Information Costs and Networks in International Trade

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Abstract

This paper discusses the impact of information costs on the organisation of international trade. The conditions under which trade is organized through an information intermediary, the incentives for network building and the implications for trade volumes are analysed using a stylised model. The model illustrates how information barriers can affect the way trade is organised. The model shows how direct trade through search and indirect trade through an information intermediary can coexist in equilibrium. The framework is employed to discuss the effects of information and communication technology improvements on the organization of international trade. Results suggest that for a range of parameter values improvements in information technology, such as access to the Internet, can strengthen the incentives for network building by information intermediaries, increasing trade volumes traded indirectly through the network and raising world welfare. Moreover, direct ties between certain traders are introduced to reflect the operation of an ethnic network of traders, which can be shown to crowd out intermediation.

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1 Introduction

An aspect of international trade that has yet to be explored in depth is the extent to which costly information affects the way international trade is organized. Trade transactions may occur directly between traders or through trade intermediaries. This paper examines how information costs associated with identifying a suitable trading partner, and the resulting uncertainty in forming a trade match, can provide profitable opportunities for intermediaries to build information networks and fulfill a matching function.

A common feature across the theoretical trade literature, ranging from traditional trade models of comparative advantage to the more recent New Trade Theory, is that agents operate under perfect information. Economic agents are assumed to have perfect information regarding goods and factor prices around the world as well as different product characteristics and technologies. Consequently, all trade opportunities, arising through different mechanisms in each of the different types of models, are exploited as soon as they arise and resources are allocated efficiently.

In practice, economic agents have imperfect information regarding the world economy in which they operate. Resources are required for information acquisition and trading decisions are sometimes taken under imperfect information. Producers need to conduct market research in order to locate opportunities in other markets. Moreover, they need to ensure their goods conform to quality standards and other regulations in foreign markets as well as locate suitable trading partners and organise transportation and distribution. To respond optimally to trade incentives traders require information about foreign markets, prices, product characteristics, and potential trading partners. Portes and Rey (1999) point to a lack of information about international trading opportunities and identify a need to tap into ‘deep knowledge’. Unlike the efficient markets of the theoretical literature, much of trade involves a process of searching and matching for which the effective flow of information is vital. Agents need to search for suitable trading partners and communicate with them to negotiate the terms of the transaction. Incomplete information in the international market makes the matching of agents with productive opportunities difficult and prevents prices from allocating scarce resources across countries. Indeed, there is not nearly as much trade as standard models suggest there should be. Trefler (1995) finds that trade is ‘missing’ relative to the Heckscher-Ohlin-Vanek prediction by up to 50%.

Trade costs have been posited as a possible solution to Trefler’s ‘missing trade’ puzzle, as well as to the six puzzles in international macroeconomics identified by Obstfeld and Rogoff (2000). The empirical evidence points to the fact that trade costs are very large, even in the absence of formal barriers to trade such as tariffs. Anderson and van Wincoop (2003) calculate the tariff equivalent estimate for total trade barriers to be 170% from foreign produce to final user for industrialised countries where trade costs are defined to include all costs incurred in getting a good to a final user other than the production cost of the good itself. Trade costs include transportation costs, time costs, policy barriers (tariffs, non-tariff barriers, regulations), information costs (search, communication), contract enforcement costs, distribution costs as well as costs of exchanging currencies etc. There has been renewed interest in disentangling the components of trade costs to
gain a deeper understanding on how these can individually affect trade patterns, volumes and welfare. This paper explicitly focuses on the information component of trade costs and examines some of the theoretical implications for the organisation of trade.

The available evidence suggests that trade costs are high on average but also highly variable across goods and countries. Hummels (1999) provides detailed data on freight rates and found trade barriers to be very high and variable while Hummels (2001) finds that fast transport (air shipping and faster ocean vessels) is equivalent to reducing tariffs of manufactured goods from 32% to 9% between 1950-1998. A wide range of empirical studies have used proxies to try and capture the importance of information costs, communication costs and links between countries, using the gravity equation. Freund and Weinhold (2000) find an increasing and significant impact of the internet on total trade flows from 1997-1999. A 10% increase in the relative number of web hosts in one country is found to lead to about 1% greater trade in 1998 and 1999.

Fink, Mattoo and Neagu (2002) incorporate communication costs into a model of bilateral trade and find that international variations in communication costs have a significant influence on trade patterns. Moreover, the impact of communication costs on trade is larger for trade in differentiated goods, by as much as a third. Harris (1995) also finds that information and communication needs are much greater for differentiated goods and that trade in these products is likely to be more sensitive to variations in the costs of communication.

Historical ties between countries, geographical proximity as well as sharing a common language have also been found to increase bilateral trade flows. Melitz (2002) finds that a common language promotes international trade both directly and via translation and that the major European languages are more efficient than other languages in promoting trade. Diversity of tongues at home and literacy also boost foreign trade. Moreover, Rauch (1999) finds evidence that proximity, common language and colonial ties are more important for differentiated products than for products traded on organised exchanges in matching international buyers and sellers. Nevertheless, Rauch’s results imply that countries sharing linguistic and historical links trade twice as much in homogeneous goods on organised exchanges (grains, oil seeds, fuels, metals etc) as countries that do not. This evidence suggests that although trade in differentiated goods appears more sensitive to communication technology, proximity and linguistic and historical links, the importance of these for trade in homogeneous goods should not be overlooked.

Anderson and van Wincoop (2003) survey the empirical evidence on trade barriers and unbundle trade barriers into tariff-equivalent parts: 21% for transportation costs (freight costs and a 9% time tariff equivalent of the time value of goods in transit), 55%

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1 Whether the communication costs are seen to affect fixed or variable costs of trade depends on the role that communication costs are assumed to play in the transaction. If communication is primarily relevant in facilitating search for trading partners, then its costs could be seen as affecting the fixed or sunk costs of trading. This is the view take by Harris (1995) and that of Freund and Weinhold (2000) about the impact of the Internet. Fink, Mattoo and Neagu (2002) assume, however, that communication costs affect trade primarily by influencing variable costs between two nations, resulting in a gravity equation.
for retail and wholesale margins, an 8% policy barrier, a 7% language barrier, a 14% currency barrier, a 6% information barrier and a 3% security barrier (overall border barriers are 44%).

These empirical findings suggest that trade costs, in their different guises, as proxied by internet mass, communication costs, common language etc are significant in explaining bilateral trade, particularly for differentiated goods. An important question that needs to be addressed, is what is the nature of the costs that these proxies are capturing? The hypothesis is that historical and cultural ties generate more contacts between countries thereby facilitating information flow and thus trade. Moreover, geographical proximity, common language and information and communication technologies affect the ease with which new contacts can be made. This can facilitate the search for new trading opportunities, whether through direct search of through trade intermediaries.

There is a growing literature on the importance of face-to-face contact for economic relationships. Storper and Venables (2004) describe face-to-face contact as a communication technology that assists the transmission of uncodifiable information. A common language can better facilitate this information transmission. Moreover, face-to-face contact may generate trust that can facilitate the exploitation of trade opportunities in the face of contract enforcement problems. Since it is impossible to have face-to-face contact with all possible trading partners, agents are thought to rely on informal networks for information transmission. Such networks can help overcome information problems by providing market information and supplying matching and referral services.

There is considerable empirical evidence documenting the impact of ethnic and business networks on bilateral trade. Rauch and Trindade (1999) find that ethnic Chinese networks increased bilateral trade in differentiated products within Southeast Asia, between 1980 and 1990, by at least 150%. This suggests that the informal trade barriers these networks help overcome are important. Gould (1994) finds that immigration to the US increases US bilateral trade with the immigrants’ countries of origin. He identifies the establishment of business contacts as the key channel through which immigration affects trade. Finally, Ellis’ (2000) findings from 133 foreign market entries of manufacturing firms suggest that foreign market opportunities are commonly acquired via existing inter-personal links rather than collected systematically via market research.

Besides informal ethnic or business networks that facilitate trade by reinforcing direct links between individuals across countries, trade can be facilitated through intermediation. Over 95% of world trade is carried out by sea, for which almost all trade transactions include an intermediary at some stage. Trade intermediaries can serve many functions, one of which is the brokering of information. Intermediaries develop and

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2 Gould (1994) identifies another channel through increased US preferences for goods produced in the country of origin, but this is found to be of secondary importance.

3 Source: Braemer Seascope Ltd.

4 Intermediation is the term often used to describe the activities of middlemen who purchase goods from producers and then resell them. There is a broad literature on the role of middlemen: middlemen may reduce search costs in markets [Rubinstein and Wolinsky (1987), Yavas (1992)], they may lower total selling costs, they may be experts in markets with adverse selection [Biglaiser (1993)] and also guarantors of quality under producer moral hazard [Biglaiser and Friedman (1993)].

In contrast, the emphasis of this paper is on the role of intermediaries as brokers of information not
operate networks of brokers, charterers, importers, exporters and shippers in particular geographical areas or sectors, which they use to match trading partners, typically for a success fee. Rauch and Watson (2002) present some summary statistics from a Pilot survey of international trade intermediaries based in the US. Despite the small number of observations, their evidence suggests that 50% of differentiated-product intermediation does not involve taking title of goods and reselling, while the figure for homogeneous-good intermediation is only 1%. Further, 36% of the revenue of differentiated-product intermediaries is reported as coming from success fees based on the value of transactions, while the figure for homogeneous-good intermediation is only 1%. This is consistent with the search based or network view of trade, pioneered by Rauch (1999), Rauch and Trindade (1999) and others, that posits that the information requirements for differentiated goods are much greater due to the need to match specific characteristics. The evidence to date supports this, pointing to a more pronounced role of information intermediaries and ethnic networks for trade in differentiated goods.

I hope, at this stage, to have convinced the reader that the information requirements for trade are far from trivial and the implications of these for trade volumes, patterns and welfare are worthy of study. This paper builds a theoretical model to show how information costs can affect the organisation of international trade. The model shows how direct trade through search and indirect trade through an information intermediary can coexist in equilibrium. The framework is employed to discuss the effects of information and communication technology improvements and ethnic networks on the organization of international trade. The following subsection briefly reviews the theoretical literature.

1.1 The Theoretical Literature

The facilitation of trade through information-sharing networks, and the resulting implications for the pattern of trade and welfare, have only recently begun to be formally developed. Recent literature on networks in international trade [Casella and Rauch (2001)] focuses on gaining insight on how information-sharing networks among internationally dispersed ethnic minorities or business groups can overcome informal trade barriers such as inadequate information about trading opportunities and weak enforcement of international contracts [Anderson and Marcouiller (1999)].

Casella and Rauch (2001) develop a model where output is produced through a joint venture. Agents have complete information domestically but cannot judge the quality of their match abroad. Introducing a subset of agents with social ties that have complete information in international matches with other group members is shown to increase aggregate trade and income, but hurt the anonymous market by depriving it disproportionately of the groups more productive members. The authors assume costless matching in the international market. There is lack of information about the quality of foreign matches, but the finding of a partner, albeit random, is costless. If the match fails the agents return to the domestic market, again costlessly. This model focuses on the effects of pre-existing social ties or group membership and doesn’t address the issue of contacts-building or the role of trade intermediation.

brokers of the goods themselves.
Rauch and Watson (2002) model the supply of ‘network intermediation’ where agents endogenously choose whether to be producers or intermediaries, depending on their endowment of ‘contacts’. They carry out comparative statics and welfare analysis to show that the incentives to form network intermediaries may be sub-optimal and suggest policies to encourage trading companies. Once again, the building of contacts is not modelled – agents have an endowment of contacts from a known distribution of contacts. Their emphasis lies in the endogenous choice to become an intermediary.

In another vein, Konya (2002) models the role of cultural differences in international trade by examining the incentives to study foreign cultures and languages as a means of overcoming cultural and linguistic barriers. Since learning decisions in a country generate a positive externality on trading partners, the model predicts that learning decisions are, in general, inefficient.

1.2 The Contribution of This Paper

This paper is a first step towards addressing some key questions on the research agenda for international trade that arise from empirical findings. What information barriers and costs separate nations and traders? How do information costs enter into trade costs? How can network structures help overcome these information costs and how do they affect trade and welfare? Moreover, how might improvements in information or communication technology affect the way trade is organised? How might direct links between agents, through, say, ethnic networks affect trade patterns and volume?

This paper contributes to the theoretical literature on information costs and trade by analysing the impact of information costs on the organisation of international trade. In particular, it examines the conditions under which trade is organized through an information intermediary. The intermediary’s incentives for network building are explicitly modelled as a function of information costs and other parameters. The size of the intermediary’s network is endogenously determined, as is the success fee he charges for each match. As such, the model can be used to explain the emergence of information intermediaries in the face of high information costs and to evaluate the implications for trade volumes and welfare.

Information intermediaries can be said to sell access to the network of contacts they have accumulated. As such, they fill a ‘structural hole’ between the two sides of the market, bridging the information gap\(^5\). By controlling information in this way, the intermediary can profit from matching importers and exporters.

The model shows how, with diminishing returns to network building, direct trade through search and indirect trade through an information intermediary can coexist in equilibrium. The framework is employed to discuss the effects of information and communication technology improvements on the organization of international trade. Results suggest that for a range of parameter values improvements in information technology, such as access to the Internet, can strengthen the incentives for network building by

\(^5\) The term ‘structural hole’ is a sociological term introduced by Burt (1992). It refers to an information gap which prevents two groups from coming together. An information intermediary creates value and profits by bridging a structural hole.
information intermediaries, increasing trade volumes traded indirectly through the network.

The framework easily allows the introduction of direct ties between a subset of traders. These ties may reflect a co-ethnic or business network or perhaps historical ties that allow information to flow freely between certain individuals. Either way, the result is frictionless trade for this subset of traders. Direct ties, such as those operating through a co-ethnic network are shown to generate some crowding out of intermediated trade.

The paper does not explain why countries have trade opportunities. Instead, it discusses how information costs may affect the realisation of trade transactions for a given set of trade opportunities. Moreover, transport costs and the role of geographical distance are not discussed in the model.

The paper is organised as follows. The model is presented in section 2. Diminishing returns in network building are introduced in Section 3. Co-ethnic ties are introduced in Section 4. Section 5 concludes and Section 6 outlines the way forward in this line of research.

2 The Model

Consider an economic environment in which there is a continuum of exporters on the interval \([0, 1]\) in the Home country and a continuum of importers on the interval \([0, 1]\) in the Foreign country. Both importers and exporters are distributed uniformly with unit density. It is assumed that the importers and exporters match in pairs to trade 1 unit of output, where each match generates a joint surplus \(S > 0\). If agents fail to locate their match, they do not trade at all. Assume for simplicity that all agents are risk neutral.

Suppose the importer and exporter distributions are placed opposite each other, as in Figure 1. An exporter can only match and trade with his importing counterpart on the opposite line. That is, the importers and exporters match one-to-one. The framework can best be seen to reflect trade in differentiated goods where goods have specific characteristics\(^6\). With no trade frictions, importers and exporters identify each other costlessly and all trade opportunities are exploited generating \(S\).

Further suppose, for concreteness, that \(q(i) = 1 - i\), so the expected joint surplus of direct trade is \((1 - i) S\). Note that the current set up where \((1 - i)\) matches take place,

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\(^6\) Alternatively, the good traded may be homogeneous and the horizontal differentiation over the \([0,1]\) interval may reflect differences in the time of delivery.
Figure 1: Importers and exporters.

Each generating $S$ is isomorphic to assuming that all trades take place but that the search process required to achieve a match erodes the gains from trade by a proportion $i$. Throughout the paper we maintain the former interpretation but results can easily be re-interpreted using the latter.

Suppose there is a single intermediary with access to a particular technology for building contacts with importers and exporters\(^7\). The intermediary can invest in an information network, which takes the form of a list of exporters and a list of importers. He locates importers and exporters at random and collects the pertinent information for trade. Thus the network includes information such as location, product characteristics, required delivery date etc that are needed to determine a match.

A network can be defined as a group of importers and exporters and the information links between them. In this case, the intermediary has information about each of the importers and exporters signed up and they become aware of the intermediary. The traders do not however, find out information about each other. Setting up the network requires a fixed cost $F$. The marginal cost of seeking out an additional trader to join the network, $c(i)$, is a convex function so $c'(i) > 0$ and $c''(i) > 0$. It is therefore assumed to be increasingly costly to locate traders as the level of information costs rises. Also let $c(0) = 0$ so that it is costless to locate and approach people under perfect information.

Crucially, the barriers to information flow, which are captured by parameter $i$, affect both traders seeking each other and the intermediary’s marginal cost for building the network. That is, more efficient information flow, as captured by a lower value of $i$, improves the search technology of traders, but also facilitates more efficient network

\(^7\)Although in practice we observe a number of trade intermediaries in competition for clients, often information intermediaries develop contacts in a particular niche, such as for trade in a particular sector or geographical region.
Let $P_X$ and $P_M$ be the proportion of exporters and exporters on each list respectively, where $P_X \in [0, 1]$ and $P_M \in [0, 1]$. Hence the intermediary’s total cost is given by (1).

$$C = F + c(i) [P_X + P_M]$$

(1)

The intermediary withholds the details of the list thereby preventing the traders from trading ‘behind his back’ so to speak. Otherwise, the intermediary would be unable to extract a share of the trade surplus. He does reveal the size of the network ($P_X$ and $P_M$), however, thereby allowing traders to evaluate the probability of finding their match by trading through the network. Importers and exporters can only be matched up accordingly with the assistance of the intermediary, who then receives a fraction of the surplus generated. Note, that only the traders that have been ‘signed up’ by the intermediary can approach him to find a match (in seeking out a proportion of importers and exporters, the intermediary makes himself known to these traders).

Importers and exporters located by the intermediary choose whether or not to look for their partner indirectly via the network. If they choose not to contract with the intermediary, or the intermediary fails to match any given pair, they face a probability $q(i)$ of matching directly and generating expected joint gains from trade at $(1 - i)S$ that are split between the importer and exporter. Let $\alpha_X$ and $\alpha_M$ be the exporter’s and importer’s surplus share, respectively, where $\alpha_X + \alpha_M = 1$. For simplicity, assume that both parties have equal bargaining power and so split the surplus equally between them. That is, $\alpha_X = \alpha_M = \frac{1}{2}$. Exporters’ and importers’ expected payoffs from direct trade ($E^{DT}(\Pi_X)$ and $E^{DT}(\Pi_M)$ respectively) are expressed in equation (2).

$$E^{DT}(\Pi_X) = E^{DT}(\Pi_M) = \frac{1}{2}q(i)S = \frac{1}{2}(1 - i)S$$

(2)

Under indirect trade, the intermediary brings together matching traders through the network for a share of the surplus generated. The joint surplus generated per match is $S$. The probability of a match taking place will depend on network size ($P_X$ and $P_M$) and will be less than 1 if not all traders are part of the intermediary’s network.

Let $\alpha_j(i)$ denote the share of $j$, given the level of information costs $i$, where $j = \{X, M, I\}$. For simplicity and comparability with the direct trade case, allow exporters and importers equal power i.e. $\alpha_X(i) = \alpha_M(i) \equiv \alpha_T(i)$. Equation (3) follows, where $\alpha_T(i)$, the surplus share of the intermediary, is determined endogenously.

$$2\alpha_T(i) + \alpha_T(i) = 1$$

(3)

The maximum number of matches that can be achieved through the network is $\min \{P_X, P_M\}$, the minimum number is $\max \{P_X + P_M - 1, 0\}$ while the expected number of intermediated matches is $P_X P_M$. In equilibrium, $P_X = P_M \equiv P$ since equalising the size of the lists maximises the expected number of intermediated matches for any given level of investment. This implies the maximum number of matches is $P$, while the minimum number of matches is $2P - 1$ for $\frac{1}{2} \geq P \geq 1$ and 0 for $P < \frac{1}{2}$. For an exporter (importer) deciding whether to trade via the network, the probability of her partner also being in the network is $P$, the proportion of importers (exporters) registered on the
intermediary’s list. The expected number of intermediated matches given a network of size $P$ is therefore $P^2$.

Consider any pair $j$ of trade partners $(X_j, M_j)$. There are four possible positions for this pair. First, both partners may lie outside the intermediary’s network and so can only match with probability $q(i)$. This event occurs with probability $(1 - P)^2$ and generates an expected payoff of $\frac{1}{2}q(i)S$ for each trader. Second, both partners may be inside the network, an event occurring with probability $P^2$. The payoff to each trader when matched by the intermediary is $(1 - \alpha_I(i))P^2$. Third, $M_j$ lies inside the network and $X_j$ outside. This occurs with probability $P(1 - P)$ and, since a match cannot be made through the intermediary, generates an expected payoff to each of $\frac{1}{2}q(i)S$. Finally, $X_j$ lies inside the network and $M_j$ outside, also with probability $P(1 - P)$ and with an expected payoff to each of $\frac{1}{2}q(i)S$.

It follows that the expected payoff to any trader $j$, given a network size $P$, can be expressed in equation (4):

$$E(\Pi_X | \text{network size } P) = E(\Pi_M | \text{network size } P) = \frac{1}{2}S \left\{ q(i)(1 - P)^2 + [1 - \alpha_I(i)]P^2 \right\}$$

To ensure trader participation, the intermediary must ensure that $\alpha_I(i)$ is sufficiently low such that the expected payoff from signing up to the network when approached by an intermediary is at least as large as the expected payoff from direct trade. This requires that the expected payoff of equation (4) is at least as large as that of (2). The network participation constraint can therefore be shown to be:

$$\alpha_I(i) \leq 1 - q(i)$$

In equilibrium, the intermediary will extract as much as surplus as possible while maintaining trader participation. It follows that in equilibrium $\alpha_I(i) = 1 - q(i) = i$ for all values of $P^8$. The intermediary’s share is therefore determined only by the level of information costs.

Note that the same result is found if we compare the expected payoff to any trader conditional on being approached by the intermediary with that of the direct trade option. The expected payoff to any trader $j$, conditional on being approached by the intermediary, is expressed in equation (6) and captures the fact that the trading partner will also lie in the network with probability $P$ and outside the network with $(1 - P)$.

$$E(\Pi_X | \text{approached by intermediary}) = E(\Pi_M | \text{approached by intermediary}) = \frac{1}{2}S \left\{ P[1 - \alpha_I(i)] + (1 - P)q(i) \right\}$$

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8It is assumed that they choose to trade via the intermediary when indifferent between the two modes of trade. Alternatively assume the intermediary offers an infinitesimally small addition amount, $\varepsilon$, for choosing the network.
Comparing (6) to (2) yields the same participation constraint (5). The timing is therefore as follows. The intermediary randomly locates a proportion $P$ of importers and exporters (to be determined endogenously) and offers to sign them up to his network on the condition that he retains a share $i$ of the trade surplus in the event of a successful match. The traders accept this offer and then all possible matches through the network are made. Any traders that are outside the network or fail to match through the intermediary match with probability $q(i) = (1 - i)$.

The intermediary chooses $P$ to maximise expected profits subject to constraint (5). The expected profits of the intermediary are therefore described by equation (7):

$$E(\Pi_I) = iSP^2 - 2Pc(i) - F$$  \hspace{1cm} (7)

For a given level of information costs $i$, and appropriate parameter values for $S$ and $F$, the intermediary has an incentive to maximise network size. The optimal network size, conditional on covering fixed costs, is therefore 1. It follows that for the range of information costs under which fixed costs can be covered, the network includes all traders, so $P = 1$. For positive levels of fixed cost $F$ there will be some range of values of $i$ under which the network is not viable and so $P = 0$.

The intermediary’s expected profit for a full network is given by (8).

$$E(\Pi_I|P = 1) = iS - 2c(i) - F$$  \hspace{1cm} (8)

Now define $\hat{i}$ as the level of information costs above which $E(\Pi_I|P = 1) \geq 0$. It therefore follows that for $i \leq \hat{i}$, $P = 0$ and for $i \geq \hat{i}$, $P = 1$. It follows that in equilibrium, trade will take place either entirely directly or entirely through the network. The equilibrium is described by Propositions (1).

**Proposition 2** For sufficiently high levels of information costs $\hat{i} \leq i \leq 1$, where $0 \leq F \leq iS - 2c(i)$, the network includes all traders and the intermediary extracts a portion $i$ of the gains from trade such that $P = 1$ and $\alpha_I(i) = i$. All trade matches occur indirectly through the intermediary. Alternatively, under sufficiently low levels of information cost $0 \leq i \leq \hat{i}$, where $F > iS - 2c(i)$, the fixed cost is prohibitively high relative to information costs and so the intermediary is inactive. That is, $P = 0$ and $q(i)$ trade matches occur directly.

Proposition 1 can be illustrated with the use of an example. Figure 2 graphs network size ($P$) against information cost ($i$) for values $F = 5$, $S = 16$, $c(i) = i^2$. The graph depicts isoprofit contours of the intermediary. The lowest contour depicted is the zero-profit isoprofit contour with higher contours reflecting positive profit levels. For any given level of $i$ the intermediary chooses network size $P$ such that the highest possible isoprofit contour is attained.

At some critical value of information costs $\hat{i}$ profit is zero. For values of $i$ above $i^*$, network-building is profitable and the network includes all traders. All trade matches therefore occur indirectly. As information costs decline, so does the share of the gains from trade appropriated by the intermediary. The lower is $i$, the better is the outside option available to traders through search and so the smaller the share the intermediary
can extract as a success fee upon matching the two sides of the market. Below \( \hat{i} \), the intermediary can no longer sustain the network. Note that the smaller is \( F \), or the higher is \( S \), the lower will be the threshold level \( \hat{i} \) below which the network stops being viable.

Trade volume under the direct search option is depicted in Figure 3. The expected number of units traded, \( q(i) = 1 - i \), falls from 1 to 0, and the gains from trade, \( q(i)S \), fall from \( S \) to 0 as information costs rise.

Now consider the effect of introducing an intermediary illustrated in Figure 4 below. For \( i > i^* \), the network is viable and includes all traders. Since all traders approach the intermediary and are matched for a share of the gains, \( i \), all trade opportunities are exploited and the volume of trade is 1. The intermediary helps match the two sides and dramatically increase trade volume for high values of \( i \). For low values of \( i \), the network is not viable, so the volume of trade follows the direct trade path. This yields the rather unintuitive result that improvements in information technology can lower trade volumes. In a sense, the traders’ outside option of direct trade becomes ‘too good’ and the intermediary is unable to compensate traders’ accordingly and cover costs with a very small success fee.

Recall that we can re-interpret the direct trade search technology such that all trade matches occur, but a proportion \( i \) of the gains from trade are eroded due to the costs of search. Under this interpretation, all matches take place over the entire range of possible values of \( i \). The expected gains from trade are invariant to the interpretation we choose, however, the ex post distribution of the gains differ. With \( q(i) \) defined as a probability, only a proportion of trade matches occur generating the entire gains from trade. With
Figure 3: Trade Volume under Direct Trade

Figure 4: Trade volume with intermediary
the alternative interpretation of \( i \), all traders trade but generate a smaller gain.

Now consider the welfare implications of introducing the intermediary. When \( i > i^* \), the intermediary leaves the traders indifferent relative to direct trade, and gains a profit 
\[
\Pi_I = iS - F - 2c(i) > 0.
\]
Hence the total trade gains, and thus welfare, are higher with the intermediary in place. This is due to the fact that information costs are a real resource cost. For a given \( i \) assuming network viability, the intermediary’s technology allows for more efficient matching than under direct trade, but cannot generate the level of welfare that would result under full information. It follows that \( W^{DT} < W^{IT} < W^{FI} \).

Note that despite the jump in trade volume depicted in Figure 4, there is no corresponding jump in welfare as information costs decline in the economy. As information costs fall and approach \( i^* \), the profit of the intermediary is squeezed as traders’ share in trade surplus rises. At \( i^* \), \( \Pi_I = 0 \) and the the joint trade surplus generated through direct trade is \((1 - i^*)S\). Further declines in \( i \) below \( i^* \) smoothly increase welfare towards \( S \).

### 3 Introducing Diminishing Returns

The results of Section 2 are extreme in the sense that, in equilibrium, the information network either includes all traders or none at all. For parameters such that network building is profitable, it pays for the intermediary to expand the network to include all traders. It is never optimal for the network to include only a fraction of traders, while a decline in information costs triggers a complete shift from indirect to direct trade.

In practice, networks are by no means exhaustive and thus it is of interest to develop a framework in which an interior solution to network size obtains \([P \in (0, 1)]\). This can be achieved by introducing diminishing returns to network building. The marginal cost of expansion, \( c(i, P) \) is now an increasing function of both \( i \) and \( P \), as described by (9) - (11).

\[
\frac{\partial c(i, P)}{\partial i} > 0 \quad \text{and} \quad \frac{\partial^2 c(i, P)}{\partial i^2} > 0 \quad (9)
\]
\[
\frac{\partial c(i, P)}{\partial P} > 0 \quad \text{and} \quad \frac{\partial^2 c(i, P)}{\partial P^2} > 0 \quad (10)
\]
\[
\frac{\partial^2 c(i, P)}{\partial P \partial i} > 0 \quad (11)
\]

As before, a higher level of information costs raises the marginal cost of the intermediary in acquiring information on traders and thus the marginal cost of a network expansion. Now his marginal cost is also rising in network size. The notion is that it becomes increasingly more costly to manage larger networks as more information comes in about traders. The intermediary now chooses \( P \) to maximise expected profits (12) subject to the constraint (5).

\[
E(\Pi_I) = \frac{1}{2}iSP^2 - 2Pc(i, P) - F \quad (12)
\]
In equilibrium, an interior solution for network size is obtained for certain parameter values. The results are illustrated through the use of examples with suitable parameter values and cost functions.

The 'general' case is illustrated in Figure 5 which graphs network size \((P)\) against information cost \((i)\) for values \(F = 2, S = 16\) and \(c(i, P) = 7.5i^2P^2\). The equilibrium configuration of trade is described by Propositions (2), (3) and (4):

**Proposition 3** For sufficiently low levels of information costs relative to fixed cost trade takes place directly and \(q(i)\) matches are made. The intermediary is inactive so \(P = 0\). This corresponds to \(0 \leq i < \hat{i}\), where \(\hat{i}\) is defined as the level of information costs above which \(E(\Pi_I) \geq 0\).

**Proposition 4** For intermediate values of information costs relative to fixed cost, corresponding to \(\hat{i} \leq i \leq \hat{\hat{i}}\), all trade takes place indirectly and \(P = 1\), where \(\hat{\hat{i}}\) is defined as the level of information costs above which the optimal network size is smaller than 1. Since the network includes information on all traders, the expected number of matches is 1 and \(\alpha_I(i) = i\).

**Proposition 5** For information costs above threshold \(\hat{\hat{i}}\), the intermediary remains active but operates a restricted network, thus \(P < 1\). The expected number of intermediated matches is \(P^2\) and \(\alpha_I(i) = i\). Of the \(P\) importers and \(P\) exporters in the network, \(P[1-P]\) of each are expected to fail to match indirectly. These traders join the \((1-P)\) importers and \((1-P)\) exporters outside the network yielding \((1-P^2)\) importers and exporters looking to match directly. \((1-P^2)q(i) = (1-P^2)(1-i)\) trade matches occur directly. Therefore, direct and indirect trade occur simultaneously.

As the level of information costs falls from 1, the network expands until \(P = 1\) when \(i = \hat{\hat{i}}\). This occurs because of the diminishing returns to network-building. As information costs decline, the intermediary’s marginal cost of network building declines. The lower marginal cost due to lower \(i\) allows the intermediary to profitably expand his network size. This result is counter to common wisdom that improvements in information technology reduce the role of intermediaries until all trade takes place directly. The key intuition behind this result is that improvements in information or communication technology improve the direct search process while at the same time lower the cost of network building. As \(i\) falls, the intermediary can build contacts easier, thereby providing incentives to expand the network size. In particular, the marginal cost of network-building falls at an increasing rate while the improvement in the probability of a direct match increases at a constant rate.

Hence, when information frictions in the economy are very high, a decline in information costs can increase the intermediated trade relative to direct trade. Once the upper bound of \(P = 1\) is reached, all trade matches occur through the intermediary. Further declines in \(i\) squeeze the profit of the intermediary as his share of the gains from trade declines. For \(i \leq \hat{\hat{i}}\), it is no longer profitable to operate the network so all trade takes place directly.
Figure 5: Network size for parameters $F = 2$, $S = 16$, $c(i, P) = 7.5i^2 P^7$

The volume of trade achieved in this general case with the diminishing returns to network size assumption is illustrated in Figure 6. For low levels of information frictions in the economy, the network is unsustainable and all trade is direct, yielding a trade volume of $q(i)$. For the intermediate range of information frictions in which the network encompasses all traders, all traders are matched indirectly so trade volume is 1.

Now consider the trade volume in the upper range of $i$. The network includes $P$ importers and $P$ exporters, where $P < 1$. Of these traders, only $P^2$ match on average, leaving $P(1 - P)$ importers and exporters unmatched, with their respective counterparts outside the network. These traders join the $(1 - P)$ importers and exporters outside the network yielding $(1 - P^2)$ importers and exporters looking to match directly. $(1 - P^2) q(i) = (1 - P^2) (1 - i)$ trade matches occur directly. Therefore, direct and indirect trade occur simultaneously. At $i = 1$, the search process available for direct trade offers no matches whatsoever, so total expected trade is $P^2 < 1$. As $i$ falls, the network expands yielding a larger number of intermediated trade matches, while at the same time, $q(i)$ is positive, albeit very small, generating a small number of direct matches. In terms of relative magnitude, given that $P$ is restricted but large nevertheless, the expected number of intermediated matches is approximately 0.7 when $i = 1$. This rises to 1 as $i$ falls. This indicates that although direct and indirect trade occur in the upper region of $i$, direct trade is small relative to the indirect trade due to the large size of the network and the low probability of a match through direct search when $i$ is very high.

In terms of welfare, the intermediary adds to welfare by implementing a contact-
Figure 6: Expected trade volume in the general case under diminishing returns. This figure corresponds to the pattern of network activity depicted in Figure 6.
building technology that is more efficient at using resources than the direct search method. Since the intermediary leaves the traders he matches indifferent between direct and indirect trade, his profit is a pure resource gain. Although the current framework results in all welfare gains accruing to the intermediary, one can imagine a setting where competing intermediaries lower their success fees to attract traders to their network. Under such a scenario, the gains from intermediation are shared more equally across traders and intermediaries.

### 3.1 Comparative Statics: Increasing $F$

This section illustrates how a rise in fixed costs can affect network size, using suitable parameter values. Figure 7 graphs network size ($P$) against information cost ($i$) for values $F = 5$, $S = 16$ and $c(i, P) = 7.5i^2 P^7$. Increasing fixed costs from 2 to 5 reduces the profitability of the network such that it is never optimal for the intermediary to operate a full network. The lowest isoprofit contour in Figure 7 corresponds to zero profits for the intermediary. The isoprofit contours below this, depicted in Figure 5, now correspond to losses for the intermediary. The critical value $\hat{i}$, above which operating the network is profitable, is higher than in Figure 5 and corresponds to a network size of $P < 1$. Thus $\hat{i}$ and $\hat{i}$ merge into a single threshold we now label $i^*$

Changes in the fixed set-up cost for the network will affect the range of information
cost levels over which the intermediary is active. Moreover, the network may never include all traders for high values of $F$.

Recall that the density of the distribution of importers and exporters is 1. Raising the density of traders has the same effect as lowering the fixed cost of the intermediary. Alternatively, as the density of traders and thus matches increases, the network is viable for a wider range of fixed costs.

4 Introducing Co-Ethnic Ties

In this section we introduce ties between some traders. In contrast to the anonymous traders of earlier sections, now suppose that a subset of $n$ importers and $n$ exporters know each other and so can communicate costlessly. A possible explanation for this could be that this subset are of the same ethnicity and so these traders form an informal co-ethnic network. Alternatively, other historical ties may have brought the traders in contact with each other.

We can distinguish between two cases. First, the simple case in which the $n$ importers and exporters who know each other match exactly. This could reflect a situation in which certain importers and exporters have a long-standing trading relationship and therefore do not require an intermediary or direct search. This implies there will be $n$ frictionless matches, irrespective of $i$, generating a joint surplus of $nS$. Effectively, the co-ethnic network has the effect of reducing the size of the trader line available to the intermediary for ‘recruitment’ from 1 to $(1 - n)$. This will have implications for network-building both in the simple framework and in that with diminishing returns to network building.

Suppose that the $n$ co-ethnic matches take place and subsequently network-building or direct trade occurs. This by-passes the complication where a portion of the traders the intermediary approaches contains members of the co-ethnic group who will never trade through the intermediary.

The second case is where the $n$ importers and exporters know each other, but are randomly located on the lines and so may not necessarily match. This better reflects the notion that traders have a set of co-ethnic contacts. In this case, prior to approaching an intermediary or searching directly, traders costlessly communicate with their co-ethnic counterparts and find out if they can match with them. Any matches take place costlessly and generate a joint surplus of $S$ each. The expected number of co-ethnic matches is $n^2$, so $n^2S$ surplus is generated. The remaining $n(1 - n)$ traders in each country are left to find matches through direct trade or the intermediary. Effectively the maximum network size falls from 1 to $(1 - n^2)$.

Although somewhat different, both cases are structurally similar. The effect of the network in both cases is to reduce the possible size of the network. For the rest of this section we focus on the former case, for simplicity. Note however that in earlier sections $P$ had a dual interpretation of absolute network size and proportion of traders in the network. Since the importers and exporters available for recruitment are now fewer than 1, $P$ can no longer be interpreted as a proportion, only as an absolute amount.

From the perspective of the intermediary, the marginal cost of recruiting traders is
unchanged, although there are now fewer traders to recruit. Crucially, however, recruiting a particular number of traders now corresponds to a larger proportion of the whole set and thus generates a larger number of expected matches. The expected number of intermediated matches for a given network size $P$ is now $\left(\frac{P}{m}\right)^2 > P^2$ (for the same investment cost). This has the effect of increasing expected revenue for any given $P$ providing incentives for an active network for a wider range of information costs. At the same time, there is less intermediation in the sense that the network size is crowded out.

Under diminishing returns to network building equilibria in which direct, intermediated and co-ethnic trade co-exist in equilibrium can be generated. The analysis is still work in progress and will be added shortly.

5 Conclusions

This paper contributes to the theoretical literature on information costs and trade by analysing the effect information costs have on the organisation of international trade, the volume of trade and welfare. In a world of information barriers where only a fraction of matches take place through direct search, there is scope for an information intermediary to act as a broker of information bringing the two sides of the market together.

In the simple case without diminishing returns to network-building, the model predicts that when information costs in the world economy are high, all trade matches will take place through the intermediary who operates and all-encompassing network. As information and communication technology improves, traders’ direct search technology improves and the profits of the intermediary are squeezed. When information frictions in the economy fall below a certain threshold, the intermediary is no longer viable and trade takes place indirectly using direct search. Not all matches take place since the search technology only matches traders with a probability that rises as information costs fall, but only reaches 1 when all frictions are eradicated. This would lead us to expect that bilateral trade flows between countries facing high information costs should take place largely through intermediaries, while countries with good information technology and communication networks will experience more direct trade.

Introducing diminishing returns to network building results in the intermediary restricting the network size below 1 when information frictions in the economy are high. In this setting, both intermediated trade and direct trade occur in equilibrium, although the latter constitutes a small portion of trade volume. Improvements in information and communication technologies that lower information costs are predicted to generate an expansion in intermediated trade as the lower costs of contact-building allow the intermediary to expand his network. Further improvements in information technology eventually lead to the collapse of intermediated trade and all trade flows take place directly. An example may be the impact of internet usage, as reflected by a decline in $i$, on trade. The internet simultaneously facilitates direct trade matching, thereby squeezing intermediaries, but also improves the ease with which the intermediaries themselves can build contacts and perform their matching function. As such, the model predicts an increase in intermediation activity with the introduction of the internet, which with more widespread internet usage will eventually be replaced by the traditional disinter-
mediation conventionally associated with the internet.

In terms of the empirical stylised facts, the model performs well in that bilateral trade between Home and Foreign increases with improvements in information/communication technology, such as the internet, that reduce the information frictions in the economy. Moreover, the trade enhancing effects of co-ethnic networks and trade intermediation are analysed. The model also allows for different types of trade to occur simultaneously: direct trade with search, co-ethnic trade through direct ties and intermediated trade and examines when different modes of trade emerge.

One of the key findings is that unlike co-ethnic networks which bring together relatively small sets of traders, trade intermediaries can assist in overcoming the information hurdles of finding a suitable trading partner. One policy implication of the model is that encouraging trade intermediaries can be very beneficial for information management and international trade.

6 The Way Forward

There is considerable scope for further research in the area of information costs, networks and international trade. The model presented is highly stylised and so can only capture a limited set of mechanisms through which information costs and flow can affect trade.

First, the model does not incorporate a geographical dimension. Geography has been found to be important not only because of the importance of transport costs for trade flows, but because distance and information costs can plausibly be linked. There is a need to unbundle the different aspects of trade costs and examine their impact on trade separately. Moreover, the introduction of a third country could assist in analysing how ethnic networks and information networks may alter the pattern of international trade.

Further, the specific ways in which information costs affect the search process for trading partners are not well documented. The information barrier identified in this paper is that of locating a trading partner. The processes described in this paper are somewhat arbitrary due to our still limited understanding of how information costs affect trade. Moreover, information problems in many other stages of the trade process are likely to be of importance. For example, there may be imperfect information about the traded good itself.

The model does not discuss the market for intermediaries. Rather than examining the operation of one intermediary an obvious extension to the model is allowing for free entry of intermediaries, which can give rise to multiple networks competing for traders. The viability of multiple intermediaries will depend largely on the relative size of fixed costs to market size. In practice, intermediaries often act cooperatively by allowing access to each others’ network while at the same time competing to expand their list of contacts. In an economic environment in which access to information is so important, exclusive access to certain information is very valuable. It is this exclusivity that allows the intermediary in the model to extract all additional surplus from traders. There is scope for these issues to be further explored.
Another highly stylised feature is that importers and exporters can only trade one-to-one. In practice, there are several trade options available to importers and exporters, which need to be identified and evaluated. Introducing a range of possible matches may yield interesting results and offer more in the way of policy implications.

The model presented is highly applicable to the real estate market, where real estate agents are information intermediaries operating in particular geographic areas or in different types of property. There is an information problem in that buyers and sellers of property face barriers making direct matching unlikely. Instead, real estate agents market to buyers and sellers who can be matched up through the agent for a percentage of the value of the property. This market is particularly appropriate as real estate agents do not buy the properties and sell them on as often occurs in goods intermediation. As such, disentangling the different types of intermediation is less of a challenge in the real estate market. Moreover, there is increasing real estate activity online, both in the form of direct advertising that can generate direct trade matches but also through online real estate agencies. The real estate sector may therefore provide a good means of testing the predictions of the model empirically.

Information costs and search may also further inform the foreign direct investment versus trade debate. Choi (2002) studies the effect of the internet on the volume of inward FDI. Using bilateral FDI data from 14 source countries and 53 host countries and employing a gravity equation, Choi finds that when the number of Internet hosts or users in a host country increases by 10%, FDI inflows increased by more than 2%. This compares to a 1% increase in bilateral trade found by Freund and Weinhold (2000).

Overall, information costs appear to be an important component of trade costs. This paper reveals how information frictions in locating a trading partner can affect not only the volume of international transactions, but also the way in which trade is organised.

7 References


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