Outsourcing with Home Bias and Trade Policy*

Hitoshi Sato†
IDE and Hiroshima University
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Abstract

This paper examines a simple model of outsourcing involving matching frictions and home bias in firms’ acquisition of intermediate goods. Two groups of seller firms—local sellers and foreign sellers—may face different degrees of search frictions even though they are identical in terms of productivity. Two groups of buyer firms are considered: one group accepts local and foreign sellers equally, whereas the other group accepts only local sellers and never acquires intermediate goods from foreign sellers (communication with foreign sellers may be too costly for this group). The existence of buyers whose demand is biased toward locally produced intermediate goods allows unbiased buyers to exploit foreign sellers. Though only few buyers have biased demand, the entry of foreign sellers would be greatly deterred. In such an environment, the home government may adopt rent-shifting trade policies rather than mitigate production inefficiency caused by the home bias.

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†Institute of Developing Economies (IDE-JETRO), 3-2-2 Wakaba, Mihama-ku, Chiba 261-8545, Japan. E-mail: hitoshi.sato@ide.go.jp
1 Introduction

Trade in intermediate goods is renowned to form a substantial portion of international trade. Particularly, against the backdrop of fragmentation in international production, the recent trend of rising trade in intermediate goods has attracted academic interest from various perspectives. Among them, the determination of firms’ boundaries in international trade has been intensively studied following a seminal work by Antrás (2003). Particularly, combined with within-sector heterogeneity (Melitz, 2003), patterns of firms’ self-sorting into internationalization modes, such as in-house offshoring (foreign direct investment) and foreign outsourcing, have been both theoretically and empirically elucidated.\footnote{Theoretical contributions includes studies by Antrás and Helpman (2004) and Antrás and Helpman (2008). Tomiura (2007) offered one of the earliest empirical studies investigating the pattern of heterogeneous firms’ internationalization. Using Japanese firm-level data, he revealed that firms that choose foreign outsourcing tend to have greater productivity than non-internationalization firms but lower productivity than firms that select in-house offshoring. These findings are largely consistent with theoretical predictions by Antrás and Helpman (2004) and Antrás and Helpman (2008).} Another strand of trade literature addresses labor market implications of trade in intermediate goods. Feenstra and Hanson (1999) examined production fragmentation in a North-South trade framework and argued that skill premiums would rise in both the North and the South through vertical production sharing between the economies. Grossman and Rossi-Hansberg (2008) developed a model of task trade and considered the consequences of foreign outsourcing.

An important but relatively unexamined question concerns the implications of trade in intermediate goods for trade policy. A notable exception is Antrás and Staiger (2012), who highlighted international holdup problems between producers of final goods and those of intermediate goods. International holdup problems occur because relation-specific investments are necessary in an environment of imperfect contracts. According to Antrás and Staiger (2012), trade policy, including trade agreements, can mitigate the inefficiency caused by the international holdups.

This study attempts to address the abovementioned question, and originates in two empirical facts. First, relation-specific transactions, rather than anonymous market transactions, prevail in the trade of intermediate goods because they are highly likely to be customized according to buyers’ needs. Second, only a portion of firms uses imported intermediate inputs (even within a narrowly defined industry). This study presents a simple model of outsourcing featuring matching frictions and a home bias in the acquisition of intermediate goods. The model comprises two types of seller firms—local and foreign.
sellers—and two types of buyer firms—buyers who acquire intermediate goods only from local sellers (buyers with home bias) and buyers who are indifferent between local and foreign sellers (buyers without home bias). As demand by some buyers is home-biased, the two types of sellers, each of which randomly searches for a buyer, may face different degrees of search frictions despite all sellers being identical in terms of productivity. The existence of buyers with biased demand allows buyers with unbiased demand to exploit foreign sellers.

The model predicts that the entry of foreign sellers will be greatly deterred though only a small group of buyers have biased demand (refuse to purchase from foreign sellers). However, interestingly, the home government has an incentive to reduce search costs and/or encourage buyers to purchase from foreign as well as local sellers, as buyers can shift rents from the foreign country by importing the intermediate goods.

Another interesting finding is that a home biased in the demand for the intermediate goods reduces production efficiency as well as search costs. However, the home government may adopt rent-shifting trade policies rather than mitigates the negative production effect from home bias. The model’s predictions are quite similar to the inefficiency caused by a large economy’s manipulation of terms-of-trade through tariffs (Bagwell and Staiger (2002)). Thus, the model identifies a novel reason why two countries may have an incentive to cooperate in mitigating the inefficiency caused by matching frictions and home bias in the acquisition of intermediate inputs.

The rest of the paper is organized as follows. Section 2 presents a base model to examine the effects of matching frictions and the home bias in the acquisition of intermediate goods. Section 3 places the base model in an international trade setting and examines the welfare implications of the base model. Section 4 summarizes results from the base model and concludes with directions for future research.

2 The Base Model

This section presents a simple model of outsourcing, in which producers of a final good are allowed to acquire an intermediate good from either domestic or foreign suppliers.\footnote{Herein, “outsourcing” is defined as per the definition that seems to have become standard: “the acquisition of goods or services from an unaffiliated party ..., and independently of whether the unaffiliated supplier is located at home or abroad” (Helpman (2011)).} Although the model is rudimentary and employs several assumptions, it identifies the salient features of about the purchase price of the intermediate goods when matching frictions
exist between producers of final goods and suppliers of intermediate goods and when final producers of final goods are biased toward domestically supplied intermediate goods (home bias).

2.1 Setup

To construct a simple trade model that incorporates matching frictions and biased procurement of the intermediate goods, an equilibrium search framework developed by Black (1995), who examined labor market discrimination, is used. The framework is applied to a two-country trade model in which final goods producers may use domestically produced or imported intermediates. Consider a production sector that contains many producers of final and intermediate goods. Each producer of final goods (buyer) must purchase one unit of an intermediate good from its producer (seller). Two types of buyers are assumed: Type-1 buyers acquire the intermediate goods only from “local” sellers (d-sellers) and never from “foreign” sellers (f-sellers). Type-2 buyers are indifferent between domestic and foreign sellers and buy the intermediate goods from d-sellers or f-sellers.

Besides transportation costs, firms have several reasons for avoiding imported intermediate inputs. When firms require intermediate inputs that must be customized or modified to fit their needs, they need capable intermediate goods producers who are induced to make relation-specific investments (Grossman and Helpman, 2005). In the literature on intra-sectoral heterogeneity, the costs of forming business-to-business relationships are reduced to fixed costs, facilitating the sorting of firms according to modes of procurement, including domestic sourcing, foreign outsourcing, and sourcing from foreign affiliates (Antràs and Helpman, 2004, 2008; Kasahara and Lapham, 2013). Essentially, only sufficiently productive firms can cover these fixed costs and select foreign sourcing. In addition to firms’ productivity, managers’ personal characteristics, such as familiarity with foreign markets and attitudes toward risk, may affect decisions concerning foreign sourcing (Todo and Sato, 2014).\(^3\) It is assumed that the share of type-1 buyers is exogenously given by \(\theta\) in the base model, and \(\theta\) serves as an index of the degree of home bias in the acquiring intermediate goods. A latter section covering the extensions of the base model will discuss heterogeneity in form productivity.

The intermediate goods market is imperfect in that sellers must seek buyers, and their

\(^3\)Todo and Sato (2014) argued that the personal characteristics of a firm’s president can influence its decision to sell its goods in foreign markets. However, the same logic is applicable to decisions about acquiring intermediate inputs from foreign markets.
search is accompanied by a fixed flow search cost, \( F_s \). Further, we assume that information about the types of buyers is private and that sellers’ searches are random. Hence, each seller has probability \( \theta \) of being matched to a type-1 buyer.\(^4\) It is assumed that when a seller is matched to a buyer, the pairwise match quality, \( \alpha \), is revealed to the seller. The match quality affects the quality of the intermediate goods and augments the value of the final output by \( \alpha \) such that one unit of the final good earns the revenue \( p(1 + \alpha) \) where \( p \) is the (quality-exclusive) price of the final good. The match quality \( \alpha \in [0, \bar{\alpha}] \) is randomly drawn from the commutative distribution function \( G(\alpha) \). We assume that although \( G(\alpha) \) is public knowledge, the realized match quality is the seller’s private information until the final goods are sold.\(^5\) Furthermore, we assume that information about the types of buyers is private and that sellers’ searches are random. Hence, each seller has probability \( \theta \) of finding a type-1 buyer.

Knowing \( G(\alpha) \), the buyer offers a purchase price, \( v + \alpha p \), to the seller on a take-it-or-leave-it basis. The revenue sharing rule that the buyer relinquishes the entire match premium, \( \alpha p \), to the seller is merely for maintaining the model’s tractability. This sharing rule does not qualitatively affect the model’s predictions. When match quality, \( \alpha \), is high, the seller is likely to accept a lower purchasing price, which increases the buyer’s share, \( p - v \). Thus, the buyer can benefit from high match quality. Denoting the search value for the seller by \( V_s \), the seller accepts the buyer’s price offer only when \( v + \alpha p \geq V_s \). If the seller accepts the offered price, the production of the final good occurs immediately. Otherwise, the seller continues to search for a new buyer. No separation will occur after production of the final good commences.

### 2.2 The Bellman Equations for Sellers

Letting \( v_i^j \) be the price that type-\( i \) buyers, \( (i = \{1, 2\}) \), offer to type \( j \)-sellers, \( (j = \{d, f\}) \), the search value for a local seller, \( V_s^d \), is given by

\[
V_s^d = \theta \mathbb{E} \max\{v_1^d + \alpha p, V_s^d\} + (1 - \theta) \mathbb{E} \max\{v_2^d + \alpha p, V_s^d\} - F_s. \tag{1}
\]

The local seller accepts the offer only when \( v_i^d + \alpha p \geq V_s^d \) holds. Denoting the lowest quality level at which the local seller marginally accepts buyer \( i \)'s offer by \( \alpha_i^d = (V_s^d - v_i^d)/p \),

\(^4\)That sellers search for buyers is an assumption to simplify the model. It is more likely that buyers and sellers seek each other. Later, a model extension in this direction will be pursued by introducing a standard matching function a la, for example, Pissarides (2000).

\(^5\)Match quality \( \alpha \), or the relation-specific quality of the intermediate goods, may be observable to both buyers and sellers. However, we here assume that the quality is unverifiable—at least at the contract stage.
Equation (1) can be arranged as follows:

$$\theta \int_{\alpha_1^d}^{\infty} (v_1^d + \alpha p - V_s^d) dG(\alpha) + (1 - \theta) \int_{\alpha_2^d}^{\infty} (v_2^d + \alpha p - V_s^d) dG(\alpha) = F_s,$$  \hspace{1cm} (2)

which implies that the local seller finds its threshold match qualities with which the net expected gain from forming a match with a buyer equals the fixed per-period search cost.

The search value for a foreign seller is similarly defined; however, the foreign seller can obtain a price offer at probability $1 - \theta$. The search value for the foreign seller, $V_s^f$, is given by

$$V_s^f = \theta V_s^f + (1 - \theta) E \max\{v_2^f + \alpha p, V_s^f\} - F_s.$$  \hspace{1cm} (3)

Using the threshold match quality, $\alpha_2^f$, at which the seller marginally accepts the offer, Equation (3) is rewritten such that

$$\int_{\alpha_2^f}^{\infty} (v_2^f + \alpha p - V_s^f) dG(\alpha) = \frac{F_s}{1 - \theta}.$$  \hspace{1cm} (4)

Equation (4) has exactly the same interpretation as Equation (2). However, the foreign seller’s search cost is appropriately discounted by the degree of type-1 buyers’ home bias in acquiring intermediate goods.

2.3 Buyers’ Optimization

Type-$i$ buyer matched to $j$-seller earns expected profits $\pi_i^j$ such that

$$\pi_i^j = [1 - G(\alpha_i^j)](p - v_i^j), \quad i = \{1, 2\} \quad \text{and} \quad j = \{d, f\}.$$  \hspace{1cm} (5)

Recall that the threshold match quality is given by $\alpha_i^j = (V_s^j - v_i^j)/p$. The (quality-exclusive) price of the final goods, $p$, is assumed to be exogenous. Setting a low $v_i^j$ increases the buyer’s profit share, $p - v_i^j$, but reduces the probability that the seller accepts the offered price. Buyer $i$ sets $v_i^j$ to maximize expect profits $\pi_i^j$, and the first-order conditions (FOCs) are given by

$$v_i^j = p \left[1 - m(\alpha_i^j(v_i^j))\right],$$  \hspace{1cm} (6)

where

$$m(\alpha) \equiv \frac{1 - G(\alpha)}{g(\alpha)}$$

is the inverse of the hazard function. We assume that $m(\alpha)$ is strictly decreasing in $\alpha$, which is satisfied for many distributions including the uniform, the normal, and the gamma
distributions. The assumption of \( m'(\alpha) < 0 \) is sufficient for satisfying the second-order condition.\(^6\)

Consider the FOCs related to local sellers. They are

\[
v^d_1 = p \left[ 1 - m \left( \frac{V^d_s - v^d_1}{p} \right) \right], \quad \text{and} \quad v^d_2 = p \left[ 1 - m \left( \frac{V^d_s - v^d_2}{p} \right) \right],
\]

respectively, and reveal that both types of buyers have the same form of FOCs. Therefore, the offered price that local sellers receive does not depend on buyers’ types, namely, \( v^d_1 = v^d_2 \). Therefore, the threshold match quality for local sellers, \( \alpha^d \), does not depend on the types of buyers (i.e., \( \alpha^d_1 = \alpha^d_2 \)).

### 2.4 Equilibrium

Buyer’s FOCs for local sellers imply that both types of buyers offer the same price to local sellers; consequently, local sellers’ threshold match qualities are also the same, irrelevant to which type of burets they are matched. Thus, Equation (2) can be simplified as follows:

\[
\int_{\alpha^d}^{\infty} (v^d + \alpha p - V^d_s) dG(\alpha) = F_s.
\]

This equation implies that the share of the type-1 firms, \( \theta \), does not affect the search value for local sellers, \( V^d_s \). This result is intuitive because both types of buyers are indifferent between local and foreign sellers.

The model contains four unknowns: two equilibrium purchasing prices (\( v^d \) and \( v^f \)) and two search values (\( V^d_s \) and \( V^f_s \)). Equations (4), (6), and (8) simultaneously determine these four variables. Totally differentiating Equation (6), we obtain

\[
\frac{dV^d_s}{dv^d_i} = \frac{m'(-1)}{m'(-1)} > 1.
\]

Likewise, totally differentiating Equations (4) and (8) generates

\[
\frac{dV^f_s}{dv^f_i} = 1.
\]

In a \((v^d_i, V^d_s)\) space, buyers’ FOCs have a slope greater than unity (Equation (9)), whereas sellers’ Bellman equations have a slope equal to unity (Equation (10)). Therefore, the four unknown variables are uniquely determined. Furthermore, \( dV^f_s/d\theta < 0 \) holds for all \( v^f_2 \). Thus, the case is \( v^f_2 < v^d_2 \) and \( V^f_s < V^d_s \): i.e., compared to local sellers, foreign sellers receive lower price offers from type-2 buyers and, concomitantly, have lower search values.

\(^6\)Second-order conditions are given by \(-1 + m'(\alpha_i) < 0\). Thus, \( m'(\alpha) < 0 \) is a sufficient condition for assuring that the expected profits in Equation (5) are concave.
2.5 Analytical Solution

To facilitate the analysis, the model is solved by applying a uniform distribution to the cumulative distribution function (cdf) of match quality, $G(\alpha)$. Specifically, it is assumed that match quality follows $\alpha \sim U(0, \bar{\alpha})$, where $\bar{\alpha} \geq 1$ is assumed. It is necessary to restrict the model’s parameters to allow threshold match qualities to take to take certain values within this domain.

**Assumption 1.**

The (effective) per-period fixed search cost is limited by

$$\frac{F_s}{1 - \theta} < \frac{\bar{\alpha}p}{2}. \quad (11)$$

As shown in Equation (4), $F_s/(1-\theta)$ can be interpreted as the effective (per-period) fixed search cost when a seller may encounter a buyer who will not acquire the intermediate goods from the seller at probability $\theta$. As shown later, as the search costs increase, sellers tend to lower the threshold match quality to increase the probability of a successful match. Thus, to avoid negative threshold match qualities, this assumption warrants that the effective search cost, $F_s/(1-\theta)$, is no greater than the average of match premium, $\bar{\alpha}p/2$.

The detailed derivation is provided in the Appendix: the model’s solutions are as follows.

The (match-premium exclusive) price that type-2 buyers offer foreign sellers is given by

$$v_f^2 = p - \sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}. \quad (12)$$

The threshold match quality, $\alpha_f^2$, is given by

$$\alpha_f^2 = \bar{\alpha} - \sqrt{\frac{2\bar{\alpha}F_s}{p(1 - \theta)}}. \quad (13)$$

The search value for a foreign seller is

$$V_f^s = p(1 + \bar{\alpha}) - 2\sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}, \quad (14)$$

and the expected profits of a buyer matched with a foreign seller is given by

$$\pi_f^2 = \frac{2F_s}{1 - \theta}. \quad (15)$$

The counterpart variables for local sellers, such as $v^d$, $\alpha^d$, $V^d_s$, and $\pi^d$, are easily obtained by setting $\theta = 0$ for Equations (12), (13), (14), and (15), respectively.
Several things should be noted. First, both \( v^d \) and \( v^f_2 \) decrease as \( F_s \) increases, and the revenue share for buyers increases regardless of whether they acquire the intermediate goods from local sellers or from foreign sellers. As an extreme case, suppose that \( F_s = 0 \). Then, \( v^d = v^f_2 = p \). Intuitively, when \( F_s \) is 0, a seller continues to search until it finds a buyer who offers the highest possible price, \( p \), and will earn \( p(1 + \alpha) \) in total. The seller can obtain all revenues, leaving the buyer with nothing. Buyers can exert monopsony power over sellers only if \( F_s \) is non-zero, and the monopsony power increases as the search cost \( F_s \) increases. By contrast, suppose that \( F_s = 0 \). The home bias for intermediate goods does not matter for foreign sellers in this case. Only when search costs exist (i.e., non-zero \( F_s \)), type-2 buyers can exploit type-1 buyers’ home-biased preferences.

Second, as \( \theta \) increases, a type-2 buyer reduces the purchasing price only to a foreign seller (left panel of Figure 1).\(^7\) This is because the type-2 buyer can exploit the search friction caused by the existence of type-1 buyers, who purchase the intermediate goods only from local sellers. Foreign sellers have a lower threshold match quality than local sellers because foreign sellers face more severe search frictions than local sellers due to the buyer’s home bias in procurement. Consequently, the search value for the foreign seller decreases as \( \theta \) increases (center panel of Figure 1). A higher \( \theta \) enables type-2 buyers to earn greater expected profits because their revenue share \( p - v^f_2 \) and the probability of successful match, \( 1 - G(\alpha^f_2) \) both increase (right panel of Figure 1).

Third, as shown in Equation (15), changes in \( \bar{\alpha} \) do not affect buyers’ expected profits. However, because \( \frac{\partial v^f_2}{\partial \bar{\alpha}} > 0 \), an increase in \( \bar{\alpha} \) raises sellers’ search values (see the Appendix for the formal derivation). An increase in \( \bar{\alpha} \) can be interpreted as a technological improvement, which has two effects: buyers can lower \( v^j_i \) because the expected value of \( \alpha p \) increases. Although a decreased \( v^j_i \) raises the profit share for buyers, sellers also raises the threshold match quality, which in turn reduces the probability of a successful match. Thus, these two effects of a technological improvement cancel each other, and concomitantly, expected profits \( \pi_{ij} \) are independent from technological changes.

Fourth, the final goods price \( p \) does not affect buyers’ expected profits. The logic is the same as that for the fact that changes in \( \bar{\alpha} \) do not affect buyers’ expected profits. An increase in \( p \) raises the revenue share for buyers, \( p - v^j_i \), but lowers the threshold match

\(^7\)Figure 2 presents comparative statics of purchase prices, search values, and buyers’ profits with respect to the ratio of type-1 buyers, \( \theta \). The price of the final good \( p \) is set as 6 and the search cost \( F_s \) as 0.3. The match quality \( \alpha \) is assumed to follow a uniform distribution with the support between 0 and 1. The intrinsic quality of intermediate goods is normalized to unity.
quality, $\alpha_i^j$, which leads to a lower successful match probability. The size of these positive and negative effects is equal. Thus, buyers’ expected profits are intact when the final goods price changes.

Fifth, we show the expected number of buyers for whom a foreign seller searches until a successful match is formed. The number of buyers for whom a foreign seller searches, $s^f$, is given as the inverse of the successful match probability, i.e., $[(1 - \theta)(1 - G(\alpha^f_2))]^{-1}$:

$$s^f = \frac{\alpha p}{2F_s(1 - \theta)}. \quad (16)$$

The expected number of buyers for whom a local seller must search before successful matching is obtained by setting $\theta = 0$. Equation (16) suggests that the expected number of searches by a foreign seller exceeds that of a local seller. Thus, holding all other things constant, foreign sellers have a lower match probability than local sellers.\(^8\) As expected, an increase in $\bar{\alpha}$ or $p$, which raises sellers’ search values, reduces the match probability because sellers become willing to wait to draw a higher-match quality. An increase in $F_s$ has an opposite effect, and an increase in $\theta$ enlarges the match probability dispersion across (the two types of) sellers.

The differences in matching consequences across foreign and local sellers and their welfare implications can be summarized as follows. To highlight the effect of biased buyers’ procurement behavior, foreign and local sellers are identical except for search difficulty, stemming from the fact that some buyers acquire intermediate goods only from local sellers. Buyers with unbiased procurement preferences (type-1) can exert greater monopsony power over foreign sellers than local sellers. Consequently, a buyer can earn larger profits when matched to a foreign seller than to a local seller. However, the threshold match quality for a local seller is lower than that for a local seller, which means that a buyer can raise expected profits by forming a match with a foreign seller—though production efficiency declines.

3 International Trade

In this section, I set the base model in an international trade framework to examine the effects of match frictions and home bias on national welfare.

\(^8\)This is compared to the threshold match quality for local sellers, which is low for foreign sellers, increasing the probability that a foreign seller draws an acceptable match quality (the indirect effect of $\theta$). However, some buyers never purchase from foreign sellers, which lowers foreign sellers’ probability of forming successful matches (the direct effect of $\theta$). Equation (16) implies that the direct effect of $\theta$ is always dominant.
3.1 Setup

Following Antràs and Staiger (2012), consider a world of two small countries, Home \((d)\) and Foreign \((f)\), and the large rest of the world (ROW). The role of ROW in the model is to peg the price at which a final good is available to Home and Foreign. The price of the final goods is exogenously fixed at \(p\). It is assumed that Home is inhabited by a unit measure of producers of the final goods (i.e., buyers in the base model) and \(N^d\) of producers of the intermediate goods (i.e., local sellers in the base model). Foreign is inhabited by \(N^f\) of producers of the intermediate goods (i.e., foreign sellers in the base model). The measure \(\theta\) of buyers are type-1 who purchase the intermediate good from only local sellers, and the measure \(1 - \theta\) of buyers are type-2, who purchase the intermediate good from local and foreign sellers.

Home and Foreign consumers have identical preferences that take a quasi-linear form such that

\[
U^j = q^j_0 + u(q^j), \quad j = \{d, f\},
\]

where \(q^j_0\) represents consumption of the numeraire good and \(q^j\) is consumption of the final goods in Home \((j = d)\) and Foreign \((j = f)\). The subutility function \(u(\cdot)\) satisfies \(u' > 0\) and \(u'' < 0\). As is standard, the numeraire good is assumed to be traded without trade costs and is available in sufficient quantities so that Home and Foreign consumers always consume it in positive quantities. Under this utility function, all general equilibrium forces are absorbed by the numeraire sector.

The measure of social welfare in each country is given by consumer surplus plus profits (plus trade tax revenue if it is applied). Country \(j\)'s demand for final goods is given by \(q(p^j) = u'^{-1}(p^j)\), with consumer surplus defined as \(CS^j \equiv \int_{p^j}^{\bar{p}} q(p)dp\), where \(\bar{p}\) is the price at which country \(j\)'s demand for the final goods disappears.

To obtain the profits earned by buyers, first consider a type-1 buyer’s expected profits. Dividing the total number of searches by local sellers by the total mass of buyers (which is equal to unity) gives the probability of encountering a local seller, \(N^d s^d\). Similarly, the probability of encountering a foreign seller is \(N^f s^f\). Therefore, a type-1 buyer earns expected profits

\[
\Pi_1 = N^d s^d \pi^d,
\]

and a type-2 buyer earns

\[
\Pi_2 = N^d s^d \pi^d + N^f s^f \pi^f.
\]
As the mass of type-1 buyers is $\theta$ and that of type-2 buyers is $1 - \theta$, aggregate profits earned by buyers in the home country are given by

$$\theta \Pi_1 + [1 - \theta] \Pi_2. \quad (20)$$

Sellers’ profits are measured by their search value, $V_s^j$. Under free trade, so long as $V_s^f \geq 0$, Foreign sellers search for buyers in Home. We assume that this condition holds.\(^9\) Home welfare under free trade is given by

$$W^d = CS^d(p) + \theta \Pi_1 + [1 - \theta] \Pi_2 + N^d V_s^d, \quad (21)$$

whereas the counterpart for Foreign is given by

$$W^f = CS^f(p) + N^f V_s^f. \quad (22)$$

### 3.2 Welfare

#### 3.2.1 No Matching Frictions

To clarify the model’s structure, the welfare analysis is commenced with an extreme case: there are no match frictions—i.e., $F_s = 0$. As argued in the previous section, buyers offer all revenues to sellers, and sellers’ threshold match quality is $\bar{\alpha}$. Thus, $v_i^j = p$ for all $i$ and $j$ (namely, $\pi_j^i = 0$), and $V_s^j = p(1 + \bar{\alpha})$. Each country’s welfare is given by

$$W^d = CS^d(p) + N^d p(1 + \bar{\alpha}) \quad (23)$$

$$W^f = CS^f(p) + N^f p(1 + \bar{\alpha}) \quad (24)$$

Without search frictions, all profits belong to producers of the intermediate goods (sellers). World aggregate welfare under free trade is

$$W^d + W^f = CS^d(p) + CS^f(p) + (N^d + N^f) p(1 + \bar{\alpha}), \quad (25)$$

which is the highest possible welfare level.

\(^9\) When $\bar{\alpha} = 1$, the condition that $V_s^f \geq 0$ is equivalent to Assumption 1 (except for equality). Thus, foreign sellers always exist in Home under free trade. However, if $\bar{\alpha} > 1$, the condition of $V_s^f \geq 0$ is more strict than Assumption 1.
3.2.2 Matching frictions without home bias

Next, consider the case in which \( F_s > 0 \), but \( \theta = 0 \): there are search frictions \((F_s > 0)\) while all buyers are type-2 \((\theta = 0)\) and there is no home bias. In this case, \( s^d = s^f = \sqrt{\alpha p / 2F_s} \) and \( \pi^d = \pi^f = 2F_s \). Hence, home buyers’ total profits are \( \Pi_2 = (N^d + N^f) \sqrt{2\alpha p F_s} \).

The search value is identical between local and foreign sellers and given by \( V^d = V^f = p(1 + \bar{\alpha}) - 2\sqrt{2\alpha p F_s} \). Therefore, social welfare is given by

\[
W^d = CS^d(p) + N^d p(1 + \bar{\alpha}) + (N^f - N^d) \sqrt{2\alpha p F_s},
\]
\[
W^f = CS^f(p) + N^f \left[ p(1 + \bar{\alpha}) - 2\sqrt{2\alpha p F_s} \right].
\]

World aggregate welfare is given by

\[
W^d + W^f = CS^d(p) + CS^f(p) + (N^d + N^f) \left[ p(1 + \bar{\alpha}) - \sqrt{2\alpha p F_s} \right].
\]

Three points are noteworthy. First, search costs reduce production efficiency, and consequently, world aggregate welfare declines compared to the case without matching frictions—see Equations (25) and (28). This occurs because the threshold match quality declines through search frictions \((\alpha^d_i = \bar{\alpha} - \sqrt{2\alpha F_s / p})\). Second, search frictions shift profits from Foreign to Home. This occurs because Home buyers have monopsony power over Foreign sellers. If \( N^f > N^d \), Home’s aggregate welfare is larger than that without matching frictions. Third, if the search cost, \( F_s \), is too high, Foreign sellers will earn negative profits and will not enter Home’s market (no international trade in the intermediate goods). Therefore, if Home’s government can reduce the search cost, it obviously has an incentive to do so. The chosen level of the search cost is the level which exactly realizes \( V^f_s = 0 \).

3.2.3 Matching frictions with home bias

Consider the case in which \( \theta > 0 \). The expected profits earned by Home buyers are given by \( \theta \Pi_1 + (1 - \theta) \Pi_2 = N^d \sqrt{2\alpha p F_s} + N^f \sqrt{2\alpha p F_s / (1 - \theta)} \). Local suppliers gain \( N_d V^d_s = N_d p(1 + \bar{\alpha}) - 2\sqrt{2\alpha p F_s} \). Therefore, aggregate welfare is

\[
W^d = CS^d(p) + N^d \left[ p(1 + \bar{\alpha}) - \sqrt{2\alpha p F_s} \right] + N^f \sqrt{2\alpha p F_s / (1 - \theta)},
\]
\[
W^f = CS^f(p) + N^f \left[ p(1 + \bar{\alpha}) - 2\sqrt{2\alpha p F_s / (1 - \theta)} \right].
\]
World aggregate welfare is

\[ W^d + W^f = CS^d(p) + CS^f(p) + (N^d + N^f)p(1 + \bar{\alpha}) - N^d\sqrt{2\alpha pF_x} - N^f\sqrt{\frac{2\alpha pF_x}{1 - \theta}} \]  (31)

In this case, Home can shift profits from Foreign even more.

4 Conclusions

This study presented a simple model of outsourcing with matching frictions and home bias in the acquisition of intermediate goods. These model’s features reflect a two-fold economic reality. First, relation-specific transactions—not anonymous market transactions—are important because intermediate inputs are highly likely to be customized to buyers’ needs. Hence, final goods producers or intermediate goods producers must search for appropriate counterparts. Second, only a portion of firms uses imported intermediate inputs (even within a narrowly defined industry).

Regardless of its simplicity, the model yields interesting results about outsourcing. First, when sellers of intermediate goods incur search costs, buyers have monopsony power over the sellers and can increase their revenue share. The revenue allocation between a buyer and a seller does not affect aggregated welfare if transactions of the intermediate goods are limited within an economy. However, in the case of foreign outsourcing, search costs provide the opportunity to shift rents from the sellers’ country to the buyers’ country. Second, the search costs reduce production efficiency not because they use production inputs but because sellers tend to accept lower match quality. Third, buyers’ home bias toward locally-produced intermediate goods enhances buyer’s monopsony power over foreign sellers. Due to production inefficiency and reduced revenue share, foreign intermediate goods sellers (and the foreign country) suffer from lower profits. Compared to the case of matching frictions without home bias, buyers (and the home country) can further increase welfare, and the world aggregate welfare falls.

These observations imply that the government of the country that is a net importer of the intermediate goods has an incentive to import intermediate inputs to the extent to which foreign sellers earn zero profits from the home intermediate goods market. To attain such a level of imports, the government may reduce search costs or encourage firms to use imported intermediate goods. However, the base model proposed herein suggests that the level of imports is too low from the viewpoint of world welfare.
The model in this study suggests several directions for future research. First, the model is highly specific yet provides ample room for generalization. For example, the mass of sellers is exogenously given in the base model. Ideally, it should be endogenously determined. This generalization will pave the way to introduce firm heterogeneity and improve the predictions about the exports of intermediate goods. Second, the base model considers an asymmetric setting in which buyers are located only in the home country. This specification is convenient to highlights the model’s mechanism and its welfare consequences. However, to address the issue of trade policy, it is necessary to consider both asymmetric and symmetric country cases. These extensions will be studied in the future.
References


Figure 1: Effects of $\theta$ on purchasing price, search value, and buyers’ expected profits
A Analytical Solution for the Base Model

Suppose that match quality $\alpha$ is distributed according to the uniform distribution with range in $[0, \bar{\alpha}]$. With this distribution, the inverse of the hazard function is given by $m(\alpha) = \bar{\alpha} - \alpha$.

The FOCs for buyers in Equation (6) are expressed by

$$v_i^j = p(1 - \bar{\alpha} + \alpha_i^j). \quad (A.1)$$

Using the fact that the threshold match quality is $\alpha_i^j = (V^j_s - v_i^j)/p$, the FOCs are rearranged as follows:

$$V^j_s = 2v_i^j - p(1 - \bar{\alpha}). \quad (A.2)$$

Next, the expression for the search value in Equation (4) is given by

$$\frac{[V^f_s - v_2^f]^2}{2p} - \bar{\alpha}[V^f_s - v_2^f] + \frac{\bar{\alpha}^2p}{2} = \frac{\bar{\alpha}F_s}{1 - \theta}.$$ \quad (A.3)

Equation (A.3) is a quadratic equation with respect to $V^f_s - v_2^f$, and its solution is given by

$$V^f_s - v_2^f = \bar{\alpha}p \pm \sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}, \quad (A.4)$$

from which we choose the model’s solution such that

$$V^f_s - v_2^f = \bar{\alpha}p - \sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}, \quad (A.5)$$

because $[V^j_s - v_2^j]/p = \alpha_i^j \in [0, \bar{\alpha}]$.

Equations (A.1) and (A.5) determine $v_2^f$ and $V^f_s$ as follows:

$$v_2^f = p - \sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}, \quad (A.6)$$

and

$$V^f_s = p(1 + \bar{\alpha}) - 2\sqrt{\frac{2\bar{\alpha}pF_s}{1 - \theta}}. \quad (A.7)$$

Hence, the threshold match quality, $\alpha_2^f$, is given by

$$\alpha_2^f = \frac{V^f_s - v_2^f}{p} = \bar{\alpha} - \sqrt{\frac{2\bar{\alpha}F_s}{p(1 - \theta)}}. \quad (A.8)$$

For $\alpha_2^f$ to take appropriate values, the following parameter restriction is imposed:

$$\frac{\bar{\alpha}p}{2} > \frac{F_s}{1 - \theta}. \quad (A.9)$$
which implies that the effective search cost, $F_s/(1 − \theta)$, is no greater than the simple average of match premium $\bar{\alpha} p/2$.

Another important condition is $V_s^f \geq 0$, which is equivalent to

$$\frac{F}{1−\theta} \leq \frac{(1+\bar{\alpha})^2p}{8\bar{\alpha}}.$$  \hspace{1cm} (A.10)

The counterpart variables for local sellers can be obtained by simply setting $\theta = 0$ in Equations (A.6), (A.7), and (A.8).

The buyer firms’ expected profits are given by

$$\pi^f_j = [1−G(\bar{\alpha}^f)](p−v^f_j) = \sqrt{2F_s\bar{\alpha}(1−\theta)} \sqrt{2\bar{\alpha} p F_s(1−\theta)} = \frac{2F_s}{1−\theta}$$  \hspace{1cm} (A.11)

**B  The effect of technological improvement**

From Assumption 1, we have

$$p^2 > \frac{2p F_s}{\bar{\alpha}(1−\theta)}.$$  \hspace{1cm} (B.1)

Partially differentiate $V_s^f$ with respect to $\bar{\alpha}$ yields

$$\frac{\partial V_s^f}{\partial \bar{\alpha}} = p - \left(\frac{2p F_s}{1−\theta}\right)^{-0.5} \left(\frac{2p F_s}{1−\theta}\right)$$

$$= p - \sqrt{\frac{2p F_s}{\bar{\alpha}(1−\theta)}} > 0$$  \hspace{1cm} (B.2)

where the last inequality comes from (B.1).