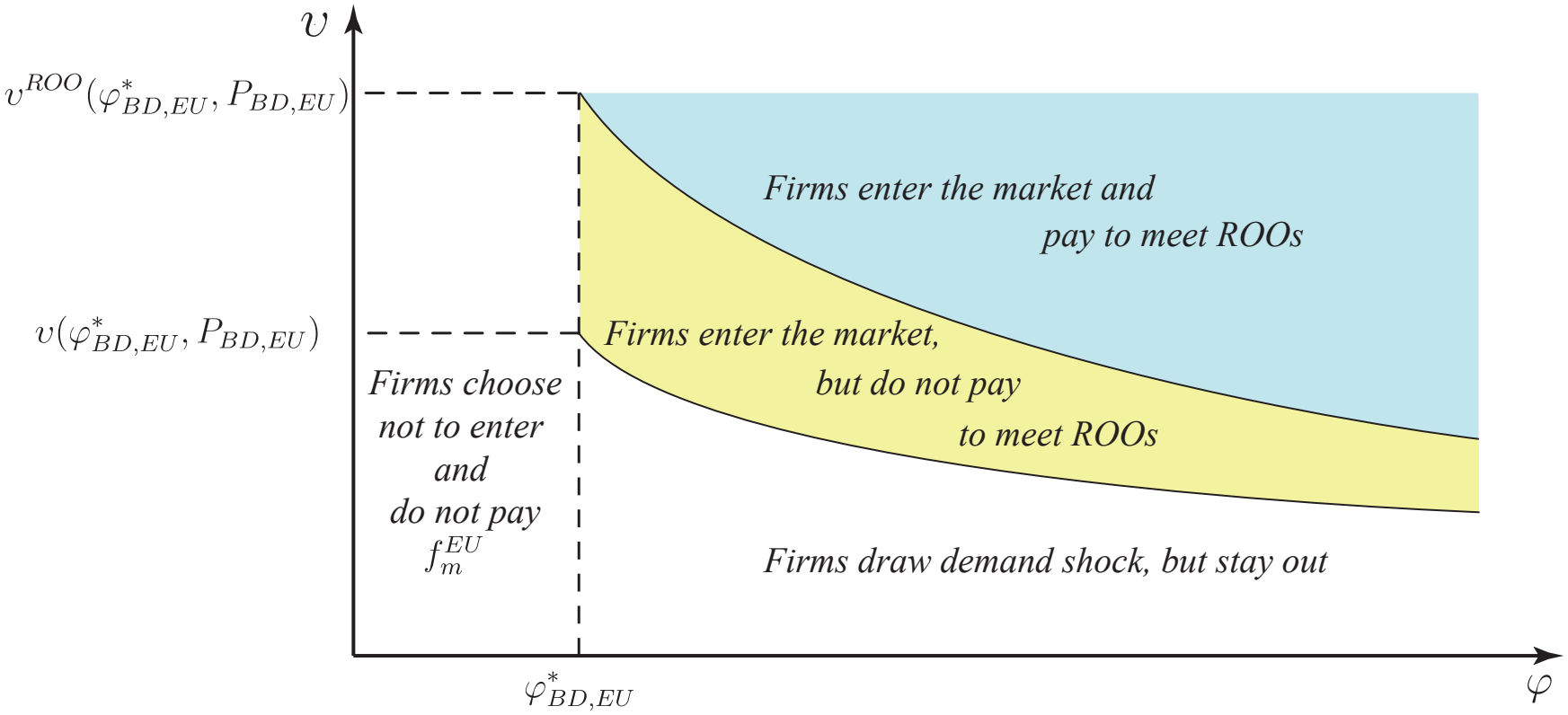
Model Timing



Stage 3: Trade-off Locus for US



Stage 3: If ROO are an Option - Trade-off



- Two bounds for EU
- Only lower bound for US

Stage 1, 2

Stage 2:

- ϕ is known by each firm, v_{ij} NOT known

Marginal firm:

$$\begin{aligned} \phi^*_{BD,EU} &: \quad E_v\left[\pi^{Total}_{BD,EU}\left(\phi, v, P_{BD,EU}\right)\right] - f_m^{EU} = 0 \\ \phi^*_{BD,US} &: \quad E_v\left[\pi_{BD,US}\left(\phi, v, P_{BD,US}\right)\right] - f_m^{US} = 0 \end{aligned}$$

Stage 1: ϕ and v_{ij} NOT known

$$\begin{aligned} &E_\phi\left[E_v\left[\text{Net Profit from EU market}\right]\right] + \\ &E_\phi\left[E_v\left[\text{Net Profit from US market}\right]\right] = f_e \end{aligned}$$

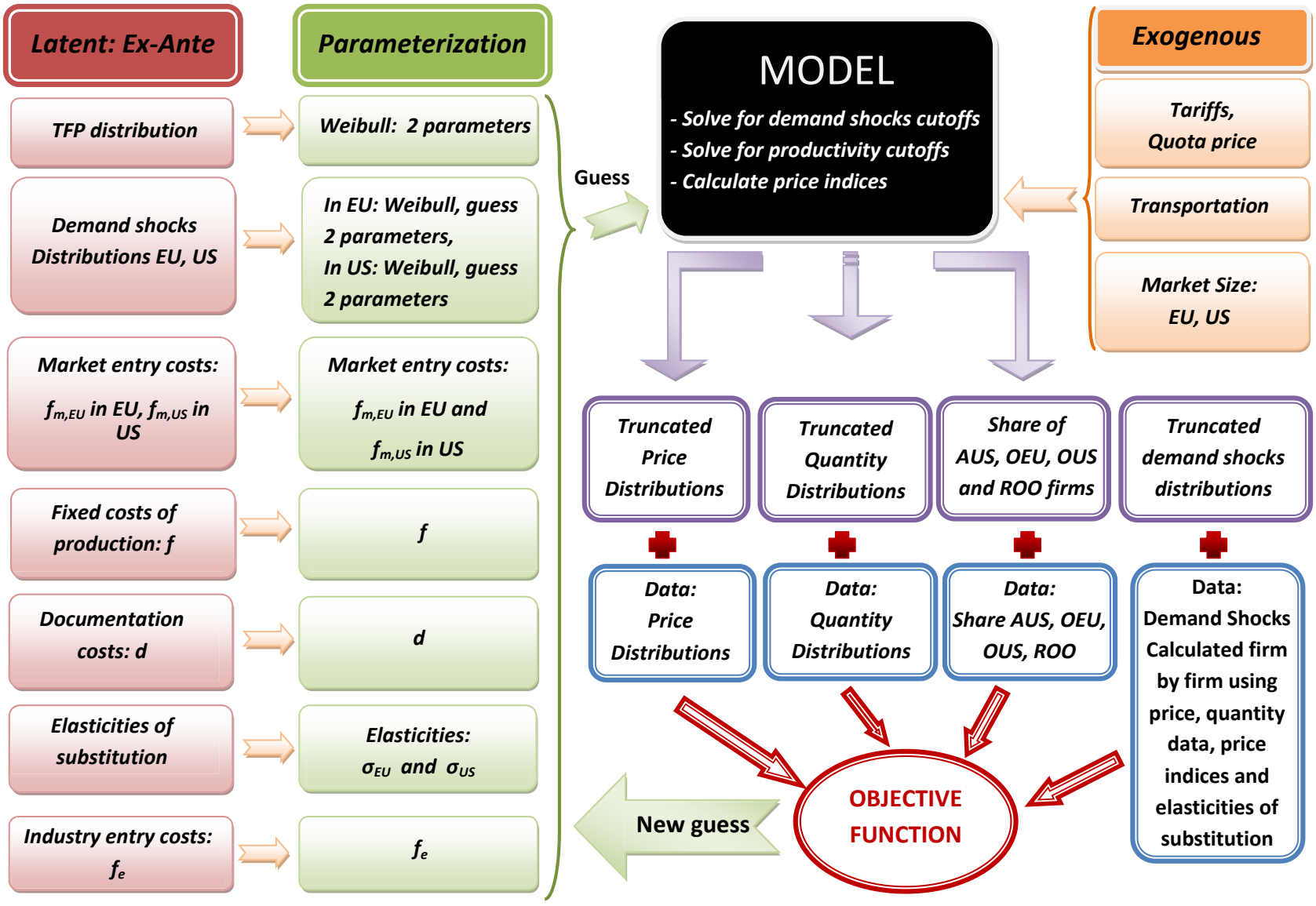
Data

- Bangladeshi customs data ("universe") for 2004 financial year. IGC project.

- Sector: Mens and boys cotton trousers (HS 620342)
  * About 800 firms.
  * Distribution of prices and quantities for AUS, OUS, OEU firms.
  * Shares of AUS, OEU and OUS firms.
  * Share of firms invoking ROO in EU market.
  * Do NOT use panel dimension of the data.

- UN Comtrade database
  * Total US and EU imports of woven apparel from Bangladesh
  * Total US and EU imports of woven apparel

Estimation Outline



Some Identification Intuition

- Matching shares of AUS, OUS, OEU firms helps match variance of demand shock distributions - more variance tends to raise OUS share.
- Matching shares of firms that meet ROOs helps identify $\frac{d}{f}$.
- Matching the position of the quantity distributions help pin down f.
- Matching distributions sheds light on remaining parameters.

Some Exogenous Inputs

Table 1: Trade Policy Parameters

	α	t	t^{ROO}	$\tau + \mu$
EU	0.85	0.12	0	1.14
US	1	0.2	0.2	1.14+0.07

Results: Demand Shocks

- Distributions fit well overall
- US demand shocks mean and variance higher than in EU
- Marketing differences: Chain store effect?

Other Estimates: Elasticities of Substitution

Elasticities of substitution		
	EU	US
σ	1.34	1.45
Std. Error	0.03	0.03

Results: Structure of Fixed Costs

Fixed costs in absolute terms		
	Estimate	*Std. Error*
	Market Entry Costs	
f_m^{EU}	251,250	19,054
f_m^{US}	67,869	5,237
	Documentation Costs	
d	4,240	317
	Industry Entry Costs	
f_e	77,348	5,372
	Fixed Production costs	
f	6,404	476

Policy Experiments

- Two Scenarios: *Exogenous* and *Endogenous* quota license prices in US.
  - Changes in welfare muted with endogenous license prices: 70% of exogenous case.
- Complete removal of preferences for Bangladesh firms: Lose-Lose
  - Welfare loss $481m in EU, $69m in US endogenous license prices.
- Changing costs of meeting ROO
  - No yarn requirement: win-win. $293m in EU and 6m in US
  - Double documentation costs: lose-lose. $25m loss in EU and 1m in the US.
- Fixed cost compensation raises exports by 1.5 to 81.2 dollars per dollar spent. Later interventions more powerful.

Long-run Equilibrium Implications of Policy Changes

	Baseline	No preferences	Higher doc. costs	No yarn req.
Tariff EU: ROO / NO	0% / 12%	12% / 12%	0% / 12%	0% or 12%
Tariff in US	20%	20%	20%	20%
Cost disadvantage	0.85	**1.00**	0.85	**1.00**
Documentation costs d/f	0.66	**0.00**	**1.32**	0.66
		Endogenous quota price setting		
Quota license price (change)	=0.07	-100%	-5.7%	+43.4%
EU imports from BD	*482.3m*	*-31.7%*	*-1.5%*	*+17.1%*
US imports from BD	*233.6m*	*-11.9%*	*-0.1%*	*+1.1%*
Implied mass of entrants	4,712	-22.3%	-0.7%	+5.8
Price index in EU	100%	+19.1%	+0.87%	-9.38%
Price index in US	100%	+1.1	+0.01%	-0.1%
Share of ROO firms	70.2%	0%	57%	77.7%
Tariff Revenue in EU	447k	+8,742%	+125.9%	-34.2%
Tariff Revenue in US	46,728k	-11.9%	-0.1%	+1.1%
Change in welfare EU	—	*-480,936k*	*-25,208k*	*+293,418k*
Change in welfare US	—	*-68,538k*	*-709k*	*+6,191k*
		Exogenous quota price setting		
EU imports from BD	*482.3m*	*-45.5%*	*-2.24%*	*+22.7%*
US imports from BD	*233.6m*	*-41.6%*	*-1.94%*	*+14.3%*
Change in welfare EU	—	*-707,595k*	*-37,343k*	*391,918k*
Change in welfare US	—	*-238,328k*	*-11,193k*	*82,650k*

Short-run Equilibrium Implications of Policy Changes

	Baseline	No preferences	Higher doc. costs	No home yarn req.
Tariff EU: ROO / NO	0% / 12%	12% / 12%	0% / 12%	0% or 12%
Tariff in US	20%	20%	20%	20%
Cost disadvantage (α)	0.85	**1.00**	0.85	**1.00**
Doc.costs (d/f)	**0.66**	**0.00**	**1.32**	0.66
			Change in mass of firms, %	
Mass of exporters	485	0.00%	0.00%	-0.21%
			Change in cutoffs %	
Product.cutoff, EU	0.8508	0.00	0.00%	0.00
Shock cutoff, EU	0.1866	+0.37%	0.00%	+0.37%
			Change in BD revenues before & after tariff	
$R_{BD,EU}$	482.3m	+0.97%	+0.01%	+4.64%
$(1-t_{BD,EU})R_{BD,EU}$	481.8m	-11.06%	-0.11%	+4.68%
			Approximated change in welfare ($)	
Price index in EU	100%	-1.63%	-1.09%	-3.67%
Tariff revenues in EU	447k	+12,964%	+130%	-43%
Change in welfare, EU	—	+107,433k	+33,712k	+111.610k

Long-run vs Short-run Effects

- Turning off entry channel changes damps down effects
- Can lead to opposite welfare conclusions depending on parameters
- Removing preferences (+107m), *increasing* documentation costs (+34m), and removing Home Yarn requirements (+112m) *raise* EU welfare. No US effect by construction
    * Preference removal: LR (-) vs. SR (+)
    * Higher documentation costs: LR(-) vs. SR(+)
    * No Home-yarn requirement: LR(+) vs. SR(+)
- Fixed entry calculations might be quite misleading!

Fixed Costs Compensation Efficiency

	Baseline	Ind. Entry	EU entry	US entry	Docum.	Fixed
Costs compensated:	—	f_e	f_m^{EU}	f_m^{US}	d	f
Original (estimated)	—	*77,348*	*251,250*	*67,869*	*4,240*	*6,404*
	—	*Endogenous quota price case*				
Compensation amnt.	—	318	1,826	2,328	3,192	2,117
Market share in EU	482.3m	+0.11%	+1.68%	+1.30%	+1.37%	+6.54%
Market share in US	233.6m	+0.04%	+0.08%	+5.78%	+0.06%	+3.19%
Mass of entrants	4712	+0.22%	0.47%	2.62%	0.39%	12.34%
Tariff Revenue in EU	447k	+0.12%	+2.14%	+1.49%	-93.1%	+86.3%
Tariff Revenue in US	46,728k	+0.04%	+0.08%	+5.78%	+0.06%	+3.19%
Change in welfare EU	—	1.9m	28.5m	22.1m	22.7m	111.7m
Change in welfare US	—	0.2m	0.5m	33.4m	0.4m	18.4m
Policy efficiency	—	*0.4*	*5.5*	*11.4*	*4.8*	*24.8*
		Exogenous quota price case				
Compensation amnt.		317	1,820	2,001	3,185	1,912
Market share in EU	482.3m	+0.28%	+2.07%	+8.59%	+1.76%	+14.69%
Market share in US	233.6m	+0.46%	+1.04%	+23.6%	+0.95%	+27.75%
Change in welfare EU	—	4.8m	35.2m	146.6m	29.4m	252.6m
Change in welfare US	—	2.6m	6.0m	136.8m	5.5m	159.8m
Policy efficiency	—	*1.5*	*8.3*	*57.1*	*7.1*	*81.2*

Large Entry Effects: Logic

- Decomposition of policy experiment outcomes into extensive (via margins and via entry) & intensive margins.
  - Entry part of extensive margin does most of the work.
- Ex ante profits are very flat in mass of entry. Policy shifts curve up so large entry effects
  - Low substitution between BD firms means new entrants make room for themselves
  - Lower BD price means BD firms steal from ROW firms: small country assumption
    - This channel does less if substitutability in BD and ROW is reduced
  - Marginal TFP firms with marginal demand shock produces f
  - So marginal firm produces more than f on average making marginal firms more important economically
- Quotas mute impact in US and in EU: US quotas prevent EU policies from being effective

Relation to Krugman and Chaney

- Krugman (1980): homogeneous firms + low $\sigma \Rightarrow$ tariff won't reduce imports much as goods poor substitutes
- Chaney (2008): heterogeneous firms + low $\sigma \Rightarrow$ tariff reduces imports a lot as marginal firm has little disadvantage from high cost so sells a lot even if it's profits are low. Hence, large effect of tariff on trade flows.
- No free entry in Chaney! Most of action comes from entry margin.

Policy importance:

- Trade facilitation vs direct aid as aid/development tool.
- Conversely, devastating impact of poor infrastructure, rule of law, corruption,..
- Such aid may also be in donor's narrow interest
- Approach can be used to evaluate policy interventions

THANK YOU!

Method of Moments

$$\left[\frac{1}{N}\sum_{i=1}^{N} m_i(X,\theta)\right]' W \left[\frac{1}{N}\sum_{i=1}^{N} m_i(X,\theta)\right] \longrightarrow \min_{\theta}$$

- Shares of firms across markets component:

$$m^{Share}_{i,AUS}(X,\theta) = I\left[Firm\ i\ is\ AUS, \theta\right] - S^{e}_{AUS}.$$

- Distributions component:

$$m^{P}_{ijk}(X,\theta) = I\left[p_{ij} \in \left[\ddot{\ddot{p}}^{j}_{k}(\theta), \ddot{\ddot{p}}^{j}_{k+\varepsilon}(\theta)\right]\right] - \varepsilon$$

$$m^{q}_{ijk}(X,\theta) = I\left[q_{ij} \in \left[\ddot{\ddot{q}}^{j}_{k}(\theta), \ddot{\ddot{q}}^{j}_{k+\varepsilon}(\theta)\right]\right] - \varepsilon,$$

$$\begin{aligned} m^{v}_{ijk}(X,\theta) \quad = \quad & I\left[v_{ij} \in \left[\ddot{\ddot{v}}^{1}_{jk}(\theta,X), \ddot{\ddot{v}}^{1}_{jk+\varepsilon}(\theta,X)\right]\right] - \\ & -I\left[v_{ij} \in \left[\ddot{\ddot{v}}^{2}_{jk}(\theta,X), \ddot{\ddot{v}}^{2}_{jk+\varepsilon}(\theta,X)\right]\right] \end{aligned}$$

  * Where $j \in \{OEU, AUS, OUS\}$, k-th percentile, $\varepsilon-$bin size.

- W is *unitary* at the first step, and the *optimal* at the second.

Results: Productivity Distributions

- AUS firms for both EU and US markets firms fit is good
- OEU, OUS firms distribution of price and quantity fits relatively badly
- Model has OEU and OUS firms being low productivity (high price) unlike data
  * High productivity firms need very bad EU or US shock to be OEU or OUS
- Capacity constraint in real world?
  * Only demand shock matters if there are capacity constraints
  * Lets high productivity (low price) firms sell to only one market
  * Limited quantity

Results: Demand Shocks

Distribution of demand shocks				
	EU		*US*	
	Estimate	Std. Err.	Estimate	Std. Err.
Shape (γ)	0.32	0.008	0.17	0.003
Scale (λ)	1.39	0.087	0.57	0.020
	Implied means and Coefficient of Variation			
Implied mean shock	10.4		421.8	
Coefficient of variation	4.9		30.7	

Digression: Price Index Small Country

- $R_{BD,US}$ is total Bangladeshi sales to the US: COMTRADE
- R_{US} is total exports of apparel to the US: COMTRADE

$$R_{BD,j} = \frac{\left(P_{BD,j}\right)^{1-\sigma_j}}{\left(P_{BD,j}\right)^{1-\sigma_j} + \sum_{i \in \Omega_{(-BD)}} \left[P_{i,j}\right]^{1-\sigma_j}} R_j.$$

- $\left(P_{BD,j}\right)^{1-\sigma_j}$ comes from estimation.
- Solve for $\sum_{i \in \Omega_{(-BD)}} \left[P_{i,j}\right]^{1-\sigma_j} = \bar{P}_{-BD,US}$.
- In our simulations we keep this fixed in accordance with our partial equilibrium assumptions.

Endogenous quota price: Setup

- Survey: Original quota price in the US market about 7%
  - This level is used in estimation
- Allow quota price to change, keeping Quantity old from BD to US constant ($Q_{BD,US}$)
  - Note: Export revenue changes via price index changes
- Solve for model unknowns & for a new quota price
- Compare results to exogenous quota price case

Long-run Equilibrium Implications of Policy Changes

- No yarn requirement (win - win)
- Liberalizing preferences raises entrants by around 5.8% in industry
- 9.4% fall in price index in EU, and 0.1% fall in US from lower cost and price and more entry
- Large changes in cutoffs
- Welfare effects:
  - EU: TR falls by 34.2%, CS rises, welfare rises by $391 million
  - US: TR rises by 1.1%, CS rises, welfare rises by $83 million
- EU policy raises US welfare: win - win scenario
- US quotas would insulate: BD quotas made more binding. Also reduces positive impact on EU as less entry occurs.

Long-run Equilibrium Implications of Policy Changes

	Baseline	No preferences	Higher doc. costs	No yarn req.
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Long-run Equilibrium Implications of Policy Changes

- Removal of preferences (lose - lose)
- Reduces profits, less entry, price indices rise
- Welfare Effects
  * EU: TR increases by 8,742%, CS falls, welfare falls
  * US: TR falls 11.9%, CS falls, welfare falls
  * EU policy reduces US welfare: lose - lose
- US quotas provide insulation: BD quotas made less binding

Long-run Equilibrium Implications of Policy Changes

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Long-run Equilibrium Implications of Policy Changes

- Documentation costs double (lose - lose)
- Fewer firms meet ROOs so lower cost and price, but pay tariffs so higher price.
  * Small increase in price indices from less entry
  * Small changes in cutoffs
- Welfare Effects, Endogenous quota price
  * EU: TR rises by 125.9%, CS falls, welfare falls by $25.0m
  * US: TR falls by 0.1%, CS falls, welfare falls by $0.7m
- EU policy reduces US welfare
- US quotas would provide insulation: BD quotas made less binding.