

# Advanced Topics in Trade

## Lecture 8b - Domestic Value Added of Exports: Theory and Evidence From China (Kee and Tang, 2015)

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April 3, 2015

# What is this paper about?

1. Propose empirical methods to measure DVA in exports using firm and transaction-level data.
2. Provide a detailed record of the trend, the pattern, and the mechanism of the rising DVA in Chinese exports (2000-2007).
3. China defied the global downward trend of the ratio of domestic value added to gross exports (DVAR).
4. Based on a theoretical model, examine the determinants of the rise in China's DVA in exports at the firm level.

# Results

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# Results

- ▶ Over 2000-2007, the ratio of domestic value added to gross exports (DVAR) from Chinese exporters gradually increased from 0.65 to 0.70.
- ▶ Most of the increase is due to rising DVA
  - ▶ Among processing exporters;
  - ▶ Within industries;
  - ▶ Within firms.

# Reasons for the increase in DVAR

- ▶ Firm level regressions show that processing exporters
  - ▶ substitute imported materials with domestic materials;
  - ▶ decrease import varieties;
  - ▶ increase export varieties (country-HS6 or HS6).
- ▶ This material substitution is driven by an increasing supply and decreasing prices of upstream input varieties.
- ▶ This increase in upstream varieties are related to a continuous input tariff reduction facing the upstream sectors.

# Road Map

- ▶ Data
- ▶ Methodology
- ▶ Aggregate Patterns
- ▶ Empirical evidence at the firm level
- ▶ Simple model to identify the determinants of firm DVAR
- ▶ Exploring the determinant of the within-firm rise in DVAR
- ▶ Conclusions

# Data

- ▶ **Data set 1** : the universe of Chinese import and export transactions in each month between 2000 and 2006.
  - ▶ Data on imports and exports (in USD) at the HS 8-digit level from a firm to/from each country.
- ▶ **Data set 2** : firm-level manufacturing survey data from China's National Bureau of Statistics (NBS).
  - ▶ Covers all state-owned firms and all private firms with sales > 5 million RMB (about 600K USD during the sample period).
  - ▶ Balanced-sheet variables: firm ownership, output, value added, exports, employment, original value of fixed asset, and intermediate inputs.

# Methodology

- ▶ A textbook identity: total revenue of a firm ( $PY$ ) :

$$PY = \pi + wL + rK + P^D M^D + P^I M^I$$

where  $\pi$  = profits,  $wL$  = wages,  $rK$  = cost of capital,  $P^D M^D$  = cost of domestic material,  $P^I M^I$  = cost of imported material.



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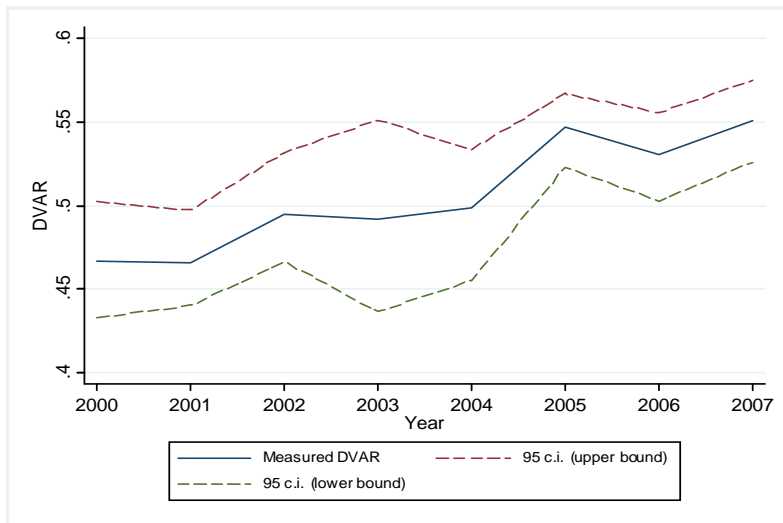
$$DVA = EXP - IMP = \pi + wL + rK + P^D M^D$$

- ▶  $DVAR$  is therefore

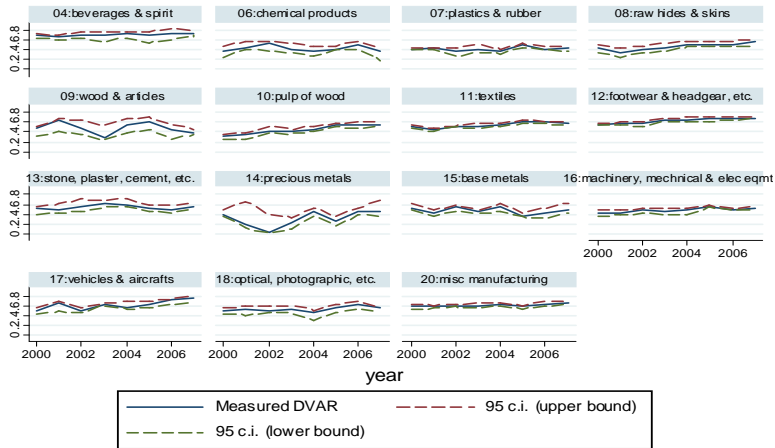
$$DVAR = \frac{DVA}{EXP} = \frac{EXP - IMP}{EXP} = 1 - \frac{P^I M^I}{PY}$$

- ▶ A firm's  $DVAR$  depends on **the share of imported materials in total revenue**, regardless of the production function.

## DVAR in Chinese Processing Exports (Bootstrapped Sample); a 5 ppt increase from 2000 to 2007



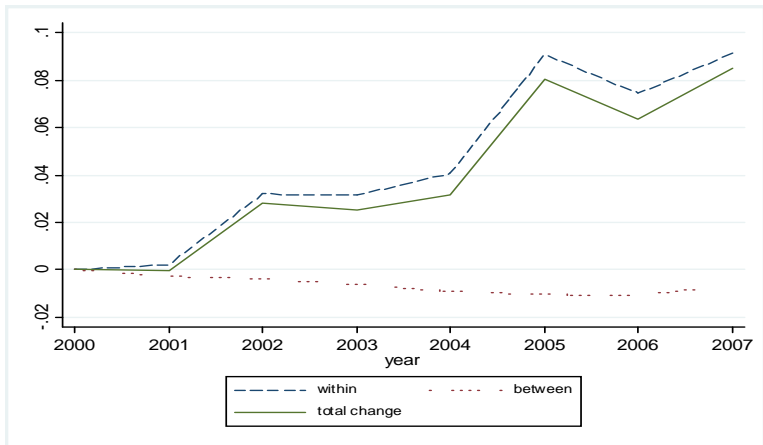
# DVAR in Chinese Processing Exports by Industry (Bootstrapped Sample)



Graphs by d

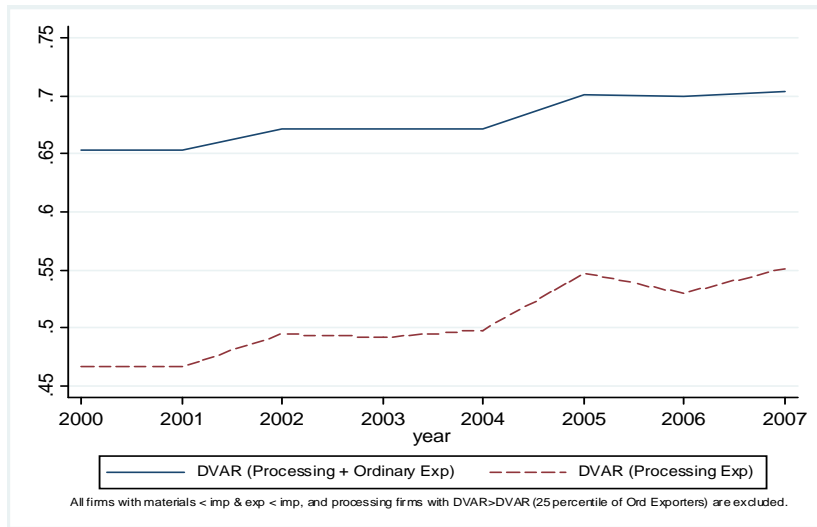
# The rise in DVAR is not due to between-sector changes.

$$\Delta DVAR_t = \underbrace{\sum_{j \in I_{it}} \bar{w}_{jt} (\Delta DVAR_{jt})}_{\text{within}} + \underbrace{\sum_{j \in I_{it}} (\overline{DVAR}_{jt}) (\Delta w_{jt})}_{\text{between}},$$



## DVAR in Overall Exports

By assuming that a non-processing exporter allocates its imports to foreign and domestic sales proportionally.



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# Reasons for the rising DVAR?

- ▶ We already showed that the increase in DVAR is not due to reallocation of resource between industries.
- ▶ Within a sector, high DVAR firms could increase sales more, while low DVAR firms may exit.
- ▶ On the other hand, it could also be a within-firm upgrading phenomenon, due to
  1. Rising production costs;
  2. Firms substitution imported materials with domestic materials ⇒ China moved up the global production chain.
    - ▶ What drives the substitution?

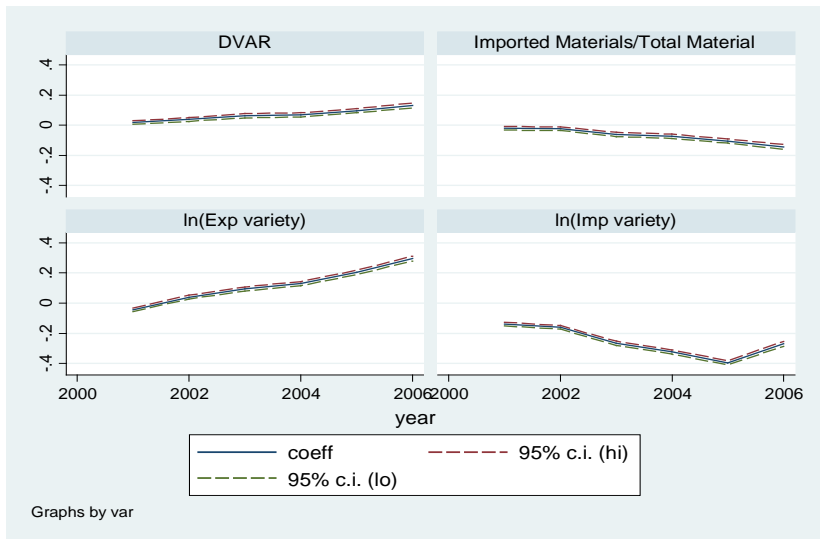
# Dependent variable: DVAR of firm exports

Table 4: Dependent Variable: The Ratio of Domestic Value Added in Exports to Gross Exports (DVAR)

Sample	(1) All	(2) All	(3) Dom private	(4) Foreign	(5) Multiple Ind	(6) Unfiltered
$\beta_{2001}$	0.0319*** (0.006)	0.0316*** (0.006)	0.119** (0.056)	0.0339*** (0.006)	0.0247*** (0.004)	0.0268*** (0.005)
$\beta_{2002}$	0.0544*** (0.006)	0.0548*** (0.005)	0.161** (0.070)	0.0532*** (0.007)	0.0495*** (0.004)	0.0503*** (0.005)
$\beta_{2003}$	0.0744*** (0.006)	0.0751*** (0.005)	0.246*** (0.080)	0.0742*** (0.006)	0.0738*** (0.005)	0.0711*** (0.005)
$\beta_{2004}$	0.0795*** (0.005)	0.0800*** (0.005)	0.179*** (0.068)	0.0797*** (0.005)	0.0817*** (0.005)	0.0756*** (0.005)
$\beta_{2005}$	0.108*** (0.006)	0.109*** (0.006)	0.277*** (0.068)	0.108*** (0.006)	0.121*** (0.005)	0.103*** (0.005)
$\beta_{2006}$	0.139*** (0.006)	0.140*** (0.006)	0.320*** (0.067)	0.139*** (0.008)	0.149*** (0.005)	0.136*** (0.006)
$\beta_{2007}$	0.156*** (0.006)	0.157*** (0.007)	0.317*** (0.078)	0.157*** (0.007)	0.167*** (0.005)	0.155*** (0.006)
$\left(\frac{P^D M^D + P^I M^I}{PY}\right)_{it}$	-0.0205*** (0.005)	-0.0204*** (0.006)	0.0127 (0.068)	-0.0202*** (0.006)	-0.0186*** (0.004)	-0.0107** (0.004)
$\left(\frac{wL}{PY}\right)_{it}$		0.001 (0.011)	0.113 (0.232)	0.001 (0.012)	-0.0035 (0.005)	-0.0045 (0.006)
N	19855	19813	1038	18446	32443	33412
R-sq	.0782	.0789	.131	.0798	.102	.0647

Note: Firm and year fixed effects are always included. Data set: merged NBS-customs data. Columns (1) and (2) use the whole sample; columns (3) and (4) include only domestic private and foreign-invested firms, respectively. Column (5) includes firms that operate in multiple industries as well. Column (6) includes single-industry firms that do not satisfy our rules to filter firms that engage in indirect trade. Bootstrapped standard errors are in parentheses. \* p<0.10; \*\* p<0.05; \*\*\* p<0.01.

# Summary of the firm-level regression results



# Theory on Firms' DVAR

- ▶ The accounting identity:

$$DVAR_{it} = 1 - \frac{P_t^I M_{it}^I}{P_{it} Y_{it}} = 1 - \frac{P_t^M M_{it}}{P_{it} Y_{it}} \frac{P_t^I M_{it}^I}{P_t^M M_{it}},$$

- ▶ A firm's *DVAR* only depends on the share of imported materials in total materials.
- ▶ Given a translog cost function,  $P^M(P_{it}^I, P_{it}^D)$  is symmetric, homogeneous of degree one, and can provide a second-order approximation to any functional form of price aggregates:

$$\begin{aligned} \ln P^M(P_t^I, P_t^D) &= \alpha_i + \alpha_{0I} \ln P_t^I + \alpha_{0D} \ln P_t^D \\ &+ \frac{1}{2} \alpha_{II} (\ln P_t^I)^2 + \alpha_{ID} (\ln P_t^I) (\ln P_t^D) \\ &+ \frac{1}{2} \alpha_{DD} (\ln P_t^D)^2. \end{aligned}$$

# Theory on Firms' DVAR

- ▶ When the unit cost function is translog, the share of imported materials in total materials is a log-linear function of the relative input prices as follows:

$$\begin{aligned}\frac{P_t^I M_{it}^I}{P_t^M M_{it}^M} &= \frac{\partial \ln P^M(P_{it}^I, P_{it}^D)}{\partial \ln P_{it}^I} \\ &= \alpha_{0I} + \alpha_{II} \ln P_{it}^I + \alpha_{ID} \ln P_{it}^D \\ &= \alpha_{0I} - \alpha_{ID} \ln \frac{P_t^I}{P_t^D},\end{aligned}$$

- ▶ *DVAR* depends positively only on  $\frac{P_t^I}{P_t^D}$  (given that  $\alpha_{ID} > 0$ ):

$$DVAR_{it} = 1 + \frac{P_t^M M_{it}^M}{P_{it} Y_{it}} \left( \alpha_{0I} + \alpha_{ID} \ln \frac{P_t^I}{P_t^D} \right), \forall i, t.$$

## Factors Affecting $P_t^I/P_t^D$

- ▶ **Exchange Rates:** Let  $E_t$  = foreign currency value of a Chinese yuan.  
 $P_t^I = P_t^{I^*}/E_t$
- ▶ Yuan depreciation  $\Rightarrow$  higher  $P_t^{I^*}/E_t P_t^D \Rightarrow$  higher DVAR



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- ▶ **Upstream Input Tariffs:** Goldberg, Khandelwal, Pavcnik, and Topalova (2010): Lower import tariffs lead to significant growth of domestic product variety (in India)  $\Rightarrow$  higher DVAR

# Exploring the reasons for the rising firm DVAR

- ▶ We first estimate

$$DVAR_{it} = \beta_i + \beta_{jt} + \beta_X X_{it} + \epsilon_{it}.$$

- ▶  $\beta_i$  = the firm fixed effect;  $\epsilon_{it}$  = residual.
- ▶ The estimated  $\beta_{jt}$ ,  $\hat{\beta}_{jt}$ , captures the average within-firm change in *DVAR* of each industry  $j$  in each year relative to 2000.
- ▶ We estimate the following system of three equations using 3SLS:

$$\hat{\beta}_{jt} = \omega_j^1 + \omega_p^1 \Delta \ln \left( \frac{P_{jt}^I}{P_{jt}^D} \right) + l_{jt}^1,$$

$$\Delta \ln \left( \frac{P_{jt}^I}{P_{jt}^D} \right) = \omega_j^2 + \omega_E^2 \Delta \ln E_{jt} + \omega_v^2 \Delta \ln V_{jt}^D + l_{jt}^2,$$

$$\Delta \ln V_{jt}^D = \omega_j^3 + \omega_T^3 \Delta \tilde{\tau}_{kt}^U + \omega_F^3 \Delta \ln FDI_{jt} + \omega_E^3 \Delta \ln E_{jt} + l_{jt}^3,$$

# Determinants of the Within-firm Increase in DVAR

Table 8: Determinants of the Within-firm Increase in the DVAR

	(1)	(2)	(3)
Dep. Var	$\Delta_{t,00} DVAR_{jt}$	$\Delta_{t,00} \ln(P^I/P^D)_{jt}$	$\Delta_{t,00} \ln(V_{jt}^D)$
$\Delta_{t,00} \ln(P^I/P^D)_{jt}$	0.315*** (0.042)		
$\Delta_{t,00} \ln(E_{jt})$ (RMB appreciation)		1.216 (0.870)	-0.061** (0.024)
$\Delta_{t,00} \ln(V_{jt}^D)$		15.789*** (2.902)	
$\Delta_{t,00} \ln(\tilde{\tau}_{jt}^U)$			-0.053*** (0.006)
$\Delta_{t,00} \ln(FDI_{jt})$			0.003* (0.001)
Industry Fixed Effects			
N	105	105	105
R-sq	0.038	0.106	0.005

$\Delta_{t,00}$  is the operator that subtracts the variable of interest from its corresponding value in 2000.

Bootstrapped standard errors (with 500 repetitions) are reported in parentheses. Coefficients are estimated using 3SLS. Columns (1), (2), and (3) are third, second, and first stages, respectively. \* p<0.10; \*\* p<0.05; \*\*\* p<0.01.

# Quantitative Analysis

- ▶ To understand how much of the change in firm and aggregate *DVAR* can be explained by our model, we would need to first estimate the translog parameter,  $\alpha_{ID}$ .
- ▶ A firm's *DVAR* depends on the share of materials in total sales,  $\frac{P_t^M M_{it}}{P_{it} Y_{it}}$ , and the translog parameter,  $\alpha_{ID}$ , as follows:

$$DVAR_{it} = 1 + \frac{P_t^M M_{it}}{P_{it} Y_{it}} \left( \alpha_{0I} + \alpha_{ID} \ln \left( \frac{P_t^I}{P_t^D} \right) \right).$$

- ▶ The partial impact of a change in  $\ln \left( \frac{P_t^I}{P_t^D} \right)$  on firm *DVAR* is

$$\frac{\partial DVAR_{it}}{\partial \ln \left( \frac{P_t^I}{P_t^D} \right)} = \frac{P_t^M M_{it}}{P_{it} Y_{it}} \alpha_{ID}.$$

## Quantitative Analysis (cont')

- ▶ With the estimate of  $\alpha_{ID}$  and the actual data on  $\frac{P_t^M M_{it}}{P_{it} Y_{it}}$ , we can calculate how much of the change in firm and industry *DVAR* is due to the change in the relative price as predicted by our model:

$$\Delta DVAR_{it} = \frac{P_t^M M_{it}}{P_{it} Y_{it}} \times \hat{\alpha}_{ID} \times \Delta \ln \frac{P_t^I}{P_t^D}$$

- ▶ such estimates allow us to assess the time-series variation in  $\sigma$  and examine whether the rise in firm *DVAR* is driven by an increasing  $\sigma$  or not.

## Quantitative Analysis (cont')

- ▶ To estimate  $\alpha_{ID}$ , we estimate the following:

$$\frac{P_t^I M_{it}^I}{P_t^M M_{it}^M} = a_i - \alpha_{ID} \ln \frac{P_t^I}{P_t^D} + \xi_{it},$$

- ▶ where  $a_i$  is the firm fixed effect that subsumes  $\alpha_{0I}$  and  $\xi_{it}$  is the residual. In other words,  $\alpha_{ID}$  is estimated from the within-firm variation in the relative price between imported and domestic materials.
- ▶ We bootstrap the standard errors and instrument for  $\ln \frac{P_t^I}{P_t^D}$  using exchange rate, FDI and upstream input tariffs.

# Conclusions

- ▶ Derive methods to use firm-level and customs transaction-level data to compute domestic value added in exports at the firm level.
- ▶ The DVAR in Chinese exports increased from 0.65 to 0.70 over 2000-2007 (processing DVAR increased from 0.47 to 0.55)
- ▶ China's moving up the global supply chain is mostly driven by processing exporters increasing their DVA.
- ▶ Regression results suggest processing firms are substituting imported materials with domestic materials (at both the intensive and extensive margins).
- ▶ The within-firm increase in DVAR appears to be caused by a large input-tariff reduction for the non-processing suppliers.