The search for trading partners and the cross-border merger decision

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Abstract

We investigate the merger decision between two firms in a vertical outsourcing relationship. The inter-firm relationship is subject both to *ex ante* matching uncertainty and to contractual efficiency issues. Cross-border merger is assumed to solve the latter, but curtails search. Unlike previous models, but in line with Chinese data, the share of FDI in vertical interfirm trade increases over time. Firms merge more quickly with lumpy contracts and/or a poor contracting environment - as long as trade is not deterred altogether. Poor institutional quality in the upstream country will lead to faster merger, unless it is so great as to deter trade completely.[1]

JEL classifications: F12, F23.

Keywords: FDI, Mergers, Outsourcing, Search

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1 Introduction

Alongside the rapid growth in world trade in recent decades, there has been an even faster increase in international trade in intermediate goods. It is becoming increasingly common for goods to be produced by a vertical supply chain that stretches over several countries – a process known as 'vertical fragmentation' (Feenstra, 1998; Hummels *et al.*, 2001; Yi, 2003). In consequence, the share of imported components in spending on final goods has generally been rising. For example, Spencer (2005) reports that, from 1974 to 1993, imports as a proportion of total purchases of electrical equipment and machinery rose from 4.5% to 11.6% in the USA and from 13.2% to 30.9% in Canada.

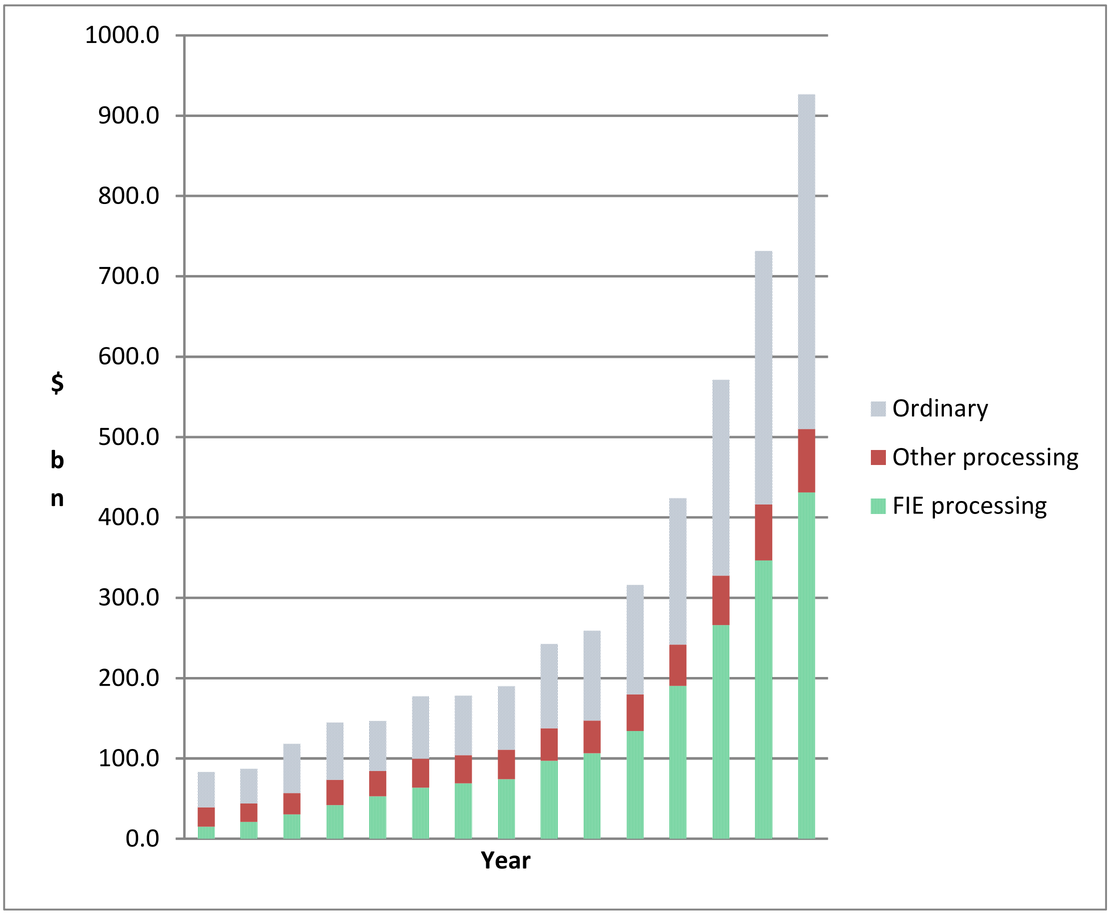
The drastic increase in vertical fragmentation and the international sourcing of intermediate goods raises the question: how are vertical, cross-border business relationships organised? We analyse the procurement process of a downstream firm in the North that wants to buy components from, or have them processed by, an upstream firm in the South. The downstream, Northern firm must choose between two possible structures for its vertical trading relationship: vertical foreign direct investment (FDI), where it merges with a Southern component supplier, and outsourcing,[2] where it trades with a Southern firm through an arm's length contract.

Figure 1 below, charts the huge growth of China's manufacturing exports between 1992 and 2006.[3] In 2006, the majority (55%) of manufacturing exports from China were so-called 'processing exports', represented by the sum of the black and vertical striped bars in the figure. 'Processing exports' are exports produced using imported inputs, so the processing activity in China forms part of an international supply chain, and the data allow us to analyse how such vertical trade is organised.

The vertical striped bars in *Figure 1*, labelled 'FIE Processing Export', are the exports of processed components by foreign-owned enterprises ('Foreign Invested Enterprises') in China, and they result from vertical FDI in China. The solid bars, on the other hand, are exports of processed components that result from outsourcing contracts between foreign buyers and independent Chinese firms.

[2] Note that we are using an industrial organisation definition of outsourcing (purchasing from another firm). Some of the trade literature would see any import of intermediate inputs as outsourcing, even if they come from a wholly-owned subsidiary.

[3] The figure is based on a previous figure in Spencer (2005), as well as one in Feenstra and Wei (2010). Thanks to Rob Feenstra for sharing his data on this.


1000.0
900.0
800.0
700.0
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300.0
200.0
100.0
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$ bn
Year
Ordinary
Other processing
FIE processing

Figure 1:

Figure 1: Chinese Exports 1992-2006: FIE processing, other processing and ordinary exports.

The message of *Figure 1* is that vertical 'processing' trade with China is increasingly organised through FDI rather than outsourcing – the vertical striped bars grow in size over time relative to the solid bars. Our model of the FDI/outsourcing decision is consistent with this observation that vertical FDI grows in importance relative to outsourcing over time.

The baseline version of our model analyses a Northern firm's search for a trading partner in the South. By paying a fixed search cost, the Northern firm meets a randomly chosen Southern firm. The randomness relates to the quality of the match between the two firms; that is, the total profitability of the vertical trading relationship. Next, the Northern firm must choose how to structure its relationship with the Southern firm. The choice – between merging (vertical FDI) and contracting (outsourcing) – incorporates the key trade-off in our model.

A merger is irreversible (demerger is assumed to be prohibitively costly), but it maximises the value from the vertical trading relationship. In contrast, outsourcing relationships are more flexible (arm's length contracts last for only one period), but – due to contractual inefficiencies – they waste some of the value in the trading relationship. A classic example might well be the protection of intellectual property and blueprints in a contractual relationship. For example, a recent study in the Sloan Management Review estimated that US corporations lost $300bn in lost business in 2013 due to Chinese IP thefts, while the value of potential profits of European manufacturers was reduced by 20%.[2] (The contractual friction might arise from relationship-specific investments that are only partially contractible. **Ben - can you expand this more ?**) Therefore, unlike previous papers (Grossman and Helpman, 2002, Rauch and Casella, 2003, Rauch and Trindade, 2003) we focus on the search process whereby firms find trading partners (as opposed to concentrating on matched pairings, once search has been completed).

After the Northern firm has made its merge/contract choice, output is produced at the end of the first period. Following a merger, the pairing of firms remains together into the infinite future. However, a contract is dissolved after one period, and the Northern firm searches again and repeats the entire process in the next

[1] The authors would like to thank Barbara Spencer, Rob Feenstra and Hong Ma for kindly sharing data, and .... for comments. Any errors are our own.

[2] Schotter and Teagarden (2014).

period. We assume that match quality is independently and identically distributed through time.

We follow Grossman and Helpman (2002) in adopting a 'transactions cost' approach to the integration/outsourcing decision. This is in the tradition of Coase and Williamson, and it views integration as entirely resolving contractual problems. (McLaren, 2000, also adopts a 'transactions cost' approach.) An alternative approach to analysing contractual frictions is the 'property rights' theory of Grossman and Hart 1986), and Hart and Moore (1999). Antràs (2003) analyses the integration/outsourcing decision in this tradition, as do Antràs and Helpman (2004). In the 'property rights' approach, vertical integration does not resolve contractual frictions. However, by reallocating 'residual control rights' over assets (i.e. ownership of assets), integration alters the 'threat point' that emerges when the contract breaks down or doesn't apply.

Whether the 'transactions cost' or 'property rights' approach is preferred depends upon the exact details of the vertical relationship one has in mind. To the extent that integration entails joint profit maximisation (as merger does) and the acquirer obtains the target's blueprints and is able to exploit them as efficiently as the target could, then the 'transactions cost' approach (integration resolves contractual frictions) seems appropriate.

We derive the cut-off between contracting and merging by comparing present values. The present values of both merging and contracting are increasing in the match quality that the Northern firm draws. However, the present value of merging is more sensitive to the match-quality draw because, following merger, the pairing of firms remains together forever. Therefore, merger becomes 'more likely' as match-quality rises, and we derive a unique cut-off between contracting and merging. *Ceteris paribus*, we show that contracting is made more attractive by rises in contract quality, and falls in the discount rate (more patience) and the fixed search cost. These results are intuitive.

Although firms are *ex ante* identical, pairings that turn out to be of a higher quality are 'more likely' to lead to FDI. Moreover, trading relationships organised through vertical FDI earn higher profits than do those organised through outsourcing. This is consistent with the empirical findings of Helpman, Melitz and Yeaple (2004) on the profitability of MNEs relative to other types of firm.

Over time, the likelihood that a firm will have merged rises. When a firm enters a new country to source components, outsourcing provides an attractive, flexible means of exploring the market for trading partners. Eventually, after (perhaps) several contractual relationships with different temporary partners, the firm finds a suitable permanent partner for merger. Therefore, in our model, outsourcing is equivalent to 'ongoing search', whereas vertical FDI is chosen by 'matched' pairings.

The pattern of Chinese 'processing exports' over time in *Figure 1* is consistent with our results. The relative importance of vertical FDI grows over time as Northern firms become more familiar with the host country. Accounting for the outsourcing/FDI mix in *Figure 1* is an important achievement. For example, Grossman and Helpman (2002) find that thick markets with many potential trading partners favour outsourcing. However, this is not the picture in China. In *Figure 1*, as China has industrialised since the mid-1980s and its export-oriented manufacturing sector has expanded, we have actually observed a growth in vertical FDI relative to outsourcing. Thus, market thickness appears to be positively correlated with vertical FDI, rather than negatively, as in Grossman and Helpman's (2002) model.

We allow for the simultaneous free entry of firms at the start of the search process. Because higher contract quality raises the present value of contracting, host countries with higher contract quality attract more entry by searching firms from the North. Therefore, in the long-run steady state, when firms are matched through vertical FDI, contract quality is positively correlated with national inward FDI intensity. Therefore, the result of the OLI framework (Markusen, 1995) that greater contract quality (e.g. stronger intellectual property rights) favours outsourcing over 'internalisation' through FDI is primarily a short-run result. We further extend the model to allow for endogenous contract length and growing markets.

The plan of the remainder of the paper is as follows. In the next section we set out our modelling framework. In section 3 we examine the individual firm's choice between merging and contracting, taking the rest of the economic environment as given. In section 4 we solve for the industry equilibrium by allowing for free entry of Northern firms into the search process. We also extend our model to look at an economy experiencing steady-state growth. Finally, section 5 concludes.

2 Model

We set up a partial equilibrium model of an industry in a two-country world, the two countries being the North and the South. [We expand this in a later section to take account of more than two countries.]

The market for final goods is in the North. Production requires two stages, upstream and downstream. Upstream firms sell semi-finished goods to downstream firms, who then complete the manufacture and sell the final products to consumers.[3] We assume that the upstream stage is located in the South and that the downstream stage is in the North, reflecting the underlying pattern of comparative advantage.

All firms are of equal *ex ante* expected efficiency. However, there is an ongoing fixed coordination cost which varies depending on the goodness of fit of the match, μ. We assume that μ is uniformly distributed on $[0, \mu_M]$, where μ_M represents the best match. Consequently, we can always say that there is a probability of $1 - (\mu/\mu_M)$ of finding a match of better quality than any given μ. For tractability, we restrict ourselves to a model where all pairs of firms have identical and constant marginal costs.

Figure 2 below shows a decision tree for a downstream firm in the North.

Figure 2: the Decision Tree and Sequence of Moves.

At first, the downstream firm in the North pays a one-off sunk cost of entry into the industry, E. Next, the firm pays a fixed search cost of S and receives a single introduction to a trading partner in the South. As described above, the quality of the match, μ, is randomly distributed on $[0, \mu_M]$. The firm must then choose between contracting with this partner or merging:[4] We allow for rapid merger where firms draw a good match quality.

Note that, although we carry out much of the analysis from the standpoint of the Northern, downstream firm, the merge/contract decision is based on joint profits, so decision-making could just as easily be seen from the perspective of the Southern, upstream firm. Indeed, all that is really needed for our model to work is that the bargaining between the two firms is Pareto efficient. Nevertheless, following Antras (2003 and 2005), we choose to assume that the downstream firm can appropriate the entire expected value of the bilateral trading relationship. This simplifies our analysis greatly. Given that the μ draw is idiosyncratic to

[3] For simplicity, we assume that an upstream and a downstream firm operate exclusively together as a pairing, whether or not they are vertically integrated by merger.

[4] The existence of a sunk cost of entry (E) is empirically plausible (e.g. Roberts and Tybout„ 1997), and it also simplifies our analysis. We assume that E is suff high so that, ex post, contracting generates positive single-period profits even for the worst quality match. This means that we can ignore an "inactivity for a period" option for incumbent firms. Without E, some firms (those with v bad quality matches) would face the prospect of making a loss (for a period) – even though the expected (ex ante) value of search might be positive!

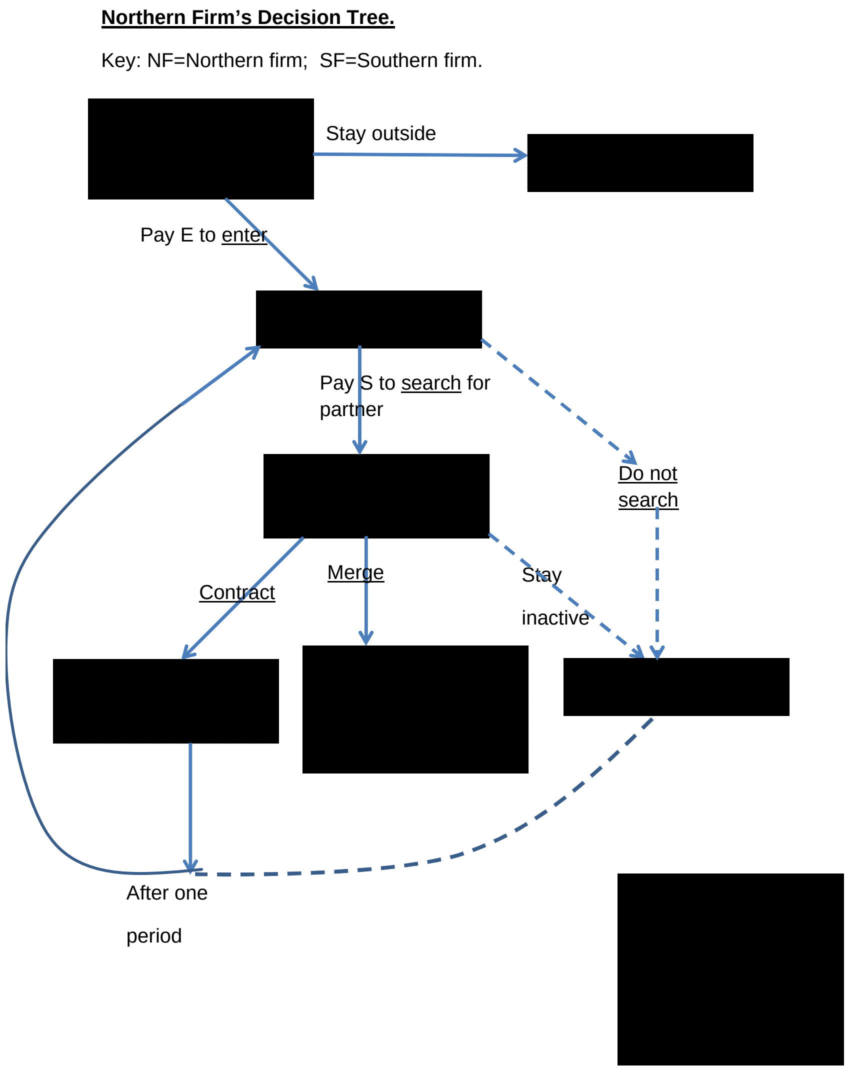
Northern Firm's Decision Tree.
Key: NF=Northern firm; SF=Southern firm.
Stay outside
Pay E to enter
Pay S to search for partner
Do not search
Contract
Merge
Stay inactive
After one period

Figure 2:

a particular pairing, we could assume that, following search, the Northern firm is presented with (at least) *two* equally good fits, who then compete in lump-sum payments to be paired with N. Following Antras (2003 and 2005), this will reduce the Southern firm's expected profits to zero, and enable the Northern firm to appropriate the entire value of the bilateral relationship.

Merger aligns the motivations of the two firms, avoiding problems of coordination (for example, ensuring blueprints are secure). Consequently, merger generates maximal value from the match but is irreversible. We denote the per-period profits of a merged pairing by $\pi + \alpha\mu$. The variable π captures the influence of product-market competition, and thus we would expect π to be strictly decreasing in the number of firm pairings in the industry, N. (For notational ease and since variations in N will play only a minor part in our analysis, we suppress the influence of N on π in what follows.) We do not need to be specific about the exact form of product market interaction; our basic story is compatible with both monopolistic competition and oligopoly. The variable α measures the return to match quality or the importance of goodness of fit between the downstream and upstream firms. (Thus, for example, small α implies that, on both sides of the market, firms are relatively homogeneous or 'adaptable'/'flexible'.) Note that we are assuming that match quality enters joint profits additively through fixed (rather than variable) costs; we make this assumption for simplicity.[5]

A **contract**, on the other hand, lasts for just one period (although the length of a contract period may vary across industries). (See below – FN 5 – for some justification of one-period contracts.) Per-period profits under contracting are denoted by $\pi + \alpha\mu - \beta c$, where the variable $c \geq 0$ measures the additional cost of contracting relative to merging and β measures the contract intensity of the joint activity. For example, if contracts are to some extent incomplete, then the two parties might withhold valuable information for fear that it will subsequently be used by a rival to gain a competitive advantage. Thus, $c = 0$ corresponds to the case of no contractual difficulties. Note that we are assuming that the profit disadvantage of contracting is independent of the quality of the match, μ; we make this assumption for simplicity.[6]

[5]McLaren (2000) makes the same assumption. Usefully, it limits the influence of product market competition on the merge/contract choice and ensures that, for given N, each firm faces a stationary environment over time. (If, for example, μ affected marginal costs – perhaps differentially between contracting and merged pairs – then a firm's variable profits in any period will depend on all other firms' μ draws and contract/merge choices). Also, the analysis is considerably less tractable when μ affects marginal costs or when μ and c interact in fixed costs.

[6]In a previous version of the paper, we assumed that the 'contractual difficulty' related to the extent to which the full profitability of the match quality could be realised under contracting – essentially, we interacted c and μ multiplicatively, with

Following the merge/contract decision, output is produced at the end of the period.

If a merger occurred, then search has ended and output is produced every period into the infinite future. We assume demerger to be prohibitively costly. Alternatively, if a contract was chosen, then at the start of the next period the downstream firm searches again and repeats the whole process.[7] Match quality is independently and identically distributed through time. *[This is a kind of 'thick market' assumption: The distribution of unmerged firms remaining in the barrel (to be found through search) is assumed to be independent of the characteristics of the firms that have already merged. Alternatively, we could say that 'match quality' is an idiosyncratic property of the pairing, and is independent of the characteristics of the two constituent firms.]*

As we discuss in the next section, our model is a variant of standard search models (Kohn and Shavell, 1974). The most important theoretical feature of these models is that there exists an unique switchpoint, μ_R, at which a player is indifferent between continuing with her current partner and searching afresh for a new partner. We term μ_R the *reservation match quality.*

3 The Merge versus Contract choice

A firm will choose between contracting and merging with its present partner on the basis of which yields the greater expected present value. The present value to the pairing of merging is assumed to increase linearly with respect to μ is the match-quality draw, i.e.:

$$V_M = \sum_{t=1}^{\infty} \frac{\pi + \alpha\mu}{(1+\rho)^t} = \frac{\pi + \alpha\mu}{\rho}, \tag{1}$$

where ρ is the discount rate expressed per contract period (so that $\rho = (1+r)^T - 1$ when contracts last for T years).

A contract lasts for only one period. After that, the contract is dissolved and the firms search again. Therefore, the present value to the pairing of contracting is

$c \in [0, 1]$ measuring contract quality. This alternative formulation gives identical qualitative results to ours, but its mechanics are considerably more messy. For additional details, please contact the authors.

[7] The intuitive justification for one-period contracts runs as follows. If a pairing wished to stay together for two periods, they would also want to stay together forever because the environment is stationary over time. However, in the case of an infinitely-lived pairing, a merger dominates a contract in profit terms. Therefore, contracts will last only for one period.

$$V_C = \frac{\pi + \alpha\mu - \beta c + \overline{V_S}}{1+\rho}, \tag{2}$$

where $\overline{V_S}$ is the expected present value to an incumbent firm of initiating a new search and is given by

$$\overline{V_S} = \Pr\{\text{contract}\} \cdot \overline{V_C} + \Pr\{\text{merge}\} \cdot \overline{V_M} - S. \tag{3}$$

In (3), $\overline{V_C}$ and $\overline{V_M}$ are, respectively, the expected present values of a *profitable* contract and a *profitable* merger; thus, for example, $\overline{V_C}$ is the expectation taken over the range of μ where contracting is optimally chosen, rather than over all $\mu \in [0, \mu_M]$. Note also that $\overline{V_S}$ is independent of the current match quality draw (i.e. $\partial\overline{V_S}/\partial\mu = 0$) since firms who start a new search abandon their current match.

To determine the firm's merge/contract choice, we proceed as follows. We solve the model under the assumption that there is a unique switchpoint between contracting and merging, μ_R, and we then show that our solution is consistent with this assumption. If contracting is chosen on $\mu \in [0, \mu_R)$ and merger on $\mu \in [\mu_R, \mu_M]$, then we have $\Pr\{\text{contract}\} = \mu_R/\mu_M$ and $\Pr\{\text{merge}\} = 1-(\mu_R/\mu_M)$. Likewise, if $\overline{V_C}$ and $\overline{V_M}$ are defined over these two intervals, then we get $\overline{V_C} = \frac{1}{1+\rho}\left(\pi + \alpha\frac{\mu_R}{2} - \beta c + \overline{V_S}\right)$ and $\overline{V_M} = \frac{1}{\rho}\left(\pi + \alpha\frac{\mu_R+\mu_M}{2}\right)$. [These formulae reflect that the average one-period contract which will not be renewed has match quality $\frac{\mu_R}{2}$,while the average merger has a match quality $\frac{\mu_R+\mu_M}{2}$]. Thus, (3) becomes

$$\overline{V_S} = \frac{\mu_R/\mu_M}{1+\rho}\left(\pi + \alpha\frac{\mu_R}{2} - \beta c + \overline{V_S}\right) + \frac{1-(\mu_R/\mu_M)}{\rho}\left(\pi + \alpha\frac{\mu_R+\mu_M}{2}\right) - S,$$

which can be solved to give

$$\overline{V_S} = \frac{(1+\rho)(2\pi - 2\rho S + \alpha\mu_M)\mu_M - 2(\pi + \beta\rho c)\mu_R - \alpha\mu_R^2}{2\rho\left[\mu_M(1+\rho) - \mu_R\right]}. \tag{4}$$

It is clear that, as expected, $\overline{V_S}$ is increasing in π (since $\mu_R \le \mu_M$) and thus decreasing in the number of product-market competitors, N.[8] We would expect entry into the industry to continue until $\overline{V_S}$ is driven down to E, the one-off sunk cost of entry.[9]

[8] Note that we show below that the equilibrium value of μ_R is independent of π.

[9] We assume that E is sufficiently large so that $\pi \ge \beta c$ in free-entry equilibrium. This means that there is a positive

Next, we solve for μ_R, which is defined as the μ-value at which $V_M = V_C$, treating $\overline{V_S}$ as endogenous. (Recall that μ is assumed to be identically distributed in every period and μ draws are assumed to be independent across periods. Thus, the search environment faced by firms is stationary over time, which implies that the probability of contracting must also be constant through time. The contract/merge decision problem in the next period replicates that in the current period.) Substituting (4) into (2), setting the result equal to (1), and solving, gives a quadratic in μ_R:

$$\alpha\mu_R^2 - 2\alpha(1+\rho)\mu_M\mu_R + (1+\rho)[\alpha\mu_M - 2\rho(\beta c + S)]\mu_M = 0. \tag{5}$$

Only the smaller root of (5) lies within $[0, \mu_M]$. Thus, the reservation match quality is

$$\mu_R = (1+\rho)\mu_M - \frac{1}{\alpha}\sqrt{\alpha\mu_M\rho(1+\rho)[\alpha\mu_M + 2(\beta c + S)]}. \tag{6}$$

If the model parameters are all strictly positive, then it is straightforward to show that $\mu_R < \mu_M$; that is, merger is always chosen with strictly positive probability. Again assuming strictly positive parameters, we can show that $\mu_R > 0$ if and only if $\frac{\alpha\mu_M}{2} > \rho(\beta c + S)$; that is, it is possible for merger to be chosen with probability one. To understand this, consider the case where firms are sufficiently impatient that $\mu_R = 0$ (define the relevant discount rate as $\rho = \rho^* = \frac{\alpha\mu_M}{2(\beta c + S)}$). The firm which is most likely to contract is that whose match quality in the current period is at the minimum ($\mu = 0$). When this is the case, the return on contracting,

$$V_C = \frac{\alpha\frac{\mu_M}{2\rho^*} - \beta c - S}{1+\rho^*} + \frac{\pi}{\rho^*}. \tag{7}$$

But if $\alpha\mu_M = 2\rho^*(\beta c + S)$, V_c will equal V_M even when $\mu = 0$.[10] In other words, potential returns on renewing a search (which rise with α and μ_M and decline with S) are never high enough to outweigh the

single-period return from contracting with even the lowest-quality match ($\mu = 0$). By implication, therefore, there is a positive single-period return from contracting with *any* match quality, which means that firms will never choose to be inactive for a period after learning their possible match quality.

[10]

$$\overline{V_S} = \frac{\mu_R/\mu_M}{1+\rho}\left(\pi + \alpha\frac{\mu_R}{2} - \beta c + \overline{V_S}\right) + \frac{1-(\mu_R/\mu_M)}{\rho}\left(\pi + \alpha\frac{\mu_R+\mu_M}{2}\right) - S$$

When $\rho = \rho^*$, $\mu_R = 0$

$$\overline{V_S} = \frac{1}{\rho^*}\left(\pi + \alpha\frac{\mu_M}{2}\right) - S.$$

For a firm with $\mu = 0$

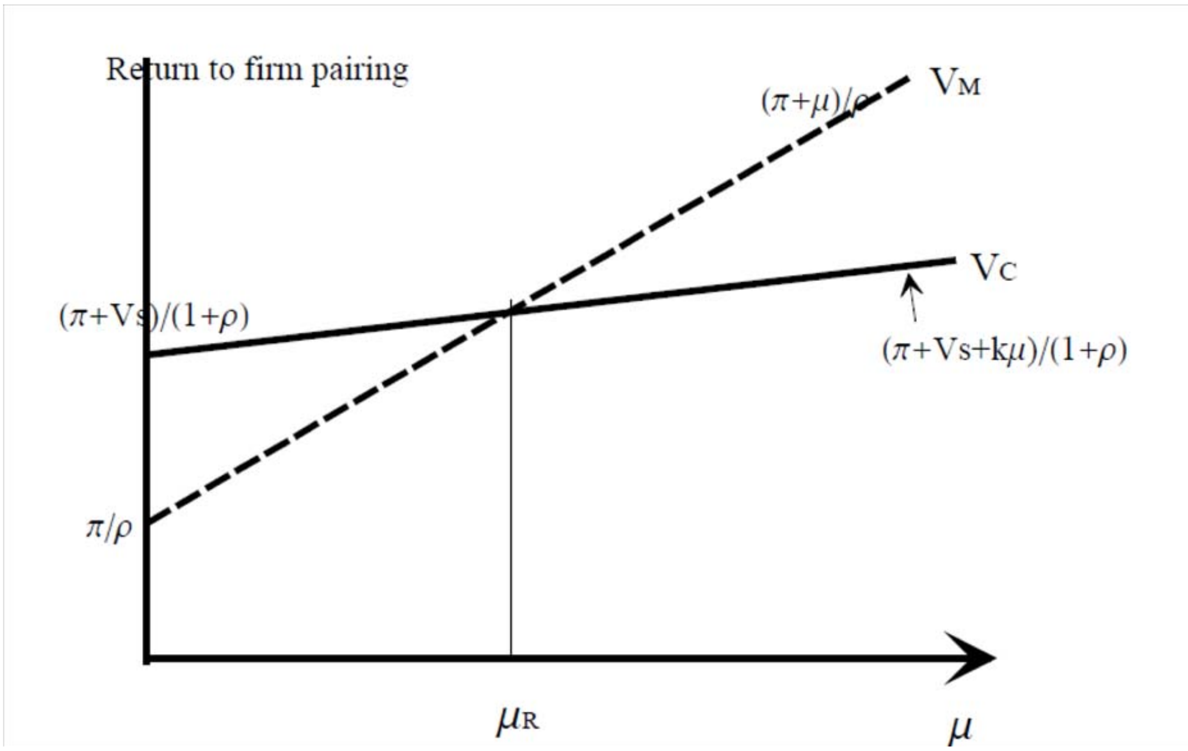

Figure 3:

costs of waiting (which depend on ρ, β and c).

Figure 3 below plots V_M and V_C against μ for specific parameter values[11]

Figure 3: Present value of merging or contracting, as a function of current match quality.

In Figure 3, V_M is steeper than V_C, as is clear from differentiating (1) and (2), because the current match-quality draw is more significant for lifetime profits under merger, where the two partners will stay together forever. The unique intersection of V_M and V_C gives the value of μ_R, the reservation match quality. *Figure 3* shows that for low μ ($\mu < \mu_R$) the firms choose to contract, while for high μ ($\mu > \mu_R$) they merge.

It should now be clear that our assumption of a single Southern upstream country is not restrictive. If

$$V_C = \frac{\pi - \beta c + \frac{1}{\rho^*}\left(\pi + \alpha\frac{\mu_M}{2}\right) - S}{1+\rho^*} = \frac{\alpha\frac{\mu_M}{2\rho^*} - \beta c - S}{1+\rho^*} + \frac{\pi}{\rho^*}. \tag{8}$$

Solve $V_c = V_M$.

$$\frac{\alpha\frac{\mu_M}{2\rho^*} - \beta c - S}{1+\rho^*} + \frac{\pi}{\rho^*} = \frac{\pi}{\rho^*} \Longrightarrow \alpha\mu_M = 2\rho^*\left(\beta c + S\right). \tag{9}$$

[11] $\rho = 0.2$, $\mu_M = 2.5$, $\alpha = 1$, $\beta = 0.5$, $c = S = 1$ and $\pi = 2$. Note that these values satisfy $\pi \geq \beta c$, so contracting yields a positive single-period return for all μ draws. These values imply $\overline{V_S} = E = 16.417$ and $\mu_R = 1.183$, which (as a consistency check) is indeed the μ-value at which V_M and V_C cross.

there were multiple Southern countries, each with their own values for the exogenous parameters and thus μ_R, then each incumbent Northern firm would choose between them as locations for search by comparing their values of $\overline{V_S}$. Thus, except in a knife-edge case, all Northern firms will search in the same Southern country.[12] This observation justifies our focus on just one Southern country.

3.1 Comparative statics

In this section, we examine in more detail the determinants of μ_R in (6). Firstly, we note that μ_R is independent of per-period variable profits, π, because these are equal under merging and contracting. Importantly, this implies that changes in the number of Northern firms in the industry do not affect the probability that a searching firm will merge in any period.

We can show that a rise in ρ reduces μ_R, i.e. makes merger more likely or quicker (see Appendix for proof). This result is intuitively appealing because merger maximises the value of the current match, whereas contracting sacrifices some current value in return for the prospect of a future gain with a better match (following a new search). Recalling that $\rho = (1+r)^T - 1$, where r is the annual interest rate and T is the contract length (in years), this result also implies that μ_R is decreasing in T: longer contracting periods, which Antràs (2005) terms "lumpier" contracts, increase the likelihood of merger.

Falls in βc, **which may represent an improvement in the contracting environment (c) or a fall in contract intensity (β),** and S both increase μ_R, i.e. make contracting more likely. The reasoning is clear: For a Northern firm that has just been introduced to a potential match, both of these are costs that will be incurred again only under contracting. However, merger still occurs with strictly positive probability even if future contracting-specific costs are zero (i.e. $c = S = 0$).[13] This is because, compared to contracting, a merger gives a firm certainty that it will retain its current trading partner – and when μ is high, the lock-in effect of merger is a plus.

A rise in α, the return to match quality, increases μ_R,[14] i.e. makes merger less likely or slower.[15]

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[12] Grossman and Helpman (2005) present a model where Northern firms simultaneously outsource in two countries in equilibrium. This possibility is created by general-equilibrium wage responses to the location of outsourced activity, which are absent from our partial equilibrium model.

[13] From (6), it is clear that $\mu_R < \mu_M$ when $c = S = 0$.

[14] $\frac{\partial \mu_R}{\partial \alpha} = \frac{\rho \mu_M (1+\rho)(\beta c + S)}{\alpha \sqrt{\alpha \mu_M \rho (1+\rho)(\alpha \mu_M + 2(\beta c + S))}} > 0$.

[15] As α tends to ∞, μ_R approaches a limit of $\left[1 + \rho - \sqrt{\rho(1+\rho)}\right] \mu_M$, which lies within $(0, \mu_M)$ – that is, as one would

Next, we examine the influence of the degree of heterogeneity across matches, as measured by μ_M. Dividing **??** by μ_M yields

$$\frac{\mu_R}{\mu_M} = (1+\rho) - \frac{1}{\alpha\sqrt{\mu_M}}\sqrt{\alpha\rho\,(1+\rho)\,[\alpha\mu_M + 2\,(\beta c + S)]}\,, \tag{10}$$

which is increasing with respect to μ_M.[16] Increasing μ_M, which increases both the mean and the variance of match quality, increases both μ_R and μ_R/μ_M, which measures $\Pr\{\text{contract}\}$. There are two further points to note here. First, if we increase both βc and S equiproportionately with μ_M, then μ_R/μ_M does not change. This is clear from inspection of (6), and it makes intuitive sense. Second, note that expected match quality is $\overline{\mu} = \mu_M/2$. If we multiply μ_M and α by factors of k and $1/k$ respectively (so that the return to average match quality does not change), then μ_R/μ_M, which measures $\Pr\{\text{contract}\}$, remains constant.

3.2 Free entry

In equilibrium with free entry, N, the number of downstream Northern firms in the industry, is implicitly defined by $\overline{V_S} = E$. The dynamics of entry work as follows: A rise in N reduces π, variable profits per pairing, and from (4), this reduces $\overline{V_S}$ towards E. (We do not specify the exact form of product-market competition – or, equivalently, the exact functional dependence of π upon N. All we require is that π be strictly decreasing in N – a very weak condition indeed, which is satisfied by all the models of monopolistic competition and oligopoly of which we are aware.)

Analysing how changing the exogenous (non-π) parameters affects the equilibrium number of firms under free entry is complicated. We proceed by considering how π has to change in order to equate $\overline{V_S}$ to E. Define this value of π as

$$\pi^* = \rho E - \beta c\rho - \alpha\mu_M(1+\rho) + \theta, \text{ where } \theta = \sqrt{\alpha\mu_M\rho(1+\rho)(2\beta c + \alpha\mu_M + 2s)} = \alpha\,(1+\rho)\,\mu_M - \alpha\mu_R.$$

Changing any of the parameters $\{\alpha, \rho, \mu_M, \beta c, S\}$ affects π^*. The effects are analysed formally in the

expect, the probability of merger remains strictly positive.

[16] $\frac{\partial}{\partial\mu_M}(\frac{\mu_R}{\mu_M}) = \frac{\rho(1+\rho)(\beta c+S)}{\mu_M\sqrt{\alpha\mu_M\rho(1+\rho)(2\beta c+\alpha\mu_M+2S)}} > 0.$

Appendix, but here we note that

$$\frac{\partial \overline{V_S}}{\partial \beta} = \frac{1}{\rho}\left[c - \frac{\partial \theta}{\partial \beta}\right] = \frac{c}{\rho}\left[-\frac{\alpha \mu_R}{\theta}\right] < 0, \tag{11}$$

as long as μ_R is positive.

By similar methodology $\frac{\partial \pi^*}{\partial \beta} = \frac{c\rho\alpha\mu_R}{\theta} > 0$, $\frac{\partial \pi^*}{\partial c} = \frac{\beta\rho\alpha\mu_R}{\theta} > 0$ and $\frac{\partial \overline{V_S}}{\partial S} = -\frac{1}{\rho}\sqrt{\frac{\alpha\mu_M\rho(1+\rho)}{\alpha\mu_M+2(\beta c+S)}} < 0$. Hence, increases in $\{\beta, c, s\}$ all lower π^* and deter new entry. These observations are intuitive.

On the other hand, rises in $\{\mu_M, \alpha\}$ will increase $\overline{V_S}$, reducing π^*, and thus encourage new entry into the industry. Specifically,

$$\frac{\partial \overline{V_S}}{\partial \alpha} = \mu_M(1+\rho)\left[\left(\frac{1}{\rho}\right) - \frac{(\alpha\mu_M + \beta c + S)}{\theta}\right] > 0, \frac{\partial \overline{V_S}}{\partial \mu_M} = \alpha(1+\rho)\left[\left(\frac{1}{\rho}\right) - \frac{(\alpha\mu_M + \beta c + S)}{\theta}\right] > 0, \tag{12}$$

for all relevant ranges of ρ. The effects of changing μ_R are analogous, so raising $\{\alpha, \mu_R\}$ encourages entrants (a higher possibility of a good quality match). The effect of changing ρ is potentially ambiguous, but if the cost of entry into the industry, E is sufficiently high, then a rise in ρ will deter entry.

Thus, the welfare analysis of changes in the economic environment (model parameters) becomes complex once free entry is allowed for. (This touches on the discussion in the next section.) For example, a fall in ρ – perhaps due to a cut in the 'lumpiness' of contracting in Antràs's (2005) terminology – increases μ_R and the probability of contracting. As discussed in the next section, this results in slower but better quality mergers. However, since $\overline{V_S}$ rises, it can also be expected to provoke fresh entry into the industry – which, note again, will now itself affect μ_R because μ_R is independent of π.

Nunn (2007) finds, empirically, that poor contract quality deters trade. Our model is consistent with this: a rise in c cuts $\overline{V_S}$ and hence raises π^* (which implies that there will be fewer firms, and less aggregate production/trade, in the industry). Crucially, this effect will also be increasing with respect to contract intensity, which is perhaps consistent with Nunn's (2007) finding that the more contract-intensive goods are, the greater will be the effect of poor contracts in deterring trade. Specifically, we derive (in the Appendix) that

$$\frac{\partial^2 \overline{V_S}}{\partial \beta \partial c} = \frac{2\rho}{\theta}\beta c + \frac{\partial \overline{V_S}}{\partial (\beta c)} - \frac{2\rho}{\theta}\beta c\left(\frac{\partial \overline{V_S}}{\partial (\beta c)}\right)^2. \tag{13}$$

so that the effect of contracting costs, c, is greater for goods where contract-intensity, β,is greater. Indeed, the term in square brackets is positive, so that the second differential is not just positive, but greater than 1.

These effects are also greater where contracts are lumpier, as we can see by differentiating (13) with respect to ρ,

which only appears on the numerator.

Finally, in relation to Nunn (2007), we can show that, as well as deterring trade (through its effect on N), a rise in c increases the probability that a searching firm will merge (i.e. reduces μ_R). **If the endogeneity of μ_R is allowed for, then we can show that the fall in N following a rise in c will be smaller than if μ_R is considered to be a constant .** That is, rapid FDI provides a route for firms to bypass the problem of poor local institutions.

4 Discussion

We first examine the effect of growth over time in the number of Northern firms on the merged/contracting composition of the industry. Assume that N grows at some steady rate, g, over time, due to increases in unmodelled aspects of the π function (perhaps final demand is growing).[17] Denote by M_t the expected number of merged firms in period t. Therefore:

$$M_t = M_{t-1} + \Pr\{\text{merge}\}\left(gN_{t-1} + N_{t-1} - M_{t-1}\right), \tag{14}$$

where the term in brackets on the RHS is the number of unmerged firms at the start of period t. Rearranging and dividing through by N_t, we get

$$m_t = \Pr\{\text{merge}\} + \frac{\Pr\{\text{contract}\}}{1+g} m_{t-1}, \tag{15}$$

[17] We focus on *positive steady-state* growth for empirical reasons, and also because it means that no incumbent firm will ever have to consider the prospect of exiting the industry, which would make modelling considerably more complicated.

where m_t is the expected share of merged firms in the industry at the end of period t, $Pr\{\text{merge}\} = 1 - \frac{\mu_R}{\mu_M}$ and $Pr\{\text{contract}\} = \frac{\mu_R}{\mu_M}$.

. Equation (15) defines a stable AR(1) process (since the coefficient on m_{t-1} is strictly less than one), with an equilibrium value of

$$m^* = \frac{\left(1 - \frac{\mu_R}{\mu_M}\right)(1+g)}{1 + g - \frac{\mu_R}{\mu_M}}. \tag{16}$$

If $g = 0$, then $m^* = 1$, as expected. Also $\frac{\partial m^*}{\partial g} = \frac{\frac{\mu_R}{\mu_M}\left(\frac{\mu_R}{\mu_M} - 1\right)}{\left(1+g-\frac{\mu_R}{\mu_M}\right)^2} < 0$, so m^* is declining in g. So, a faster steady-state growth path implies a higher ratio of contracting firms to merging ones.

Note that steady-state growth at a positive rate, g, is consistent with a stationary competitive environment, π,facing firms. In a growing economy, assuming that wages grow in line with productivity, π will remain at a level where new firms are indifferent whether or not to enter the market

Influence of μ_R: For a given growth rate of demand, the long-run equilibrium share of contracting to merged firms is lower, the lumpier is contracting or the poorer the contracting environment, (higher c). In turn, μ_R is decreasing with respect to ρ or c.

Relationship to Chinese data. *Figure 1*, above, shows the growth of both contracting and outsourcing in Chinese exports over time. An important point is that the growth in Chinese exports has been from a very low base, following the economic reforms of the early 1980s. Consequently, in the early years, both contracting and FDI were liberalised rapidly, allowing for interfirm exports to start adjusting to a much higher (and rapidly growing) equilibrium. Our model indicates two important relationships here. Firstly, as observed, the initial growth was predominantly in the form of contracting. This is a disequilibrium situation, since firm pairings who start trading will initially prefer the flexibility of contracting. However, it is notable that, while the ratio of FDI to contracting has risen over time, there remains a significant share of contracted export sales. This is sensible, in terms of our model, given the high growth rate of Chinese exports over the period.

We argue that this dynamic interpretation is both very different to, and considerably more realistic than previous, comparative static models of contracting or FDI. For example, in Grossman and Helpman's (2002) framework, we would expect a high share of FDI where the initial choice of local suppliers is low. On that basis we would anticipate a high rate of FDI initially in China, when export industries were small, but lower in recent years, as new Chinese suppliers have sprung up.

Next, we consider some **efficiency issues**. We consider how changes in the reservation match quality, μ_R, affect social welfare. Recall that a rise in μ_R reduces the probability that a searching firm will merge in any period because $\Pr\{\text{merge}\} = 1 - \left(\frac{\mu_R}{\mu_M}\right)$.

The model in this paper has been chosen for simplicity and tractibility. Recall that, in Section 2, following Maclaren (2000), we assume that the increase in firms' profits from match quality, $\alpha\mu$, is entirely in the form of reduced fixed costs. Hence, in this simple version, marginal costs of production are unchanged, and firm scale will be unchanged. It is therefore reasonable to assume that the number of firms in the industry, N, and the degree of product market competition, reflected in π, will remain constant; this means that changing μ_R will not bring any welfare effects through consumer surplus.[18] Thus, the division of the industry between merged and contracting firms affects social welfare solely through its impact on fixed costs.[19]

We assume that the market opened with N unmatched Northern firms at the start of period 1. In period $J \geq 1$, the expected number of contracting firms is $N\left(\frac{\mu_R}{\mu_M}\right)^J$, where $\Pr\{\text{contract}\} = \frac{\mu_R}{\mu_M}$. Thus, in period J, the total expected reduction in fixed costs per firm (after a little simplification) is

$$\frac{E(R_J)}{N} = \alpha\frac{\mu_R + \mu_M}{2} - \left(\frac{\mu_R}{\mu_M}\right)^J \left[\beta c + \alpha\frac{\mu_M}{2}\right] - \left(\frac{\mu_R}{\mu_M}\right)^{J-1} S, \tag{17}$$

where $\alpha\frac{\mu_R}{2} - \beta c$ and $\alpha\frac{\mu_R+\mu_M}{2}$ are the expected fixed-cost reductions for a contracting and a merged firm, respectively. The final term on the RHS captures the payment of search costs by unmerged firms; note that, in period 1, all firms must pay S (hence the $J-1$ exponent). Note also that $E(R_J)/N$ tends to $\alpha\frac{\mu_R+\mu_M}{2}$ as J tends to ∞ since, in the limit, all firms are merged.

There is an interesting trade-off between short-run and long-run welfare. Increasing μ_R increases long-run welfare, which we think of as the expected fixed-cost reduction when all firms are merged; that is, it increases

[18] Typically, of course, changes in exogenous parameters will alter both μ_R and $\overline{V_S}$.

[19] Note also that because N is fixed and the merge/contract decision affects only fixed costs, the social planner's intertemporal problem will be identical to that faced by a representative firm's – i.e. they will both choose the same μ_R cut-off. (That is, the problems of maximising expected profits and maximising expected social welfare are identical.)

the average quality of a merger.[20] However, increasing μ_R also makes firms slower to merge, which means that they incur the costs of contracting for longer. This reduces short-run welfare. (For example, setting $J = 1$ and differentiating (17) with respect to μ_R, we get $\frac{dE(R_1)/N}{d\mu_R} = -\frac{\beta c}{\mu_M} < 0$.) In essence, a higher μ_R results in better mergers (which is good in the long run) but also slower mergers (which is bad in the short run).

This highlights an interesting aspect of the search process: from the social viewpoint it can be viewed as a form of capital formation, which incurs a cost in the short run, but (over the whole stock of firms) yields a saving in the longer run.

5 Conclusions

In common with a number of previous studies, we have examined the role of search in the choice between an outsourcing relationship or vertical FDI. The main difference is that search is seen as an ongoing process, with aspects of learning-by-doing. The value of outsourcing is its relative flexibility, while the main value of FDI is to reduce transational costs, which in turn vary according to the national legal/institutional environment.

Our model produces a number of interesting predictions. Merger is seen as the outcome of this dynamic process. Merger will take place only when a firm finds a partner sufficiently well-matched that the gains from integration (such as ability to coordinate activities without jeopardising the privacy of intellectual property) outweigh the advantages of flexibility. The merger decision, at the firm level, is stochastic, but across many firms it will depend upon a combination of industry and country-specific characteristics. Some industries show higher match-sensitivity of profits (which encourages search), while others are very contract-intensive (deterring search, particularly in countries where the national legal/institutional environment is unsupportive of contracting). Some industries require lumpier contracts (essentially higher relationship-specific costs mean that changing partners needs to be less frequent) -this deters search and speeds merger. On the other hand, while factors which make short-run contracting expensive may lead to faster merger, beyond a point they will deter search completely. Our analysis provides theoretical support to the tradition

[20] **IMPORTANT:** Note that we are here treating μ_R, μ_M, α, S and βc as independent. Thus, from (6), the underlying cause of the variation in μ_R must be a change in ρ.

of Nunn (2007) in emphasising the importance of legal/institutional quality as a determinant of trade, at least within differentiated industries with high relationship-specific costs.

A key feature of our model is that it differentiates static and dynamic results. Poor institutional quality is particularly costly to outsourcers. On the one hand, it may deter search altogether, by raising the reservation price of searching firm pairings in a particular market. However, if underlying comparative advantage is strong, then this may offset the increased search costs, so that firms still engage in search. In this case, the FDI decision will be sped up - consequently, we would agree in the short-run with Markusen's (1995) OLI finding that poor contract quality favours FDI, although adding the caution that this does not apply in a long-run steady-state, where all firms will merge in our framework.

The dynamics of our model indicate that, as a new exporter grows in size, outsourcing will tend to precede FDI. This is somewhat contradictory to Grossman and Helpman's (2002) prediction (based on a thin markets model with search before trading) that increasing market size will imply an increasing share of outsourcing. We argue that the Chinese experience tends to support our predictions, and perhaps supports the existence of a search-by-matching process.

We also note that a high rate of contracting may be a phenomenon of a dynamic steady-state growth model, where exports are growing steadily and rapidly. In this case, due to overall market growth, the stock of merged firms will never fully catch up with overall trade.

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APPENDIX

Analysis of μ_R, the reservation match quality

From the main text (6), we have

$$\mu_R \equiv (1+\rho)\,\mu_M - \frac{\theta}{\alpha},$$

where

$$\theta \equiv \sqrt{\alpha\mu_M\rho\,(1+\rho)\,[\alpha\mu_M + 2\,(\beta c + S)]}.$$

We note first that our condition that $\mu_R < \mu_M$ if $\alpha\mu_M, \rho > 0$. $\mu_R < \mu_M$ requires $\theta > \alpha\mu_M\rho$. Squaring both sides and simplifying, this becomes

$$\alpha\mu_M + 2\,(1+\rho)\,(\beta c + S) > 0,$$

which holds if $\alpha\mu_M > 0$. This implies that a Northern firm will always merge with a match of maximal quality, *even if contracting and search are both costless* (i.e. $\beta c = S = 0$). This makes intuitive sense because if a Northern firm meets a top-quality match, it will want to hold on to it, and merging is the only way that it can do so.

Second, given that $\alpha, \mu_M > 0$ and $\rho \geq 0$, we note that $\mu_R > 0$ iff

$$\alpha\frac{\mu_M}{2} > \rho\,(\beta c + S)\,. \qquad (18)$$

We make this condition a maintained assumption in what follows, and it implies that contracting is chosen with strictly positive probability by a searching Northern firm. (Thus, if (18) fails, then a Northern firm always merges with its first match.) From (18), contracting is more likely to be chosen with strictly positive probability: the more important is goodness of fit (α); the higher is expected match quality ($\mu_M/2$); the more patient are firms (ρ); and the lower are the costs of contracting and searching ($\beta c, S$).

Comparative-statics analysis of μ_R: Results

1. *The contract/merge choice is independent of competitive pressure within the industry:* $\frac{\partial \mu_R}{\partial \pi} = 0$. This is intuitive because a firm pairing earns the same level of variable profits, π, under both contracting and merger.

2. *Increases in the costs of contracting and search both decrease the probability of contracting:* $\frac{\partial \mu_R}{\partial (\beta c)}, \frac{\partial \mu_R}{\partial S} < 0$. This is obvious from inspection and makes intuitive sense.

3. *An increase in the importance of goodness of fit increases the probability of contracting:*

$$\frac{\partial \mu_R}{\partial \alpha} = (\beta c + S) \sqrt{\frac{\mu_M \rho (1+\rho)}{\alpha^3 \left[\alpha \mu_M + 2(\beta c + S)\right]}} > 0.$$

(But note that the probability of merging always remains strictly positive, i.e. $\mu_R < \mu_M$.) This is intuitive, since the greater the importance of goodness of fit, the greater are the potential gains from searching.

4. *An increase in the maximal level of match quality increases the probability of contracting,* μ_R/μ_M:

$$\frac{\partial (\mu_R/\mu_M)}{\partial \mu_M} = (\beta c + S) \sqrt{\frac{\rho (1+\rho)}{\alpha \mu_M^3 \left[\alpha \mu_M + 2(\beta c + S)\right]}} > 0.$$

From this, it follows that $\frac{\partial \mu_R}{\partial \mu_M} \gg 0$, i.e. a rise in μ_M increases μ_R more than proportionately.

5. *An increase in the discount rate reduces the probability of contracting:* $\frac{\partial \mu_R}{\partial \rho} < 0$. We get

$$\frac{\partial \mu_R}{\partial \rho} = \mu_M - \frac{1+2\rho}{2} \sqrt{\frac{\mu_M \left[\alpha \mu_M + 2(\beta c + S)\right]}{\alpha \rho (1+\rho)}}$$

Therefore, $\partial \mu_R / \partial \rho < 0$ iff $(1+2\rho)\sqrt{\mu_M [\cdot]} > 2\mu_M \sqrt{\alpha \rho (1+\rho)} > 0$. Squaring both sides and simplifying gives

$$\alpha \mu_M + 2(\beta c + S)\left[1 + 4\rho(1+\rho)\right] > 0,$$

which clearly holds for all $\alpha \mu_M > 0$.

Proposition: *The following all increase the probability that (or speed with which) a searching Northern firm will merge: rises in the discount rate* (ρ) *and in the costs of contracting* (βc) *and search* (S)*; and falls in the return to match quality* (α) *and the maximal level of match quality* (μ_M)*. The probability (or speed)* *of merger is unaffected by the degree of competition within the industry (π).*

Comparative-statics analysis of the number of firms under free entry: Results

We assume that π is strictly decreasing in the number of Northern entrants. Therefore, because $\frac{\partial \overline{V_S}}{\partial \pi} = \frac{1}{\rho} > 0$, entry by Northern firms continues until $\overline{V_S}$ is driven down to E. We can analyse how parameter changes affect the free-entry number of firms by differentiating $\overline{V_S}$ w.r.t. the parameter in question; and we note that entry does not itself affect the probability/speed of merger (see Proposition above). Overall, therefore, parameter changes affect industrial structure through two distinct channels: changes in the number of Northern entrants, and changes in the probability/speed of merger by searching Northern firms.

Substituting into $\overline{V_S}$ for μ_R, and simplifying, we get

$$\overline{V_S} = \beta c + \frac{1}{\rho}\left[\pi + \alpha\left(1+\rho\right)\mu_M - \theta\right]. \tag{19}$$

We obtain the following comparative-statics effects:

1. *Increases in the costs of search (S) and contracting (βc) both decrease the number of firms:* $\frac{\partial \overline{V_S}}{\partial S}, \frac{\partial \overline{V_S}}{\partial(\beta c)} <$

0

$$\frac{\partial \overline{V_S}}{\partial S} = -\frac{1}{\rho}\sqrt{\frac{\alpha\mu_M\rho\left(1+\rho\right)}{\alpha\mu_M + 2\left(\beta c + S\right)}} < 0$$

$$\frac{\partial \overline{V_S}}{\partial\left(\beta c\right)} = 1 - \frac{1}{\rho}\sqrt{\frac{\alpha\mu_M\rho\left(1+\rho\right)}{\alpha\mu_M + 2\left(\beta c + S\right)}}$$

$\frac{\partial \overline{V_S}}{\partial(\beta c)} < 0$ iff $\sqrt{\cdot} > \rho$. Squaring both sides and simplifying, we get $\frac{\partial \overline{V_S}}{\partial(\beta c)} = 0$ iff (**??**) holds, and consequently $\frac{\partial \overline{V_S}}{\partial(\beta c)} < 0$ iff (18), which is a maintained assumption: thus, $\frac{\partial \overline{V_S}}{\partial(\beta c)} < 0$. (This finding that $\frac{\partial \overline{V_S}}{\partial(\beta c)} < 0$ iff $\mu_R > 0$ makes intuitive sense: if contracting is never chosen ($\mu_R = 0$), then changing the cost of contracting, βc, clearly won't affect a Northern firm's entry incentive.)

2. *An increase in the return to a top-quality match ($\alpha\mu_M$) increases the number of firms:* $\frac{\partial \overline{V_S}}{\partial(\alpha\mu_M)} > 0$

$$\frac{\partial \overline{V_S}}{\partial\left(\alpha\mu_M\right)} = \frac{1+\rho}{\rho}\left[1 - \frac{\rho\left(\alpha\mu_M + \beta c + S\right)}{\theta}\right]$$

The term in the square brackets will equal 0 when

$$\rho = \frac{\alpha\mu_m (2\beta c + \alpha\mu_m + 2s)}{(2\beta c + s)^2}.$$

Substituting this into the equation for μ_R implies $\mu_R = -\frac{\mu_m(\beta c + \alpha\mu_m + s)}{\beta c + s} < 0$. Higher values of μ_R than this require lower ρ, which will make $\frac{\partial \overline{V_S}}{\partial(\mu_M)}$ positive. Thus, $\partial \overline{V_S}/\partial(\alpha\mu_M) > 0$.

3. *An increase in the discount rate (ρ) reduces the number of firms: $\partial \overline{V_S}/\partial\rho < 0$*

$\partial \overline{V_S}/\partial\rho < 0$ requires

$$\pi + \alpha\mu_M > \theta - \rho\frac{\partial\theta}{\partial\rho},$$

which, after substituting in for the terms in θ and manipulating, gives

$$4(1+\rho)(\pi + \alpha\mu_M)^2 > \alpha\mu_M\rho\left[\alpha\mu_M + 2(\beta c + S)\right].$$

By setting $\pi = 0$ and rearranging, we get the following *sufficient* condition for $\partial \overline{V_S}/\partial\rho < 0$: $\alpha\mu_M(4+3\rho) > 2\rho(\beta c + S)$. It is straightforward to show that our maintained condition (18) is more demanding than this sufficient condition (because $4 + 3\rho > 1$). Thus, $\partial \overline{V_S}/\partial\rho < 0$.

Proposition: *The following all increase the number of Northern firms in the industry in free-entry equilibrium: a rise in the return to a top-quality match ($\alpha\mu_M$); and falls in the discount rate (ρ) and in the costs of contracting (βc) and search (S).*

We can now bring our two Propositions together to describe the overall effect of parameter changes on industrial structure:

Proposition: *A change in any of the exogenous parameters ($\rho, \alpha, \mu_M, \beta, c, S$) pushes the probability/speed of merger (at the level of the firm) and the equilibrium number of Northern firms in the industry in opposite directions.*

Thus, for example, increases in ρ, (βc) and S all increase Prob{merge} but decrease the equilibrium number of firms; whereas increases in α and μ_M both decrease Prob{merge} but increase the number of firms.

Some speculation: The last Proposition, together with the fact that in the long run all the firms in the industry tend to merge, suggests that parameter changes might have complex effects on the time profile of aggregate FDI. For example, a fall in (βc) reduces the probability that a searching firm will merge in any period, but it also increases the equilibrium number of Northern firms within the industry. There will therefore be a rise in (the stock of) FDI in the long run but, depending on how the probability and firm-numbers effects interact, the volume of FDI/merger activity in the short run might rise or fall.**HERE**

A welfare conjecture (poss. relevant to p. 15/16 of paper): Because a firm's contract/merge decision has no "external" effects (either on other firms or on consumers), a social planner would choose the same probability/speed of merger as firms themselves. However, because entry harms incumbents, a social planner might choose a different (lower?) number of entrant firms (Mankiw and Whinston, *RAND*, 1986).

Nunn (2007): relationship-specificity and inpact of the legal system on trade.

Nunn's main finding was that countries with better contract enforcement tend to specialise in trade in industries with important relationship-specific investments. In our model, contract enforcement is proxied by parameter c, while contract intensity is β.

$$\overline{V_S} = \beta c + \frac{1}{\rho}\left[\pi + \alpha\left(1+\rho\right)\mu_M - \theta\right]. \tag{20}$$

Note that, using the chain and product rules of differentiation

$$\frac{\partial^2 \overline{V_S}}{\partial\beta\partial c} = \frac{\partial \overline{V_S}}{\partial\left(\beta c\right)} + \beta c \frac{\partial^2 \overline{V_S}}{\partial\left(\beta c\right)^2}.$$

$$\theta \equiv \left[\alpha\mu_M\rho\left(1+\rho\right)\left[\alpha\mu_M + 2\left(\beta c + S\right)\right]\right]^{\frac{1}{2}} \Longrightarrow \frac{\partial\theta}{\partial\left(\beta c\right)} = \alpha\mu_M\rho\left(1+\rho\right)\theta^{-1}.$$

$$\frac{\partial \overline{V_S}}{\partial(\beta c)} = 1 - \frac{1}{\rho}\frac{\partial \theta}{\partial(\beta c)} = 1 - \alpha \mu_M (1+\rho)\,\theta^{-1} > 0.$$

Differentiating again implies

$$\frac{\partial^2 \overline{V_S}}{\partial(\beta c)^2} = 2\frac{\alpha \mu_M (1+\rho)}{\theta^2}\frac{\partial \theta}{\partial(\beta c)} = \frac{2\rho}{\theta}\left(1 - \left(\frac{\partial \overline{V_S}}{\partial(\beta c)}\right)^2\right).$$

Hence

$$\frac{\partial^2 \overline{V_S}}{\partial \beta \partial c} = \frac{2\rho}{\theta}\beta c + \frac{\partial \overline{V_S}}{\partial(\beta c)} - \frac{2\rho}{\theta}\beta c\left(\frac{\partial \overline{V_S}}{\partial(\beta c)}\right)^2.$$

This is a quadratic in $\frac{\partial \overline{V_S}}{\partial(\beta c)}$. Hence it will equal a constant, k, when

$$\frac{\partial \overline{V_S}}{\partial(\beta c)} = \frac{-1 + k \pm \sqrt{1 - 4\left(\frac{2\rho}{\theta}\beta c\right)^2}}{2\frac{2\rho}{\theta}\beta c}.$$

This must be positive. The larger root is the positive root. The smallest value of k for which $\frac{\partial \overline{V_S}}{\partial(\beta c)}$ is nonnegative is where

$$k = 1 - \sqrt{1 - 4\left(\frac{2\rho}{\theta}\beta c\right)^2} > 0.$$

Hence, there is no feasible solution consistent with $\frac{\partial^2 \overline{V_S}}{\partial \beta \partial c} = 0$ and $\frac{\partial \overline{V_S}}{\partial(\beta c)} > 0$.

Hence, we conclude that $\frac{\partial^2 \overline{V_S}}{\partial \beta \partial c} > 0$.

Proposition: *The impact of* contracting cost, c, on the potential competitiveness of an upstream country is greater, the larger is the contract intensity, β, of the industry.