Technical Appendix for "The Role of Intermediaries in Facilitating Trade"*

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Abstract

This paper documents that intermediaries play an important role in facilitating international trade. We modify a heterogeneous firm model to allow for an intermediary sector. The model predicts that firms will endogenously select their mode of export–either directly or indirectly through an intermediary–based on productivity. The model also predicts that intermediaries will be relatively more important in markets that are more difficult to penetrate. We provide empirical confirmation for these predictions using the firm-level census of China's trade, and generate new facts regarding the activity of intermediaries. We also provide evidence that firms begin to export directly after exporting through intermediaries.

Keywords: China, Intermediaries, Heterogeneous Firms, Middlemen, Trade Costs

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1. Introduction

This appendix provides a formal derivation of the model presented in "The Role of Intermediaries in Facilitating Trade" by JaeBin Ahn, Amit K. Khandelwal, and Shang-Jin Wei.

2. Technical Appendix for "The Role of Intermediaries in Fascilitating Trade"

We assume that the home country has N asymmetric trading partners, and focus on an open economy equilibrium because in autarky there is no role for intermediaries to export. Consumers in each country have identical CES preferences for differentiated varieties:

$$U = \left[\int_{\omega\in\Omega^j} q(\omega)^\rho d\omega\right]^{\frac{1}{\rho}},$$

where Ω^j is the set of total available varieties in the differentiated goods sector. The corresponding price index in each country is given by $P^j = \left[\int_{\omega\in\Omega^j} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$, where $\sigma = \frac{1}{1-\rho} > 1$ is the constant elasticity of substitution across varieties. Let R^j denote the aggregate expenditure in market j. We denote the home market as d.

Each consumer inelastically supplies one unit of labor and is paid a normalized wage of 1. The production technology requires a constant marginal cost and a fixed per period overhead cost, f_d. The amount of labor required to produce q units for a firm with productivity level φ is $l = f_d + \frac{q}{\varphi}$. Firms are heterogeneous and draw their productivity φ from a distribution $G(\varphi)$ after paying an entry cost. The optimal price for the domestic market is $p_d(\varphi) = \frac{1}{\rho\varphi}$, and the domestic revenue is $r_d(\varphi) = R^d\left(\frac{p_d(\varphi)}{P^d}\right)^{1-\sigma}$.

A firm that remains in the market decides whether or not to export and its mode of export. Direct exports to j requires a per period bilateral fixed cost, f_x^j and a bilateral iceberg transportation cost $\tau^j > 1$. Alternatively, firms can choose to export their varieties indirectly by relying on an intermediary sector. This indirect export mode allows firms to avoid the direct trade costs to entering market j. If the manufacturer sells its variety through the intermediary sector, it must pay a fixed cost $f_i < f_x^j$, $\forall j$. A firm that pays f_i can indirectly access all markets and we assume that if a firm directly exports to n markets, it will continue to service the remaining $N - n$ markets indirectly.

The intermediary sector is perfectly competitive with identical intermediary firms operating in each market. The manufacturer charges the intermediary a price $p_i(\varphi)$, which we derive below. As we discused in the text, the intermediary aggregates orders across its clients, incurs a per-unit cost to prepare the variety for the foriegn market (γ) as well as incurs variable trade costs to export. The foreign price of a variety exported by an intermediary is therefore

$$p_i^j(\varphi) = \gamma\tau^j p_i(\varphi) \tag{A.1}$$

Taking into account the foreign price of indirect exports, the manufacturers set their optimal price for indirect exports, $p_i(\varphi)$, by maximizing:

$$\begin{aligned}
\max_{p_i(\varphi)} \pi_i^j(\varphi) &= r_i^j(\varphi) - \frac{1}{\varphi} q_i^j(\varphi)\tau^j \\
&= p_i(\varphi) q_i^j(\varphi)\tau^j - \frac{1}{\varphi} q_i^j(\varphi)\tau^j \\
&= p_i(\varphi) R^j \left(\frac{p_i^j(\varphi)}{P^j}\right)^{-\sigma} \frac{1}{P^j}\tau^j - \frac{1}{\varphi} R^j \left(\frac{p_i^j(\varphi)}{P^j}\right)^{-\sigma} \frac{1}{P^j}\tau^j.
\end{aligned} \tag{A.2}$$

Substituting equation (A.1) into equation (A.2), the optimal price charged by manufacturers to the intermediaries is:

$$p_i(\varphi) = p_d(\varphi) = \frac{1}{\rho\varphi}. \tag{A.3}$$

We note that the price in (A.3) is identical to the domestic price. Thus, there is no price discrimination within the domestic market between domestic consumers and intermediary firms.

We can now obtain the manufacturer's profit on indirect exports by substituting the prices in equations (A.1) and (A.3) into profit expressions in equations (A.2). This yields:

$$\pi_i^j(\varphi) = \frac{1}{\sigma}\gamma^{-\sigma} R^j \left(\frac{\tau^j}{\rho\varphi P^j}\right)^{1-\sigma} \tag{A.4}$$

Similarly, we can derive the intermediary's per variety profit:

$$\pi_{int}^j(\varphi) = \frac{1}{\sigma}\gamma^{-\sigma}(\gamma - 1) R^j \left(\frac{\tau^j}{\rho\varphi P^j}\right)^{1-\sigma} \tag{A.5}$$

Finally, we consider the prices, revenues and profits for a firm that directly exports. As in Melitz (2003), the price charged for direct exports is $p_x^j(\varphi) = \frac{\tau^j}{\rho\varphi}$. The revenue from direct exports to market j is $r_x^j(\varphi) = R^j \left(\frac{p_x^j(\varphi)}{P^j}\right)^{1-\sigma}$. The profit from direct exports is

$$\pi_x^j(\varphi) = \frac{r_x^j(\varphi)}{\sigma} - f_x^j. \tag{A.6}$$

We can verify that a manufacturer's revenues from direct exports are larger than revenues from indirect exports in each market. Substituting the optimal prices $p_i(\varphi)$ and $p_i^j(\varphi)$ into (A.2), we see that $r_i^j(\varphi) = \gamma^{-\sigma} r_x^j(\varphi) < r_x^j(\varphi)$ since $\gamma^{-\sigma} < 1$. For a given variety, the revenue from direct exports exceeds indirect exports. This occurs because indirect export prices are higher because of the commision is passed on to foreign customers and demand is elastic. Thus, the market-specific indirect profit curve is flatter than the direct export profit curve in Figure 1 of Ahn, Khandelwal and Wei (2011). This shows the tradeoff that manufacturing firms face between high fixed and low variable costs on direct exports and vice versa on indirect exports.

We can now express the cutoff conditions. The cutoff condition for firms to remain active in the market is:[1]

$$\pi_d(\varphi_d) = \frac{r_d(\varphi_d)}{\sigma} - f_d = 0. \tag{A.7}$$

The indirect export cutoff (φ_i) determines the marginal firm that is just indifferent between paying f_i to gain indirect access to all markets and not. This cutoff is determined implicitly by:

$$\begin{aligned} \pi_i(\varphi_i) &= \sum_{j=1}^{N} \pi_i^j(\varphi_i) - f_i = 0 \\ &= \frac{1}{\sigma}\sum_{j=1}^{N}\left[\gamma^{-\sigma} R^j \left(\frac{\tau^j}{\rho\varphi P^j}\right)^{1-\sigma}\right] - f_i = 0 \end{aligned} \tag{A.8}$$

Additionally, there are N cutoff conditions that determine the firms that are indifferent between direct and indirect exports to each market:

$$\pi_x^j(\varphi_x^j) = \frac{r_x^j(\varphi_x^j)}{\sigma} - f_x^j = \pi_i^j(\varphi_x^j). \tag{A.9}$$

Combining equations (A.4) with (A.9) determines the direct export cutoff to market j:

$$\varphi_x^j = \left(\frac{\sigma f_x^j}{R^j}\right)^{\frac{1}{\sigma-1}} \frac{\tau^j}{P^j}\frac{1}{\rho}\left[1-\gamma^{-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{A.10}$$

In order to determine the sorting pattern, we need to impose an additional assumption. Without this assumption, it is possible that the direct export cutoff for a market may be smaller than the (global) indirect export cutoff. This would imply that the largest and/or least costly markets receive no indirect exports. However, virtually all markets receive indirect exports in the data. We therefore focus on the scenario where the slope of the profit from aggregate indirect export to all countries is steeper than the slope of the profit from direct export to country j in the Figure 1 of Ahn, Khandelwal and Wei (2011), or:

$$\frac{1}{\sigma}\sum_{j=1}^{N}\left[\gamma^{-\sigma} R^j \left(\frac{\tau^j}{\rho P^j}\right)^{1-\sigma}\right] > \frac{1}{\sigma} R^j \left(\frac{\tau^j}{\rho P^j}\right)^{1-\sigma}, \qquad \forall j \tag{A.11}$$

This assumption is equivalent saying that the aggregate indirect profits from the remaining $N-1$ countries are enough to cover the fixed costs of exporting for that marginal firm with productivity φ_x^j. This assumption (A.11) is sufficient, but not necessary, to ensure $\varphi_x^j > \varphi_i$.

[1] We focus only on the case in which it is the least productive firms that serve domestic market only. We assume that $\pi_d(\varphi_i) > 0$ which implies that $\varphi_d < \varphi_i$.

The assumptions in the model imply the following sorting pattern: firms that lie in $[\varphi_d, \varphi_i)$ serve only the domestic market, firms between $[\varphi_i, \varphi_x^j]$ indirectly export to market j, and firms with productivity greater than φ_x^j directly serve market j.

For each market, we can now derive the aggregate direct and indirect exports. The ratio of this expression is given by

$$\upsilon^j = \frac{\text{total indirect exports to market } j}{\text{total direct exports to market } j} = \frac{\int_{\varphi_i}^{\varphi_x^j} r_{int}^j(\varphi)dG(\varphi)}{\int_{\varphi_x^j}^{\infty} r_x^j(\varphi)dG(\varphi)} \tag{A.12}$$

$$= \frac{\gamma^{1-\sigma}\int_{\varphi_i}^{\varphi_x^j} \varphi^{\sigma-1}dG(\varphi)}{\int_{\varphi_x^j}^{\infty} \varphi^{\sigma-1}dG(\varphi)} = \gamma^{1-\sigma}\left(\frac{\int_{\varphi_i}^{\infty} \varphi^{\sigma-1}dG(\varphi) - \int_{\varphi_x^j}^{\infty} \varphi^{\sigma-1}dG(\varphi)}{\int_{\varphi_x^j}^{\infty} \varphi^{\sigma-1}dG(\varphi)}\right)$$

$$= \gamma^{1-\sigma}\cdot\left(\frac{Z(\varphi_i)}{Z(\varphi_x^j)} - 1\right) \tag{A.13}$$

where $r_{int}^j(\varphi) = p_i^j(\varphi)q_i^j(\varphi)$ and $Z(a) = \int_a^{\infty} \varphi^{\sigma-1}dG(\varphi)$ with $Z'(a) < 0$.

This expression makes it easy to evaluate how the share of indirect exports varies with market characteristics. Note that the global fixed cost of intermediation implies φ_i is common across destination markets, and thus indirect exports share depends only on market specific direct export cutoff, φ_x^j. We summarize the relationship in the following result

Claim 1 *All else equal, the share of exports through intermediaries is larger in countries with (i) smaller market size, (ii) higher variable trade costs, or (iii) higher fixed costs of exporting.*

To show that this claim holds, consider two markets j and k. It follows immediately from equation (A.10) that: (i) all else equal, if $R^j > R^k$ then $\varphi_x^j < \varphi_x^k$, which implies that $\upsilon^j < \upsilon^k$; (ii) all else equal, if $\tau^j > \tau^k$ then $\varphi_x^j > \varphi_x^k$, which implies that $\upsilon^j > \upsilon^k$; (iii) all else equal, if $f_x^j > f_x^k$ then $\varphi_x^j > \varphi_x^k$, which implies that $\upsilon^j > \upsilon^k$.

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