# Firms and Credit Constraints along the Value-Added Chain: Processing Trade in China

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**ECB CompNet Workshop**
**December 11, 2012**

# Motivation

❑ The rapid decline in transportation costs and trade policy barriers over the last few decades has dramatically increased international trade flows

  ▪ Rise in trade in intermediate inputs for further processing and assembly relative to trade in final consumer goods

  ▪ Growing multinational activity and cross-border linkages

❑ This splicing of global production chains raises new policy questions

  ▪ How should trade policy be designed under trade in intermediates?

  ▪ What are the welfare consequences of such trade flows and policies?

  ▪ How is the transmission of shocks across nations affected?

**This paper:** Study why firms select into different trade regimes and how this choice affects their performance

# Institutional Context

❑ We exploit two unique institutional features of China's trade environment

1. Since mid 1980s, China has waived import duties on materials imported for further processing and re-exporting as a means of export promotion
   - In 2005, 31.7% of exporters and 54.6% of exports in processing trade
   - Helped make China a key link in global supply chains

2. Processing exporters operate under two distinct regimes
   - Pure assembly: receive foreign inputs at no cost directly from trade partner
   - Processing with imports: source and pay for foreign inputs

❑ These institutional features introduce wedges between the costs and returns associated with different trade modes

# Main Findings

❑ Profitability varies systematically across trading strategies

■ Profits, profitability and value added fall as firms orient sales from ordinary to processing trade, and from import-and-assembly to pure assembly

❑ Firms' financial health determines their trade regime choice

■ Less credit constrained firms pursue more ordinary relative to processing trade, and more import-and-assembly relative to pure assembly

■ Indentify the impact of financial frictions by exploiting the variation in financial health across firms and in financial vulnerability across sectors within firms

❑ Rationalize these results with a model that incorporates credit constraints and imperfect contractibility in companies' export decisions

■ Up-front expenditures are relationship-specific, vary across trade regimes and affect parties' bargaining power

# Implications: Global Supply Chains

- ❑ Credit constraints affect the organization of production across firm and country boundaries
  - ■ Which stages of the value-added chain (input sourcing, final good production, foreign distribution) are integrated under the control of different trade parties
  - ■ Financially underdeveloped countries potentially stuck in low-value added stages of global production chains

    (Antràs, Desai & Foley 2009; Manova, Wei & Zhang 2009; Carluccio and Fally 2010; Costinot, Vogel & Wang 2011; Antràs & Chor 2011; Feenstra & Hanson 2003; Feenstra et al. 2011)

- ❑ Financial frictions influence the design of international trade contracts
  - ■ Pure assembly as a codified form of trade credit (Antràs & Foley 2011)

- ❑ Removing firms' liquidity constraint in China would increase aggregate profits by 5.5bil RMB (1.3%) and real value added by 15.2bil RMB (0.7%)

# Implications: Policy

❑ Facilitating access to imported materials can boost export performance

   ◾ Foreign inputs of superior quality enable firms in developing countries to expand product scope and upgrade product quality

   (Kugler & Verhoogen 2008, 2009; Goldberg, Khandelwal, Pavcnik & Topalova 2010; Manova & Zhang 2012)

❑ Trade policies can have differential effects across heterogeneous firms

   ◾ Less productive, constrained firms benefit more from import liberalization?

   ◾ Processing regime allows more firms to share in the gains from trade?

   ◾ Imperfect financial markets justify government regulation of trade flows?

❑ Multi-lateral tariff reductions can encourage trade in intermediates

   ◾ Complementarities in trade policies across countries (Antràs & Staiger 2011)

# Broader Contributions

❑ Growing evidence that credit constraints impede trade activity in normal times and during crisis episodes

- Manova 2007; Berman & Héricourt 2008; Chor & Manova 2009; Bricongne et al. 2010; Amiti & Weinstein 2011; Minetti & Zhu 2011 …

❑ Global production chains and their role in the transmission of shocks across countries during recent financial crisis

- Levchenko, Lewis & Tesar 2010; Johnson 2011; Bems, Johnson & Yi 2011

# Outline

1. Motivation

2. Sketch of a model

3. Empirical evidence

4. Conclusions

# Sketch of a Model

❑ Set up

  ■ Manufacturer M produces and sells to foreign buyer B

  ■ Export demand fixed with revenues R

  ■ Production requires domestic inputs $C_D$ and foreign inputs $C_F$

  ■ Marketing and distribution abroad cost F


❑ M chooses OT, PI or PA trade regime

  ■ Foreign parts sourced under OT incur ad-valorem tariff $\tau$ (later rebated)

  ■ Trade partners retain ownership rights over inputs their secure

# Cost Structure

❑ Total costs are always $C_D+C_F+F$ ex-post, but the up-front outlays and working capital needs of the Chinese producer vary across trade regimes

❑ Trade parties require working capital to fund their up-front costs
  ▪ B faces no liquidity needs, covers expenses with cash flows from operations
  ▪ M cannot retain earnings and has access to limited bank loans

| | Ordinary Trade | Import & Assembly | Pure Assembly |
|---|---|---|---|
| Exporter's Profits | $R - C_D - C_F - F$ | $\beta_{PI} (R - C_D - C_F - F)$ | $\beta_{PA} (R - C_D - C_F - F)$ |
| Exporter's Liquidity Needs | $C_D + (1+\tau) C_F + F$ | $C_D + C_F$ | $C_D$ |

# Firm Profits

❑ Imperfect contractibility exposes trade parties to hold-up problems because all investments are relationship-specific

  ■ Whether M processed inputs according to R's specifications is observable to M and R but not verifiable in a court of law

  ■ Trade partners negotiate over the surplus from the relationship with Nash bargaining weights proportional to share of total costs born

❑ M pursues the most profitable trade regime it can

  ■ Profits: $\quad\quad\quad\quad\quad \pi_{PA} < \pi_{PI} < \pi_{OT}$

  ■ Liquidity needs: $\quad TC_{PA} < TC_{PI} < TC_{OT}$

| | Ordinary Trade | Import & Assembly | Pure Assembly |
|---|---|---|---|
| Exporter's Profits | $R - C_D - C_F - F$ | $\beta_{PI}(R - C_D - C_F - F)$ | $\beta_{PA}(R - C_D - C_F - F)$ |
| Exporter's Liquidity Needs | $C_D + (1+\tau)C_F + F$ | $C_D + C_F$ | $C_D$ |

# Data Overview

❑ Chinese Customs Records matched to Census of Manufacturers, 2005

  ■ Merge based on firm names and contact information (Wang and Yu 2011)

  ■ Balance sheet data for 44% of all exporters and trade data for 67% of census manufacturers with positive exports

  ■ Large and representative matched sample: 50,606 firms

❑ Considerable variation in performance and trade activity across firms

  ■ Profits / Sales : avg 0.03, st dev 0.20

  ■ (PA+PI) / (PA+PI+OT) : avg 0.30, st dev 0.42

  ■ PA / (PA+PI) : avg 0.19, st dev 0.37

# Choice of Export Regimes

❑ Share of firms reporting exports under ordinary trade (**OT**), processing with imports (**PI**) and/or pure assembly (**PA**)
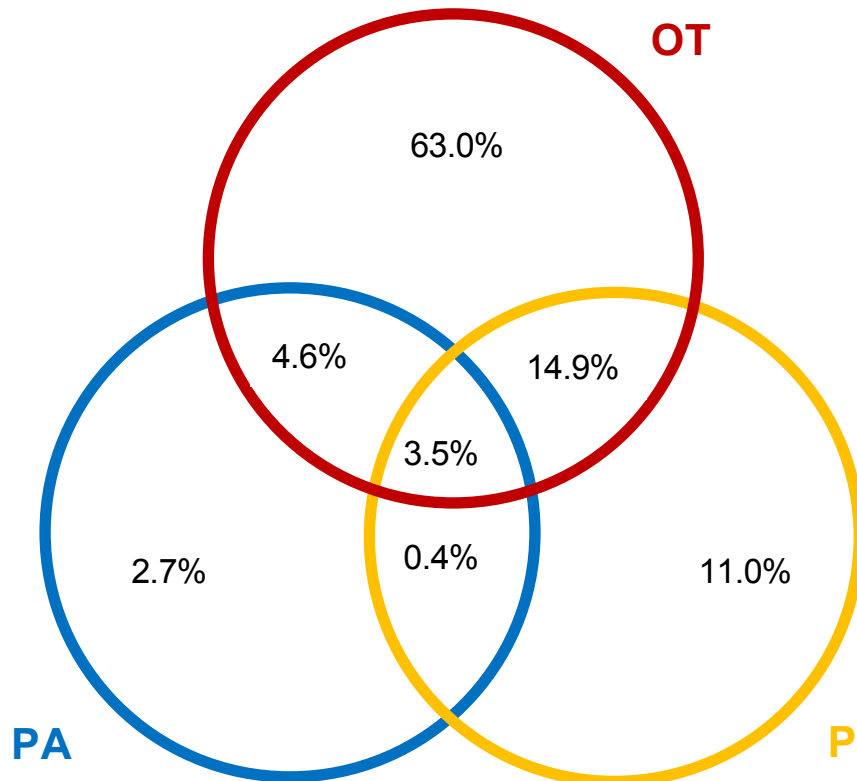
# Estimation Strategy I

❑ Document the conditional correlation between firms' performance and export trade regime choices

$$Y_f = \alpha + \beta \cdot TradeShare_f + \gamma \cdot \log L_f + \varphi_p + \varphi_i + \varphi_{own} + \varepsilon_f$$

- $Y_f$: profits, profitability, value added
- $TradeShare_f$: trade regime composition of firm exports
- $\varphi_p$, $\varphi_i$ : province and industry FE; 31 regions and 738 sectors
  control for differences in factor costs, factor intensities, trade costs, demand shocks, financial market development, institutional frictions …
- $\varphi_{own}$: ownership FE; SOE, JV, MNC
  control for differences in average productivity, managerial talent, worker skill, tax treatment, total external finance ...

# Trade Regimes and Firm Profitability

❑ Profitability and value added increase as firms re-orient foreign sales from pure assembly to processing with imports to ordinary trade

  ▪ Reallocating 10% exports from PT to OT (from PA to PI) is accompanied by 1.5% (2.8%) rise in profits

| Dep Variable: | (log) Profit | Profit/Sales | (log) Value Added |
|---|---|---|---|
| **Panel A. Processing Trade vs. Ordinary Trade** | | | |
| (PA + PI) / (PA + PI + OT) | -0.151*** | -0.016*** | -0.108*** |
| | (-5.94) | (-6.65) | (-7.19) |
| (log) Employment | 0.905*** | 0.007*** | 0.896*** |
| | (116.61) | (8.68) | (182.28) |
| R-squared | 0.39 | 0.03 | 0.55 |
| # observations | 39,784 | 50,498 | 49,717 |
| **Panel B. Pure Assembly vs. Import & Assembly** | | | |
| PA / (PA + PI) | -0.275*** | -0.013*** | -0.229*** |
| | (-7.14) | (-3.42) | (-10.74) |
| (log) Employment | 0.892*** | 0.008*** | 0.909*** |
| | (77.63) | (7.81) | (125.99) |
| R-squared | 0.44 | 0.05 | 0.58 |
| # observations | 16,603 | 22,063 | 21,704 |

# Estimation Strategy II

❑ Examine the determinants of firms' trade regime choices

$$Trade\ Share_f = \alpha + \beta \cdot Fin\ Health_f + \delta \cdot \log L_f + \varphi_p + \varphi_i + \varphi_{own} + \varepsilon_f$$

- ■ *Trade Share$_f$*: trade regime composition of firm exports
- ■ *Fin Health$_f$*: firm's financial health
- ■ $\varphi_p$, $\varphi_i$ : province and industry FE
- ■ $\varphi_{own}$: ownership FE
- ■ $\beta$ identified from the variation across firms

# Firms' Financial Health

❏ Liquidity

  ■ ( current assets – current liabilities ) / total assets

  ■ Avg 0.09, st dev 0.32

  ■ Captures firms' availability of liquid capital

❏ Leverage

  ■ short-term debt / current assets

  ■ Avg 0.99, st dev 1.28

  ■ More financial obligations in the short run imply less freedom in managing cash flows and greater difficulty in raising additional capital

❏ Expect firms with high liquidity and low leverage to be less constrained

# Trade Regimes and Firm Financial Health

❑ Firms with low liquidity and high leverage conduct relatively more processing trade, and pure assembly in particular

■ One st dev improvement in liquidity (leverage) would generate 0.8% (0.5%) decline in (PA+PI)/(PA+PI+OT) and 1.2% (2.8%) drop in PA/(PA+PI)

| Dep Variable: | Current Fin Health | | Lagged Fin Health | |
|---|---|---|---|---|
| | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
| **Panel A. Liquidity = ( current assets - current liability ) / total assets** | | | | |
| Liquidity | -0.026*** | -0.039*** | -0.025*** | -0.024*** |
| | (-5.36) | (-4.85) | (-5.09) | (-3.15) |
| R-squared | 0.44 | 0.24 | 0.44 | 0.23 |
| # observations | 50,490 | 22,059 | 46,573 | 20,555 |
| **Panel B. Leverage = short-term debt / current assets** | | | | |
| Leverage | 0.004** | 0.022*** | 0.003*** | 0.007** |
| | (2.13) | (6.85) | (3.18) | (2.05) |
| R-squared | 0.44 | 0.24 | 0.44 | 0.23 |
| # observations | 50,483 | 22,058 | 46,557 | 20,545 |

# Trade Regimes and Firm Financial Health

❑ Results robust to controlling for firm productivity and variation across export destinations

| Dep Variable: | Lagged Fin Health | | | |
|---|---|---|---|---|
| | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
| **Panel A. Liquidity = ( current assets - current liability ) / total assets** | | | | |
| Liquidity | -0.028*** | -0.039*** | -0.013* | -0.029** |
| | (-3.88) | (-3.23) | (-1.66) | (-2.24) |
| Productivity | | | -0.016*** | -0.024*** |
| | | | (-5.99) | (-6.77) |
| R-squared | 0.43 | 0.21 | 0.43 | 0.22 |
| # observations | 409,249 | 135,109 | 380,102 | 126,592 |
| **Panel B. Leverage = short-term debt / current assets** | | | | |
| Leverage | 0.005*** | 0.013*** | 0.004*** | 0.013*** |
| | (3.49) | (4.21) | (2.66) | (4.04) |
| Productivity | | | -0.016*** | -0.024*** |
| | | | (-6.28) | (-6.74) |
| R-squared | 0.43 | 0.22 | 0.43 | 0.22 |
| # observations | 409,120 | 135,054 | 380,027 | 126,542 |

# Estimation Strategy III

❑ Exploit the variation in financial vulnerability across sectors within firms

$$Trade\ Share_{fi} = \alpha + \beta \cdot Fin\ Vuln_i + \gamma \cdot Ind\ Controls_i + \varphi_f + \varepsilon_{fi}$$

- ■ *Trade Share$_{fi}$*: trade regime composition of firm exports by industry
- ■ *Fin Vuln$_i$*: sector's financial vulnerability
- ■ *Ind Controls$_i$*: sector's K, H and RS intensity
- ■ *$\varphi_f$*: firm FE
- ■ *$\beta$* identified from the variation across sectors within firms

# Sectors' Financial Vulnerability

❑ Industries differ substantially in their reliance on the financial system for technological reasons that are innate to the nature of the manufacturing process and beyond the control of individual firms

❑ Four commonly used indicators of sectors' financial vulnerability

- Working capital requirement: inventories-to-sales ratio
- Long-run investment needs: external finance dependence, R&D intensity
- Availability of collateral: asset tangibility

# Trade Regimes and Sectors' Fin Vulnerability

❑ Firms conduct relatively more processing trade, and pure assembly in particular in financially vulnerable sectors

  ■ Increasing short-run liquidity needs by 20% results in 10% rise in (PA+PI)/(PA+PI+OT) and 4% growth in PA/(PA+PI)

| Dep Variable: | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
|---|---|---|---|---|
| **Panel A. Working Capital Requirement: Inventories Ratio** | | | | |
| Inventories Ratio | 0.497*** | 0.201*** | 0.538*** | 0.084** |
| | (23.43) | (2.77) | (20.90) | (1.99) |
| R-squared | 0.86 | 0.97 | 0.83 | 0.94 |
| **Panel B. Long-Run Investment Needs: External Finance Dependence** | | | | |
| Ext Fin Dependence | 0.050*** | -0.0001 | 0.049*** | -0.002 |
| | (21.82) | (-0.03) | (18.23) | (-0.46) |
| R-squared | 0.86 | 0.97 | 0.83 | 0.94 |
| # observations | 252,296 | 59,263 | 1,142,871 | 264,585 |

# Trade Regimes and Sectors' Fin Vulnerability

❑ Unlike processing vs. ordinary exports, trade-off between PA and PI unrelated to the financing of long-run capital projects or to asset tangibility

  ■ Results robust to controlling for variation across export destinations

| Dep Variable: | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
|---|---|---|---|---|
| **Panel C. Long-Run Investment Needs: R&D Intensity** | | | | |
| R&D Intensity | 0.988*** | -0.018 | 0.901*** | -0.032 |
| | (22.81) | (-0.24) | (16.68) | (-0.55) |
| R-squared | 0.86 | 0.97 | 0.83 | 0.94 |
| **Panel D. Access to Collateral: Asset Tangibility** | | | | |
| Asset Tangibility | -0.208*** | -0.038 | -0.207*** | -0.028 |
| | (-18.05) | (-1.12) | (-15.94) | (-1.42) |
| R-squared | 0.86 | 0.97 | 0.83 | 0.94 |
| # observations | 252,296 | 59,263 | 1,142,871 | 264,585 |

# Additional Tests and Robustness

❑ Empirical patterns robust to series of specification checks

- ■ Panel for 2002-2006
- ■ Binary trade regime shares
- ■ Alternative levels of clustering

❑ Additional results corroborate interpretation

- ■ Results stronger in Chinese regions with weaker financial development
- ■ Results stronger for destinations with superior financial development
- ■ Results stronger in sectors with more relationship specificity

# Financial Devt across Chinese Provinces

❑ The export decisions of firms in financially more developed provinces are less sensitive to firms' financial health and sectors' financial vulnerability

| Dep Variable: | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
|---|---|---|---|---|
| Firm Fin Health | -0.041*** | -0.081*** | | |
| | (-3.87) | (-3.17) | | |
| Firm Fin Health x High Fin Devt | 0.019* | 0.066** | | |
| | (1.84) | (2.37) | | |
| Sector Fin Vuln | | | 1.252*** | 0.324** |
| | | | (17.77) | (2.13) |
| Sector Fin Vuln x High Fin Devt | | | -0.787*** | -0.220** |
| | | | (-10.51) | (-2.11) |
| R-squared | 0.39 | 0.23 | 0.77 | 0.92 |
| # observations | 409,249 | 135,109 | 1,142,871 | 264,585 |

# Financial Devt across Export Destinations

❑ Chinese producer more likely to choose processing trade, and pure assemble in particular, if foreign buyer has more access to external finance

| Dep Variable: | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
|---|---|---|---|---|
| Firm Fin Health | -0.039*** | -0.031* | | |
| | (-3.84) | (-1.65) | | |
| Firm Fin Health x   High Dest Fin Devt | 0.012 | -0.007 | | |
| | (1.62) | (-0.57) | | |
| Sector Fin Vuln | | | 0.413*** | 0.056 |
| | | | (12.13) | (0.92) |
| Sector Fin Vuln x   High Dest Fin Devt | | | 0.315*** | 0.104*** |
| | | | (15.09) | (3.67) |
| R-squared | 0.39 | 0.23 | 0.77 | 0.92 |
| # observations | 405,051 | 134,015 | 1,132,108 | 262,761 |

# Relationship Specificity across Sectors

❑  Financial considerations affect firms' choice of trade regime relatively more in industries that are more intensive in relationship-specific investments

| Dep Variable: | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ | $\dfrac{PA+PI}{PA+PI+OT}$ | $\dfrac{PA}{PA+PI}$ |
|---|---|---|---|---|
| Firm Fin Health | -0.008 (-0.75) | -0.020 (-0.97) | | |
| Firm Fin Health x High RS Intensity | -0.038*** (-2.63) | -0.026 (-1.04) | | |
| Sector Fin Vuln | | | 0.645*** (22.27) | 0.131*** (2.80) |
| Sector Fin Vuln x High RS Intensity | | | 0.165*** (11.12) | 0.026* (1.71) |
| R-squared | 0.40 | 0.23 | 0.77 | 0.92 |
| # observations | 400,859 | 132,753 | 1,142,871 | 264,585 |

# Firms' Import Strategies

❑ Firms' import behavior is consistent with their export strategy

■ Firms with more processing exports (pure assembly) also import more foreign materials under the processing regime (pure assembly)

**Panel A. Dep. Variable: (IPA + IPI) / (IPA + IPI + IOT)**

| | | | | | |
|---|---|---|---|---|---|
| (PA + PI) / (PA + PI + OT) | 0.603***<br>(111.97) | | | | |
| Liquidity | | | -0.026***<br>(-4.51) | -0.014**<br>(-2.33) | |
| Leverage | | | | 0.002*<br>(1.95) | 0.001<br>(0.92) |
| Productivity | | | -0.028***<br>(-12.00) | | -0.029***<br>(-12.54) |
| R-squared | 0.58 | 0.40 | 0.40 | 0.40 | 0.40 |
| # observations | 30,274 | 32,530 | 30,167 | 32,518 | 30,159 |

# Firms' Import Strategies

❑ Firms' import behavior is consistent with their export strategy

  ■ Credit-constrained firms not only export more under processing trade (pure assembly), but also import more under processing trade (pure assembly)

**Panel B. Dep. Variable: IPA / (IPA + IPI)**

| | | | | | |
|---|---|---|---|---|---|
| PA / (PA + PI) | 0.946*** (294.23) | | | | |
| Liquidity | | | -0.021*** (-2.86) | -0.015* (-1.94) | |
| Leverage | | | | 0.007** (2.02) | 0.007* (1.86) |
| Productivity | | | -0.017*** (-6.33) | | -0.016*** (-6.12) |
| R-squared | 0.93 | 0.21 | 0.21 | 0.21 | 0.22 |
| # observations | 20,483 | 20,952 | 19,505 | 20,944 | 19,500 |

# Endogeneity and Reverse Causality I

What if firms sort into different trade regimes for reasons unrelated to financial considerations?

❑ Concern 1: with frictionless capital markets, manufacturers could raise all the funds needed to pursue their optimal export strategy

  ■ Variation in liquidity needs across trade modes could explain the relationship between firms' trade regime choices and use of external finance

❑ This explanation is unlikely for three reasons

  ■ Results robust to using lagged financial health

  ■ It cannot rationalize the systematic variation across sectors within firms nor across regions in China, export destinations and sectors' RS

  ■ Profitability varies across trade regimes and unconstrained firms would have pursued most profitable export mode (OT)

# Endogeneity and Reverse Causality II

What if firms sort into different trade regimes for reasons unrelated to financial considerations?

❑ Concern 2: if financiers more willing to fund more profitable ventures, exporters active in trade regimes with lower returns would record lower liquidity and higher leverage

  ■ Variation in profitability across trade modes could explain the relationship between firms' trade regime choices and use of external finance

❑ This explanation cannot rationalize the systematic variation across sectors within firms nor across regions, destinations and RS sectors

  ■ The relative profitability of different trade regimes would have to vary in very particular ways with sectors' financial vulnerability, for reasons unrelated to the financing of production and its effect on parties' bargaining power

# Quantifying the Aggregate Distortion

❑ We can use our point estimates to quantify the potential economy-wide gains from relaxing financial frictions in China

❑ Counterfactual: the financial health of all firms improves to that of the least constrained company

$$\Delta\Pi^{China} = \sum_f \beta_{PT}^{\pi/r} \cdot \beta_{Liq}^{PT} \cdot \left(Liq_{MAX} - Liq_f\right)\cdot r_f + \sum_{f,PT>0} \beta_{PA}^{\pi/r} \cdot \beta_{Liq}^{PA} \cdot \left(Liq_{MAX} - Liq_f\right)\cdot r_f$$

$$\Delta VA^{China} = \sum_f \beta_{PT}^{VA} \cdot \beta_{Liq}^{PT} \cdot \left(Liq_{MAX} - Liq_f\right)\cdot va_f + \sum_{f,PT>0} \beta_{PA}^{VA} \cdot \beta_{Liq}^{PA} \cdot \left(Liq_{MAX} - Liq_f\right)\cdot va_f$$

- Aggregate profits and value added would increase by 5.5 bil and 15.2 bil RMB
- Represent 1.3% of actual total profits and 0.7% of actual total value added
- Caveat: these are likely lower bounds

# Conclusions

❑ Firms' financial health affects their position along the value added chain and the organization of production across firms and countries

  ■ These choices determine company profitability

  ■ Financial frictions affect the design of international trade contracts

  ■ Financially underdeveloped countries potentially stuck in low value added stages of global production chains

❑ Facilitating access to imported materials can boost export performance

  ■ Distributional consequences of trade policies and globalization

  ■ Optimal trade policy with processing trade

❑ Cross-border linkages via global production chains