Preliminary and incomplete

ENTREPRENEURSHIP IN INTERNATIONAL TRADE

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Motivated by evidence on the importance of incomplete information and networks in international trade, we investigate the supply of "network intermediation." We hypothesize that the agents who become international trade intermediaries first accumulate networks of foreign contacts while working as employees in production or sales, then become entrepreneurs who sell access to and use of the networks they accumulated. We report supportive results regarding this hypothesis from a pilot survey of international trade intermediaries. We then build a simple general equilibrium model of this type of entrepreneurship, and use it for comparative statics and welfare analysis. One welfare conclusion is that intermediaries may have inadequate incentives to maintain or expand their networks, suggesting a rationale for the policies followed by some countries to encourage large-scale trading companies that imitate the Japanese *sogo shosha*.

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I. Introduction

As classical barriers to international trade such as tariffs and transportation costs have fallen over time, researchers have increasingly focused on informal barriers to trade. One informal barrier is lack of information about international trading opportunities (Portes and Rey 1999). An important way for firms to obtain information is to tap into the "deep knowledge" of intermediaries of the type described by Rhee and Soulier (1989, p. 25):

> As highlighted in our Hong Kong survey, the most important resource that ETCs [export trading companies] have is their deep knowledge about external markets/buyers and local production capabilities/producers. Without such information, ETCs can hardly be effective in matching potential overseas buyers to local producers....the effectiveness of Japanese, Korean, and Hong Kong GTCs [general trading companies] has been based on the depth of their product-market knowledge and of the supplier-buyer network.

Such intermediaries can be characterized as selling access to and use of the networks of contacts they have accumulated (Rauch 2001, section 6).[1]

What are the sources of supply of these kinds of international trade intermediaries? The literature is virtually silent on this question, but there exist many suggestive anecdotes: a former mergers and acquisitions officer for Chase Manhattan in Hong Kong who now matches leisure-related, California-based businesses with Asian partners (Miller 1997); an industrial engineering consultant who had designed factory layouts throughout Asia, who now matches U.S. toy designers with Chinese toy manufacturers (Bigelow 1997); a leader of Daewoo's team of machine installation specialists and production line experts assigned to Bangladesh, who

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[1]These contacts could include local distributors, for example. In her study of "home bias" in international trade, Evans (2001) finds that if a firm establishes and sells from a subsidiary located in the foreign country, its local sales are nearly on a par with those of domestic firms in that market. She concludes that home bias arises from pure locational factors such as access to a local distribution network rather than inherent preference for domestic goods per se.

subsequently opened a firm "engaged exclusively with the import and export trade of Bangladesh's new garment factories" (Rhee 1990, p. 342). Such anecdotes, and intuition, suggest that actors become "network intermediaries" by accumulating deep knowledge of buyers and sellers through working with them in a non-intermediary capacity, then connecting other firms to those with whom they formerly worked when this becomes more profitable. This involves a change of role from employee to entrepreneur. We conjecture that this is a major mode of entrepreneurship in international trade, and we offer empirical support for this conjecture in the next section.

In the remainder of this paper, we develop and analyze a simple general equilibrium model of entrepreneurship (network intermediation) in international trade along the lines suggested above. An advantage of our formal approach is that we can evaluate the efficiency with which intermediation is likely to be supplied, and we can develop policy recommendations. One reason to anticipate the possibility of market failure is that, because the intermediary needs deep knowledge of the members of his network in order to know which is the best match for his client, the quality of service he provides his client is inherently unverifiable.[2] Without the ability to contract on the surplus he creates, the intermediary must rely on his bargaining power in the spot market, but this is limited because the specificity of each match leaves the intermediary with poor alternative transactions if bargaining breaks down.

Our model shows that, in equilibrium, there can be too much or too little intermediation,

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[2]In other words, the contracting problem is not caused by a weak international legal framework but rather is caused by the impossibility of verifying within the best feasible legal framework whether the quality of service promised was delivered, even if it were possible to write such a contract.

depending on the intermediaries' bargaining power and the technology of intermediation. We demonstrate how the equilibrium depends on various parameters, including the cost of maintaining a network and the distribution of network sizes in the population. We also prove that the optimal level of intermediation can be achieved by manipulating the power the intermediaries have in negotiation, and we illustrate the merit of some policies that encourage intermediaries to maintain large networks.

II. Motivating Evidence from a Pilot Survey of International Trade Intermediaries

In order to recognize whether a certain international trade intermediary fits the ideal type "network intermediary," it is helpful to have a contrasting ideal type. A natural alternative hypothesis is that international trade intermediaries provide standard wholesaling services. We would expect this to be true of intermediaries that primarily handle bulk commodities, where deep knowledge should not be necessary to match the products of specific sellers to the needs of specific buyers. Consider, for example, the career path of an entrepreneur who founded a firm that, as its main international business, buys waste paper in the United States and sells it (after some processing done outside the firm) in East Asia.[3] His first job was as a trader on a commodity exchange in the U.S. mid-Atlantic region. When he learned of a law mandating paper recycling in Los Angeles, he saw a business opportunity because he knew what companies were willing to pay for processed lumber to make paper, and computed that he could buy waste paper and turn it into a substitute raw material at lower cost. He had no previous experience with

[3] This entrepreneur was interviewed as part of the pre-test of the survey instrument used below but is not included in the sample used to produce the summary statistics in Table 1.

waste paper, its suppliers, or his East Asian clients. One might say that his entrepreneurship was based on general-purpose rather than specific human capital.

In Table 1 we report summary statistics for seven questions from a pilot survey of international trade intermediaries based in the United States. The survey was refined and pre-tested using interviews with ten San Diego-based international trade intermediaries. In the summer of 2001 it was mailed to a sample of roughly 240 international trade intermediaries culled from the membership lists of U.S. organizations belonging to the World Trade Centers Association. Respondents were asked, "Are you a founding partner of your firm?" and only those who answered "yes" are included in the summary statistics. As suggested by the preceding paragraph, the summary statistics are reported separately for intermediaries who mainly handled differentiated and homogeneous products, respectively, where differentiated and homogeneous are classified as in Rauch (1999).[4] Of course, there are many other potential conditioning variables, but the small number of responses does not allow for any formal statistical analysis. The results in Table 1 should therefore be viewed as intermediate between anecdotes and hypothesis testing; hence the title "motivating evidence" for this section.

From the first three questions in Table 1 we see that on average, when they initiated their businesses, differentiated product intermediaries had previous experience with clients outside of the United States accounting for over half of their international business, and previous experience with over half of the products that they handled internationally and over two-thirds of the

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[4]In this classification, homogeneous commodities have "reference prices" and differentiated commodities do not, where a reference price is defined as a price that is quoted without mentioning a brand name or other producer identification and is typically listed in a trade publication or on an organized exchange.

countries in which they transacted. The percentages for homogeneous product intermediaries are all lower but still substantial, indicating that such experience is an asset for them as well but not as crucial. The next two questions were an attempt to distinguish whether the respondents were operating in a matching market or a market for a competitively supplied service whose price rises and falls with demand and supply.[5] We see that on average homogeneous product intermediaries report their markup rates to be more sensitive to market demand or competitive pressure than do differentiated product intermediaries. Commission rates seem in general to be less sensitive to market forces than markup rates. Rather than taking title to goods and reselling them, we might expect differentiated product intermediaries to work on commission more than homogeneous product intermediaries in order to reduce their exposure to hold-up risk. This expectation is supported by the summary statistics for the last two questions in Table 1. If, on the other hand, the main purpose of intermediaries is to enforce contracts (e.g., Dixit 2001), one might expect intermediaries operating in matching markets rather than in competitive markets to be more likely to assume the burden of contract enforcement by taking title.

In the next section we develop a model of network-based international trade entrepreneurship in a pure matching market. This approach keeps matters simple and highlights the novel aspect of what we have to contribute. We leave to future work development of a mixed model that would be more consistent with our pilot survey results.

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[5]Stahl (1988) models competition between intermediaries buying homogeneous inputs and selling homogeneous "outputs." Spulber (1999, Chapter 3) analyzes various generalizations of Stahl's model.

III. The model

A. Assumptions and notation

Our model is populated by risk-neutral domestic agents who accumulate networks of foreign contacts through their jobs, and then either lead production projects or choose to leave their jobs to become intermediaries (entrepreneurs). Production consists of making a successful match with a foreign contact, who could for example be a distributor of consumer goods or a supplier of components. Producers first attempt to find an appropriate match within their own networks, then go to intermediaries if they fail.[6]

Formally, there is a unit mass of agents. Our model begins with each agent drawing a *network size n* at random from a fixed distribution with support [0,1], where *n* gives the probability of finding an appropriate match within one's network when leading a production project later in one's career. We let μ denote the density function for the distribution of network size, and we assume that μ is continuous and positive on [0,1]. The determination of network sizes by luck alone can be thought of as reflecting a complete lack of predictability regarding which foreign contacts will later prove relevant to production, due to industry turnover, technological change, alterations in market conditions abroad, career moves (e.g, in response to downsizing), etc.[7]

After drawing their network sizes, agents choose whether to become producers or

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[6]For simplicity we do not model purely domestic production as a fallback option. For models with purely domestic production as a fallback option but without intermediaries, see Rauch and Casella (1998) and Rauch and Trindade (2000).

[7]Since all agents are risk neutral and expected income is monotonically increasing in *n*, all agents can be expected to tailor their jobs to accumulate as large networks as possible, leaving variation in *n* across them to completely random sources.

intermediaries. If an agent with network size *n* chooses to be an intermediary, then she pays a cost $c(n)$. This cost captures effort and expenses to establish her business and to maintain her network, which no longer occurs automatically as a byproduct of her job. We assume that the function *c* is differentiable, with $c' \geq 0$.

Our model ends with the implementation of production projects. We choose units so that the value of output produced by a successful match between a producer and a contact in his own network equals one. For simplicity we assume this also equals the producer's income.[8] The expected value of output (and income) from a producer's search for a partner within his own network therefore equals *n*, which is the probability that a producer will find a partner in his own network. If a producer fails to find an appropriate match in his own network, then he matches frictionlessly with an intermediary, who then looks within her network for an appropriate partner for her client. If she locates a partner, the value of output produced equals $f(x_n)$, where *n* is the size of the intermediary's network and x_n is the number (mass) of producers that are served by an individual intermediary with network size *n*. We assume that *f* is differentiable, with $f(0) = 1$, $f(\infty) = 0$, and $f' < 0$.

The function *f* reflects the diminishing efficiency with which the intermediary serves each client as the number of clients increases, for example, due to reduced time available for the intermediary to learn the characteristics of the client firm necessary to match it correctly to her network. We assume that $x_n f(x_n)$ increases with x_n, however, so that total output generated by the services of a given intermediary is increasing in the mass of clients she serves successfully. Note

[8]We do not model foreign income. Our results would be qualitatively unchanged if foreign contacts (the network) were assigned a fixed share of output, even if that share were to differ between matches that do and do not involve an intermediary.

that $nf(x_n)$ is the expected value of output from a match between one producer and an intermediary who has a network size n and a mass of clients x_n.[9] If a successful match between a producer and one of the intermediary's contacts is made, the producer and the intermediary bargain over the division of the value of the resulting output. If bargaining breaks down then each receives zero. We assume negotiation is resolved so that the producer and intermediary receive shares of output $1-\lambda^I$ and λ^I, respectively.

Producers know each intermediary's network size.[10] Given equal bargaining power across all intermediaries, competition will equalize the expected value across intermediaries of output from a producer-intermediary match. Denoting this value by z, we have

$$z = nf(x_n) \quad \textbf{(1)}$$

for every $n \geq z$.[11] Since f is a decreasing function, equation (1) implies that intermediaries with larger network sizes serve larger masses of producers.

When deciding whether to become a producer or an intermediary, an agent with network size n compares the expected incomes from the two careers. If he becomes a producer, his expected income is given by

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[9]We could modify our model to allow an intermediary to raise the probability of a successful match between a producer and one of her contacts above n by searching for producers who will be good matches for her contacts. This would not qualitatively change our results provided that the *ranking* of expected incomes across intermediaries (i.e., by n) does not change.

[10]We could also make the opposite assumption that producers do not know each intermediary's network size, nor do the intermediaries have any way to signal their network sizes. In this case producers are matched uniformly over all the intermediaries. This less efficient matching market between producers and intermediaries does not yield qualitatively different results.

[11]Because $f(x) \leq 1$ for all x, an intermediary with a network size n can offer a match value of at most n. Thus, an intermediary with $n < z$ will not attract any producers.

$$y_n^P = n + (1 - n)(1 - \lambda^I)z. \quad \textbf{(2)}$$

If the agent becomes an intermediary, her expected income is given by

$$y_n^I = \lambda^I g(z/n)z - c(n), \quad \textbf{(3)}$$

where $g(k) \equiv f^{-1}(k)$ for $k \leq 1$ and $g(k) \equiv 0$ for $k > 1$. It follows from equation (1) that $g(z/n)$ gives the mass of producers served by an intermediary with network size n.

B. Equilibrium

Note that two types of decisions are made in our model: (a) agents decide whether to be intermediaries or producers and (b) producers who do not find partners in their own networks decide with which intermediaries to match. A specification of behavior is an *equilibrium* if each agent acts to maximize his payoff, holding fixed the actions of the others. To characterize equilibrium, we start by analyzing an individual agent's career decision in isolation.

Figure 1 shows an agent's expected payoff as a function of his network size n and his career choice, under the assumption that the marginal cost of network maintenance does not exceed the average cost, i.e., $c'(n) \leq c(n)/n$.[12] The figure is drawn taking account of the fact that z, the expected value of output from a producer-intermediary match, is fixed from the point of view of an individual agent. As shown in the figure, expected income as an intermediary increases more than linearly with network size because the number of producers served increases as well as the expected income from serving each producer.[13]

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[12]The assumption $c'(n) > c(n)/n$ can lead to interesting, qualitatively different behavior that is analyzed in section IV.B.

[13]It is interesting that it is the existence of intermediation itself that ensures that in equilibrium intermediaries will be the agents with the largest networks, because intermediation generates a

Figure 1 illustrates the following:[14]

Proposition 1. *Assume the marginal cost of network maintenance does not exceed the average cost. Given a fixed match value z, there exists a cutoff network size* $\underline{n}$ *above which agents optimally choose to become intermediaries and below which agents choose to become producers.*

This proposition is proved by demonstrating that, for given z, y_n^I increases more in response to n than does y_n^P provided that $y_n^I \geq y_n^P$, as shown in Figure 1. The complete proofs of Proposition 1 and all other Propositions are in the Appendix. This result that agents with the greatest network sizes become entrepreneurs is not surprising and is reminiscent of Lucas (1978) in which the agents with the greatest managerial talent become managers. Unlike the distribution of managerial talent, however, the distribution of network sizes is observable and could even be influenced by policy.

Proposition 1 allows us to characterize behavior in terms of the cutoff network size $\underline{n}$ and the competitive match value z. The proposition (see Figure 1) implies that $\underline{n}$ solves

$$\lambda^I g(z/\underline{n})z - c(\underline{n}) = \underline{n} + (1 - \underline{n})(1 - \lambda^I)z. \qquad \textbf{(4)}$$

In the matching market, equilibrium requires the demand for intermediation to equal the supply, i.e., that the mass of producers seeking intermediary services equals the sum of producers served by all intermediaries. Recalling that a producer with network size n needs intermediary services with probability $1 - n$ and that an intermediary with network size n serves a mass of producers

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positive intercept for producers versus a zero intercept for intermediaries in Figure 1.

[14]Figure 1 implies that intermediaries earn greater expected incomes than any producer. This feature of the model does not extend to *realized* (i.e., observed) incomes, however: the very largest intermediaries and producers who find partners within their own networks will have the highest ex post incomes, followed by the smaller intermediaries and producers who find partners with the aid of intermediaries, with producers who fail to find partners at the bottom of the income distribution.

$g(z/n)$, we have

$$\int_0^{\underline{n}} (1-n)\mu(n)dn = \int_{\underline{n}}^1 g(z/n)\mu(n)dn. \quad \textbf{(5)}$$

Equations (4) and (5) define a system in the two unknowns: $\underline{n}$, the cutoff network size, and z, the expected value of output from a producer-intermediary match. Numbers $\underline{n}^*$ and z^* describe an equilibrium if and only if ($\underline{n}^*$, z^*) simultaneously satisfy Equations (4) and (5). We have:

Proposition 2. *When the marginal cost of network maintenance does not exceed the average cost and when* $xf(x)$ *exceeds* $[1 + c(1)]/\lambda^I$ *for some* x*, there exists a unique equilibrium* ($\underline{n}^*$, z^*)*. In equilibrium, there is a positive mass of intermediaries and a positive mass of producers; that is,* $\underline{n}^* \in (0,1)$.

The condition $xf(x) > [1 + c(1)]/\lambda^I$ for some x ensures that intermediation is sufficiently productive that $\underline{n} = 1$ (all agents become producers) is not an equilibrium.

The existence and uniqueness proved in Proposition 2 facilitate the analysis of the next section.

IV. Comparative Statics and Welfare Analysis

A. Comparative statics

Our model permits comparative static analysis of changes in the bargaining power of intermediaries λ^I, the network maintenance cost of intermediaries $c(n)$, the efficiency of intermediation $f(x_n)$, and the distribution of network sizes $\mu(n)$.

Proposition 3. *An increase in the bargaining power of intermediaries or a decrease in their network maintenance cost reduces the equilibrium cutoff network size* $\underline{n}^*$ *and increases the equilibrium expected match value* z^*.

A reduction in the cutoff network size implies an increase in the number of intermediaries, which we would expect to be a consequence of increasing their bargaining power or reducing their network maintenance cost. The increase in the number of intermediaries corresponds to a decrease in the number of producers, so the number of producers handled by a given intermediary must decrease, increasing the expected value of output from a producer-intermediary match by equation (1). This comparative static result for λ^I will be useful in the welfare analysis below because λ^I has no direct effect on aggregate output, but changing it allows one to manipulate the tradeoff between having more producers, on the one hand, and having more output from each producer-intermediary match, on the other hand. An example of a real-world reduction in *c(n)* is the use of the Internet by intermediaries to reduce their need for travel to remain familiar with the characteristics of their foreign contacts.[15]

Proposition 4. *An increase in the efficiency with which intermediaries handle producers increases the equilibrium expected match value* z* *and has an ambiguous effect on equilibrium cutoff network size* $\underline{n}^*$.

The increase in the efficiency of intermediaries has an ambiguous effect on the number of intermediaries because, though it increases the attractiveness of becoming an intermediary relative to becoming a producer, it decreases the number of intermediaries needed to meet the demand for intermediary services. An example of a real-world reduction in $f(x_n)$ is improved scheduling, transactions, and other office software.[16]

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[15]Slightly more than half of the intermediaries in differentiated products who responded to the pilot survey of section 2 stated that the Internet had reduced the amount of time they spent on business travel outside of the United States, with roughly equal numbers indicating that the Internet had reduced their travel time “slightly,” “moderately,” or “dramatically.” No intermediary stated that the Internet had increased the amount of time he spent on foreign travel.

[16]Of course this form of technological progress should also increase the output from a direct match between a producer and a foreign contact, but it should increase the efficiency of intermediaries relatively more since there is no manufacturing or physical transportation component to their service.

Proposition 5. *An improvement in the distribution of network sizes in the sense of first-order stochastic dominance increases the equilibrium cutoff network size* $\underline{n}$* *and the equilibrium expected match value* z*.

This kind of improvement in the distribution of network sizes could result from a reduction in government barriers to international trade, for example, that would be expected to increase the average number of foreign contacts that domestic agents accumulate through their jobs. It is important to note that, although Proposition 5 clearly predicts an increase in the average quality (network size) of intermediaries in response to an improvement in the overall distribution of network sizes, it does not clearly predict a fall in the number of intermediaries. The reason is that the increase in $\underline{n}$ and the improvement in $\mu(n)$ affect the number of intermediaries in opposite directions, whereas they affect average intermediary quality in the same direction.

B. Welfare analysis

We preface our formal analysis with an intuitive discussion of the gains from intermediation in our model. The networks of foreign contacts accumulated by their employees can be seen as under-utilized knowledge assets of domestic firms. Intermediation consists of the entrepreneurial "unlocking" of these assets, making them available to all in return for a share of the profits to be gained from their use. The question then arises as to whether the incentives for this form of entrepreneurship are optimal. Because the intermediaries operate in a matching rather than a competitive market, there are two distortions that work in opposite directions. On the one hand, because agents' career and matching decisions are not jointly contractible (as discussed in the Introduction), intermediaries face a "hold-up problem." On the other hand, the intermediary does not take account of the "business-stealing" externality she imposes on other intermediaries. These distortions imply that, in general, the supply of intermediation in our model will not be optimal, though there will exist a bargaining weight $\lambda^{I\prime}$ that achieves the optimal level of intermediation by exactly counterbalancing the two matching market distortions.[17]

We measure social welfare by expected GDP, which we write as a function of an arbitrary cutoff $\underline{n}$ (not necessarily the equilibrium cutoff level):

$$GDP(\underline{n}) = \int_0^{\underline{n}} [n + (1-n)z]\mu(n)dn - \int_{\underline{n}}^1 c(n)\mu(n)dn. \quad \textbf{(6)}$$

Here z is assumed to be the value that satisfies the market-clearing equation (5) for the given value $\underline{n}$. It can immediately be seen that lowering the cutoff network size $\underline{n}$ and thereby increasing the number of intermediaries directly reduces output (the first term) and raises costs (the second term), but at the same time the increased number of intermediaries per producer indirectly raises output by increasing z. The first Proposition of this subsection establishes that at least some intermediation is required to maximize social welfare:

Proposition 6. GDP *is maximized by some* $\underline{n}' \in (0,1)$.

The intuition for this Proposition is that when the number of intermediaries is very small, an increase in that number causes a large decrease the number of producers per intermediary and hence a large increase in the expected value of output from a producer-intermediary match.

The next Proposition establishes that the social welfare maximum can be implemented as a market equilibrium by an appropriate choice of bargaining weight between intermediaries and producers:

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[17]Hosios (1990, esp. pp. 285-6) has shown that the existence of a sharing rule that implements the social optimum is a common feature of many models of search and matching.

Proposition 7. *There exists a value* $\lambda^{I\prime} \in (0,1)$ *for which the equilibrium* $\underline{n}^*$ *equals the* GDP-*maximizing* $\underline{n}'$*, so* GDP *is maximized in equilibrium.*

The intuition for Proposition 7 is that, although the bargaining weight does not affect expected GDP directly, it can be used to achieve the level of $\underline{n}$ that maximizes expected GDP in Proposition 6.

By assuming a constant elasticity functional form for $f(x)$, we can gain more insight into the nature of the distortions in our model that in general lead the market equilibrium to be sub-optimal. Let $f(x_n) = x_n^{-\beta}$ for $x_n \geq 1$ and $f(x_n) = 1$ for $x_n < 1$, where $\beta \in (0,1)$ is necessary to ensure that $x_n f(x_n)$ increases with x_n and that $f' < 0$ for $x_n \geq 1$. We then have $x_n = g(z/n) = (z/n)^{-1/\beta}$ for $n \geq z$, while for intermediaries with network sizes $n < z$ we have $x_n = 0$. Note that, in equilibrium, no intermediary will serve fewer than one producer.[18] We can now show that the business-stealing externality that the entry of one intermediary imposes on other intermediaries decreases with β, the degree of diminishing returns in the provision of intermediary services. Entry increases z, and we have $dx_n/dz = -(1/\beta)(n/z)^{1/\beta}(1/z)$, which decreases (in absolute value) in β for $n \geq z$. As the business-stealing externality falls, so should the tendency to have excessive entry into intermediation. It should thus be the case that the difference between the market-equilibrium population share of intermediaries and their welfare-maximizing population share decreases with β. It should also be the case that $\lambda^{I\prime}$ increases with β, since as the business-stealing externality is reduced the offsetting hold-up problem should also be reduced to maintain optimal entry into intermediation. Remarkably, it can actually be shown that $\lambda^{I\prime} = \beta$.

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[18]The assumption $f' < 0$ is violated for $x_n < 1$, but, because in equilibrium all intermediaries serve more than one producer, we can ignore this region of the function's domain. One can easily find a function that satisfies all of our assumptions and produces identical simulation results.

For a uniform distribution of network sizes $\mu(n)$, the market-equilibrium and welfare-maximizing population shares of intermediaries are given by $1 - \underline{n}^*$ and $1 - \underline{n}'$, respectively. The simulation shown in Figure 2 plots $1 - \underline{n}^*$ and $1 - \underline{n}'$ against the degree of diminishing returns in provision of intermediary services, given $\mu(n) = 1$, $c(n) = 0.1n$, and $\lambda^I = 0.5$ (equal division of match value between intermediaries and producers). As β increases from 0.25 to 0.75, the excess share of the population engaged in intermediation declines monotonically from 6.4 percent to -7.6 percent. The market-equilibrium and welfare-maximizing population shares are equal for $\beta = 0.5$ because this yields $\lambda^{I\prime} = \lambda^I$.

In this subsection we have so far retained the assumption introduced with Proposition 1 that the marginal cost of network maintenance does not exceed the average cost. With non-negative fixed costs, non-increasing marginal costs is sufficient to satisfy this assumption. It can be argued, however, that increasing marginal cost of network maintenance is a more realistic assumption than non-increasing marginal cost because an agent's contacts can be ranked by "distance," either in physical space or in knowledge or social space, and maintenance of more distant contacts should be more expensive.[19] Figure 3 illustrates the case where increasing marginal costs of network maintenance cause agents with very large networks to discard some of their contacts when they are intermediaries: they concentrate on their "core competencies," as it were, by reducing their network sizes to $\bar{n}$. This need not happen (the derivative of y_n^I with respect to n in equation (3) need not turn negative), in which case Figure 3 does not yield

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[19]This may be much less true in a purely domestic context, which could explain why large-scale, diversified intermediaries are much more common for domestic transactions than for international transactions, at least in the United States (see Rauch 2001).

qualitatively different behavior than is shown in Figure 1 (or equivalently, $\bar{n} = 1$).[20]

In the case illustrated by Figure 3, the market-clearing equation (5) and the expected GDP equation (6) need to be modified as follows:

$$\int_0^{\underline{n}} (1-n)\mu(n)dn = \int_{\underline{n}}^{\bar{n}} g(z/n)\mu(n)dn + \int_{\bar{n}}^1 g(z/\bar{n})\mu(n)dn \qquad \textbf{(5}'\textbf{)}$$

$$GDP(\underline{n},\bar{n}) = \int_0^{\underline{n}} [n + (1-n)z]\mu(n)dn - \left[\int_{\underline{n}}^{\bar{n}} c(n)\mu(n)dn + \int_{\bar{n}}^1 c(\bar{n})\mu(n)dn\right]. \qquad \textbf{(6}'\textbf{)}$$

Equilibrium is then determined by equations (4) and (5′) and the first-order condition for $\bar{n}$:

$$-\lambda^I g'(z/\bar{n})(z/\bar{n})^2 = c'(\bar{n}). \qquad \textbf{(7)}$$

We denote by ($\underline{n}^*$, $\bar{n}^*$, z^*) an equilibrium in this environment.

Equation (7) immediately raises the possibility that, given $\lambda^I < 1$, there will be "money left on the table" from the point of view of society: partial equilibrium reasoning suggests that intermediaries with very large networks should pare them back until the marginal cost of network maintenance equals the marginal contribution of network size to the *total* output generated by these intermediaries, rather than the marginal contribution to the intermediaries' *share* of the output they generate. Does this reasoning work in general equilibrium? A policy that acts like an increase in λ^I, such as a subsidy to intermediaries, might actually lower welfare by exacerbating a problem of excessive entry into intermediation.

As it turns out, we can prove that a policy that causes a small increase in $\bar{n}$ from $\bar{n}^*$ must increase social welfare if financed in a non-distortionary manner:

Proposition 8: *Assume* $x_n f(x_n)$ *is concave. If* $\bar{n}^* < 1$*, a policy that induces intermediaries to*

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[20]Figure 3 is drawn so that increasing marginal cost of network maintenance leads to violation of the assumption that marginal cost does not exceed average cost, allowing y_n^I not to increase more in response to n than does y_n^P for some $y_n^I \geq y_n^P$. This can cause Proposition 1 to fail if $\lambda^I g(z/\bar{n})z - c(\bar{n}) < 1$ so that agents with very large network sizes choose to become producers. Only the case $\lambda^I g(z/\bar{n})z - c(\bar{n}) > 1$ (shown in Figure 3) is analyzed in the text.

slightly increase $\bar{n}$ *has the effect of raising expected GDP.*

The intuition for Proposition 8 is that, by targeting inframarginal intermediaries, policy makers can leave the total number of intermediaries unchanged while improving the quality of intermediation.

Since we assume that producers can observe the network sizes of intermediaries, it is reasonable to assume the government can as well so that an incentive scheme that raises $\bar{n}$ is feasible in principle. In fact, some governments have implemented incentive schemes that could be interpreted as attempts to raise the maximum network size of international trade intermediaries. In 1975 the Korean government introduced a package of subsidies intended to stimulate the formation of "General Trading Companies" (GTCs). Among the criteria a firm had to meet to qualify for the subsidies were a minimum annual value of total exports and a minimum number of export items in excess of US$1 million (Lee 1987, Table 2). In the late 1970s and the 1980s the Turkish government phased in a subsidy package for "Foreign Trade Companies" (FTCs), which like the Korean GTCs had to meet a minimum annual export value criterion to qualify (Krueger and Aktan 1992, pp. 86-89). By 1985 Korea's top seven GTCs handled 47.9 percent of all Korean exports, and the percentage of Turkish exports handled by FTCs grew from 7 percent in 1980 to more than 50 percent by the end of 1988. In 1982 the United States passed and signed into law the Export Trading Company Act, which eased antitrust constraints for registered export trading companies and allowed banks to participate indirectly in exporting, but no subsidies accompanied these regulatory changes. The few subsequent attempts to establish large-scale, diversified U.S. trading companies all failed (Peng 1998, pp. 37-41).[21] Fields (1995, p. 214) attributes the failure of Taiwan's Large Trading Company program to "the feeble nature of incentives," though it may also have been the case that the overseas Chinese network (Rauch and Trindade, forthcoming) made general trading companies redundant for Taiwan.

V. **Conclusions** [in progress]

We developed a model of entrepreneurship in a pure matching market, where intermediaries match firms seeking international trading opportunities to networks of foreign contacts they accumulated during previous industry employment. We assumed that if a successful match between a client and one of the entrepreneur's contacts was made, the client and the entrepreneur bargained over the division of the value of the resulting output, and if bargaining broke down then each received zero. Clearly this assumption is an oversimplification, insofar as both our interviews and our pilot survey indicated that although international markets for differentiated products are thin, there do exist open markets for uncontracted product and intermediaries can (with difficulty) find alternative buyers or suppliers outside their networks. A natural extension of our model, therefore, would be to add a thin open market to which producers or intermediaries could turn if network-based matching fails.

In addition to international trade in differentiated products, our model can be applied to

[21]Peng (1998, p. 2) reports that at the beginning of the 1990s export intermediaries collectively handled approximately 5 to 10 percent of U.S. manufactured exports, whereas intermediaries handled over 40 percent of Japanese exports. This may be linked to the export performance of U.S. firms with less than 500 employees, which were estimated to produce almost half of U.S. GNP but only 10 percent of U.S. exports in 1990.

entrepreneurship in domestic markets that approximate the pure matching type. Agents that match manuscripts to publishers or screenplays to studios and head-hunters that match executives to large corporations probably all fit our model of network intermediation. Moreover, the idea of network-based entrepreneurship does not have to be restricted to intermediation. Many producers of business services or manufactured goods build up client bases, and certain employees within these firms may have primary responsibility for creation and maintenance of some of these client relationships. These employees can and do become entrepreneurs by setting up competing firms and taking with them the clients with whom they worked most closely. Indeed, this mode of entrepreneurship is sometimes subjected to contractual restrictions or litigation. We plan to model this type of entrepreneurship and address the policy issues surrounding it in future research.

PROOFS

Our propositions are restated here. Where useful, they are put in more mathematical terms than appears in the text. The following fact is used in several of the proofs. Our assumption that $xf(x)$ increases with x can be written, in differential form, as $f'(x) > -f(x)/x$. In terms of the inverse function g, this can be expressed as $-g'(k)k > g(k)$.

Proposition 1. *Assume the marginal cost of network maintenance does not exceed the average cost. Given a fixed match value* z*, there exists a cutoff network size* $\underline{n}$ *above which agents optimally choose to become intermediaries and below which agents choose to become producers.*

Proof of Proposition 1: We can characterize the set of agents who become intermediaries by comparing y_n^P and y_n^I for an individual agent, while holding the value of z fixed. Note that an intermediary with a network size below z would have no clients; this means that $y_n^P > y_n^I$ for all $n \leq z$. We shall prove that $y_n^I \geq y_n^P$ implies $\partial y_n^I/\partial n > \partial y_n^P/\partial n$. This, in turn, implies that if an agent with network size n becomes an intermediary then so will all agents with network sizes that are above n. Thus, there is a cutoff network size $\underline{n}$ which has the properties noted in the proposition.

Recall that $y_n^P = n + (1-n)(1-\lambda^I)z$ and $y_n^I = \lambda^I g(z/n)z - c(n)$. Differentiating, we have

$$\partial y_n^I/\partial n - \partial y_n^P/\partial n = \lambda^I g'(z/n)\,(-z^2/n^2) - c'(n) - 1 + (1-\lambda^I)z.$$

Recall that $-g'(k)k > g(k)$. Our assumption that $c'(n) \leq c(n)/n$ can be written $-c'(n) \geq c(n)/n$. Using these to substitute for the first two terms of the previous expression, we obtain

$$\partial y_n^I/\partial n - \partial y_n^P/\partial n > \lambda^I g(z/n)z/n - c(n)/n - 1 + (1-\lambda^I)z.$$

Factoring $1/n$ and rearranging terms, the right side of this inequality can be written

$$(1/n)[\lambda^I g(z/n)z - c(n)/n] - (1/n)[n + (1-n)(1-\lambda^I)z] + (1-\lambda^I)z/n.$$

Noting that the last term is positive, and using the definitions of y_n^I and y_n^P, we therefore have

$$\partial y_n^I/\partial n - \partial y_n^P/\partial n > (1/n)[y_n^I - y_n^P].$$

Thus, $y_n^I \geq y_n^P$ implies $\partial y_n^I/\partial n > \partial y_n^P/\partial n$. *Q.E.D.*

Proposition 2. *When the marginal cost of network maintenance does not exceed the average cost and when* xf(x) *exceeds* $[1 + c(1)]/\lambda^I$ *for some* x*, there exists a unique equilibrium* ($\underline{n}^*$, z^*)*. The equilibrium has the property that* $\underline{n}^* \in (0,1)$.

Proof of Proposition 2: For reference, we rewrite Equations (4) and (5) here:

$$\lambda^I g(z/\underline{n})z - c(\underline{n}) = \underline{n} + (1 - \underline{n})(1 - \lambda^I)z. \tag{4}$$

$$\int_0^{\underline{n}} (1 - n)\mu(n)dn = \int_{\underline{n}}^1 g(z/n)\mu(n)dn. \tag{5}$$

Note that the right side of Equation (5) is decreasing in both $\underline{n}$ and z (because g is decreasing), whereas the left side is increasing in $\underline{n}$. Furthermore, at $\underline{n} = 0$ the integral on the left equals zero, while the integral on the right is strictly positive, whereas at $\underline{n} = 1$ the reverse holds. This implies a well-defined function h: $(0,1) \to (0,1)$ that gives $\underline{n}$ as a function of z; that is, $\underline{n} = h(z)$. Furthermore, h is decreasing and continuous, with $\lim_{z \to 0} h(z) = 1$ and $\lim_{z \to 1} h(z) = 0$ (these follow from our assumptions on f).

Equation (4) implies a function m: $(0,1) \to [0,1]$ that also relates $\underline{n}$ to z; that is, $\underline{n} = m(z)$. That this function is well-defined follows from the analysis underlying Proposition 1; there exists a unique value of $\underline{n}$ for each z. We also have $\lim_{z \to 0} m(z) < 1$ and $\lim_{z \to 1} m(z) = 1$. The first limit is a consequence of our assumption that $xf(x) > [1 + c(1)]/\lambda^I$ for some x, which means $g(z/n)z > [1 + c(1)]n/\lambda^I$ for z sufficiently close to 0. This inequality implies that $y_n^P < y_n^I$ for any fixed n near 1, as z converges to zero. The second limit property is an obvious consequence of the fact that $y_n^P > 0$ and $y_n^I \leq 0$ for any fixed n, as z converges to 1.

The function m is continuous and increasing. We prove the latter using the implicit function theorem. Where z and $\underline{n}$ are interior, we have

$$m'(z) = -\,[\partial(y_n^I - y_n^P)/\partial z]/[\partial(y_n^I - y_n^P)/\partial n].$$

From the analysis in the proof of Proposition 1, and that $y_n^I = y_n^P$ where $n = m(z)$, we see that the derivative with respect to n is strictly positive. The derivative with respect to z is

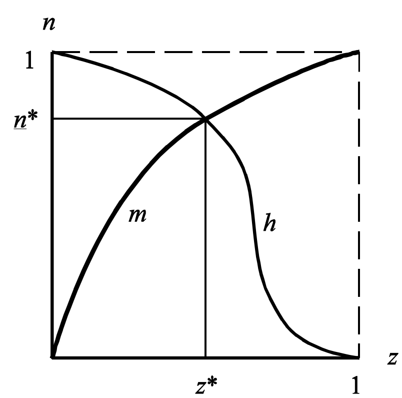
$$\lambda^I\,[g'(z/n)\,z/n + g(z/n)] - (1-n)(1-\lambda^I)z,$$

which is strictly negative because the bracketed term is negative by assumption. Thus, we know that where $m(z) \in (0,1)$, $m'(z) > 0$.

The properties of the functions h and m that we just derived imply that there is a unique number z^* for which $h(z^*) = m(z^*)$. This value z^*, with $\underline{n}^* = m(z^*)$, gives the equilibrium.

Q.E.D.

The proofs of, and intuition behind, propositions 3-5 are aided by the following picture, which illustrates the properties of the functions h and m.



Proposition 3. *Increasing* λ^I *or decreasing* c(·) *implies that* $\underline{n}^*$ *falls and* z* *rises.*

Proof of Proposition 3: This comparative statics exercise amounts to determining the effect on the functions *h* and *m* of a parameter shift. Letting α denote a generic parameter, note that

$$dm(\cdot)/d\alpha = -[\partial(y_n^I - y_n^P)/\partial\alpha]/[\partial(y_n^I - y_n^P)/\partial n],$$

evaluated at $\underline{n} = m(z)$. The denominator is positive (as noted in the previous proof). Simple calculations show that $\partial(y_n^I - y_n^P)/\partial\alpha > 0$ either when $\alpha = \lambda^I$ or when α is a parameter in the cost function such that the cost is decreasing in α. Thus, in terms of the picture above, increasing λ^I or decreasing $c(\cdot)$ has the effect of shifting the graph of *m* downward. Neither λ^I nor *c* appear in the definition of *h*. Thus, the parameter shift has the consequences stated in the proposition. *Q.E.D.*

Proposition 4. *A pointwise increase in* f *leads to an increase in* z* *but has an ambiguous effect on* $\underline{\text{n}}$*.

Proof of Proposition 4: We using the same method as in the previous proof by thinking of *f* as a function of a parameter α in addition to *x*. Suppose *f* is increasing in α. Then *g* is also increasing in α, which means $dm(\cdot)/d\alpha < 0$. In terms of the picture above, the graph of the *m* function shifts downward. Similar calculations show that $dh(\cdot)/d\alpha > 0$, so the graph of *h* shifts upward. As a result, *z** rises. However, the effect on $\underline{n}$* is ambiguous. *Q.E.D.*

Proposition 5. *An improvement in the distribution of network sizes in the sense of first-order stochastic dominance implies that both* $\underline{\text{n}}$* *and* z* *rise.*

Proof of Proposition 5: In this case, a change in the μ has no affect on the function *m*. A first-order-stochastic-dominant shift in μ (parameterized by an increasing α) boosts the probability of larger, relative to smaller, network sizes. Holding $\underline{n}$ and *z* fixed, this implies that the integral on the right side of Equation (5) increases in value, whereas the integral on the left side decreases in value. This follows from the fact that $g(z/n)$ is increasing in n, whereas $1 - n$ is decreasing in n. Because the value of the left integral is increasing in $\underline{n}$, while the value of the right integral is decreasing in $\underline{n}$, we have that $dh(\cdot)/d\alpha > 0$. Thus, both $\underline{n}$ and z^* increase. *Q.E.D.*

Proposition 6. GDP *is maximized by some* $\underline{\mathrm{n}}' \in (0,1)$.

Proof of Proposition 6: We write $GDP(\underline{n})$, where $\underline{n}$ is an arbitrarily set cutoff level and z satisfies market-clearing equation (5) for the given value of $\underline{n}$. First note that $\underline{n} = 0$ is not optimal, for in this case $GDP(0) = 0$. We next establish that $\underline{n} = 1$ is not optimal, by showing that $GDP(1) < GDP(\underline{n}^*)$ for the equilibrium value $\underline{n}^*$. Continuity of $GDP(\underline{n})$ implies that it is maximized by some $\underline{n}'$ that is strictly between 0 and 1.

Rearranging the GDP expression and substituting for $\int_0^{\underline{n}}(1-n)\mu(n)dn$ using equation (5) yields

$$GDP(\underline{n}) = \int_0^{\underline{n}} y_n^P \mu(n)dn + \int_{\underline{n}}^1 y_n^I \mu(n)dn.$$

Note that, in equilibrium, we have $y_n^I \geq y_n^P$ for all $n > \underline{n}^*$. This implies that

$$GDP(\underline{n}*) > \int_0^1 y_n^P \mu(n)dn.$$

We also know that $y_n^P > n$ because $z > 0$, which means

$$\int_0^1 y_n^P \mu(n)dn > \int_0^1 n\mu(n)dn = GDP(1).$$

Thus $GDP(\underline{n}^*) > GDP(1)$. *Q.E.D.*

Proposition 7. *There exists a value* $\lambda^{I\prime} \in (0,1)$ *for which the equilibrium* $\underline{\mathrm{n}}^*$ *equals the* GDP-*maximizing* $\underline{\mathrm{n}}'$, *so* GDP *is maximized in equilibrium.*

Proof of Proposition 7: We first note that $\underline{n}'$ is constant in λ^I. We next use the GDP expression in terms of y_n^I and y_n^P from the proof of Proposition 6. Writing this as a function of an arbitrary cutoff $\underline{n}$, the derivative can be written as

$$GDP'(\underline{n}) = \mu(\underline{n})\left[y_{\underline{n}}^P - y_{\underline{n}}^I\right] + \frac{dz}{d\underline{n}}\left[\int_0^{\underline{n}} \frac{dy_n^P}{dz}\mu(n)dn + \int_{\underline{n}}^1 \frac{dy_n^I}{dz}\mu(n)dn\right],$$

where $dz/d\underline{n}$ denotes the derivative of the relation given by equation (5). Note that $\mu(\underline{n}) > 0$ and $dz/d\underline{n} < 0$ (recall the properties of h in the proof of Proposition 2). At the GDP-maximizing cutoff $\underline{n}'$, we have $GDP'(\underline{n}') = 0$. Furthermore, if we set $\lambda^I = 1$ then $dy_n^P/dz = 0$ and thus the first integral in the bracketed expression is equal to zero. The second integral is negative (because $g'(z/n)\, z/n + g(z/n) < 0$), which means that

$$\frac{dz}{d\underline{n}}\left[\int_0^{\underline{n}} \frac{dy_n^P}{dz}\mu(n)dn + \int_{\underline{n}}^1 \frac{dy_n^I}{dz}\mu(n)dn\right] > 0$$

at $\underline{n} = \underline{n}'$. This in turn implies that

$$y_{\underline{n}'}^P < y_{\underline{n}'}^I.$$

In words, this means that, when $\lambda^I = 1$, agents whose networks are close to the GDP-maximizing cutoff value $\underline{n}'$ strictly prefer to be intermediaries rather than producers. Obviously, then, the equilibrium cutoff level $\underline{n}^*$ is strictly less than $\underline{n}'$ when $\lambda^I = 1$. It is easy to see that $\underline{n}^* = 1$ when $\lambda^I = 0$ (since in this case intermediaries earn nothing). By continuity of $\underline{n}^*$ as a function of λ^I, it follows that there is an interior value of λ^I for which $\underline{n}^* = \underline{n}'$. *Q.E.D.*

Proposition 8: *Assume* $x_n f(x_n)$ *is concave. If* $\bar{n}^* < 1$*, a policy that induces intermediaries to slightly increase* $\bar{n}$ *has the effect of raising expected GDP.*

Proof of Proposition 8: An increase in $\bar{n}$ acts like an improvement in the distribution of network sizes in the sense of first-order stochastic dominance. Proposition 5 thus suggests that both $\underline{n}^*$ and z^* (determined by (4) and (5′) for the given $\bar{n}$) will increase in response to a small increase in $\bar{n}$. This is easily confirmed by repeating the comparative static analysis of Proposition 5, substituting equation (5′) for equation (5). To see the effect of the small increase in $\bar{n}$ on expected GDP, we can rewrite equation (6′) as the sum of incomes of producers and incomes of intermediaries. By equation (7), the direct effect of $\bar{n}$ on incomes of intermediaries envelopes out, and there is no direct effect of $\bar{n}$ on incomes of producers. By equation (4), the effect of any change in $\underline{n}$ on GDP envelopes out. This leaves the effect on GDP of the increase in z^*, which increases incomes of producers and decreases incomes of intermediaries. To sign this effect, fix the allocation of producers over intermediaries at the allocation that exists prior to the increase in $\bar{n}$. The total expected output generated by every intermediary with network size $\bar{n}$ or greater equals $x_{\bar{n}} f(x_{\bar{n}})\bar{n}$. This total expected output increases with a small increase in $\bar{n}$, while the total expected output generated by all other intermediaries remains unchanged. Now allow producers to be reallocated so as to equate $z = f(x_n)n$ across all intermediaries. This reallocation must generate a further increase in total expected output provided $x_n f(x_n)$ is concave. *Q.E.D.*

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Table 1:
Summary Statistics from a Pilot Survey of U.S. International Trade Intermediaries

	Differentiated Product Intermediaries			Homogeneous Product Intermediaries		
In your first year, what percentage of your total international business involved clients outside of the United States with whom you dealt in previous occupations?	mean	s.d.	obs.	mean	s.d.	obs.
	53	38	18	32	38	5
In your first year, what percentage of the products you handled internationally did you work with in previous occupations?	mean	s.d.	obs.	mean	s.d.	obs.
	57	50	18	20	45	5
In your first year, in what percentage of the countries in which you did business did you work in previous occupations?	mean	s.d.	obs.	mean	s.d.	obs.
	71	40	18	50	50	5
What percentage of your firm's revenue is earned by taking title to goods and reselling them?	mean	s.d.	obs.	mean	s.d.	obs.
	49	36	18	99	2	5

How accurate is the following statement? "I raise my markup rate when market demand is strong or competitive pressure is weak."

	not accurate 1	2	3	4	5 accurate
Differentiated: # of answers	3	0	3	1	1
Homogeneous: # of answers	0	0	2	0	3

How accurate is the following statement? "I raise my commission rate when market demand is strong or competitive pressure is weak."

	not accurate 1	2	3	4	5 accurate
Differentiated: # of answers	5	1	0	1	1
Homogeneous: # of answers	1	0	0	0	0

What percentage of your firm's revenue is earned by charging a commission or success fee based on the value of transactions?

mean	s.d.	obs.		mean	s.d.	obs.
36	36	18		1	2	5

Note: The balance of revenue earned by differentiated product intermediaries was earned by "charging a cash flow fee, consultant fee, or retainer." Only one homogeneous product intermediary reported positive revenue from commissions, equal to five percent of the firm's total revenue.

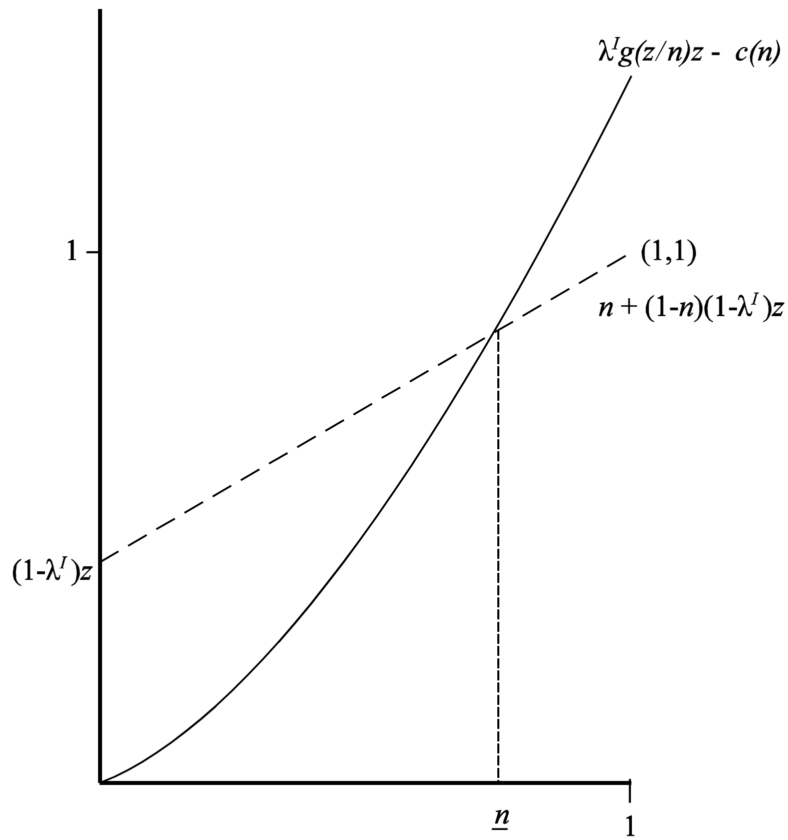

Figure 1: Expected incomes of intermediaries and producers, and cutoff network size

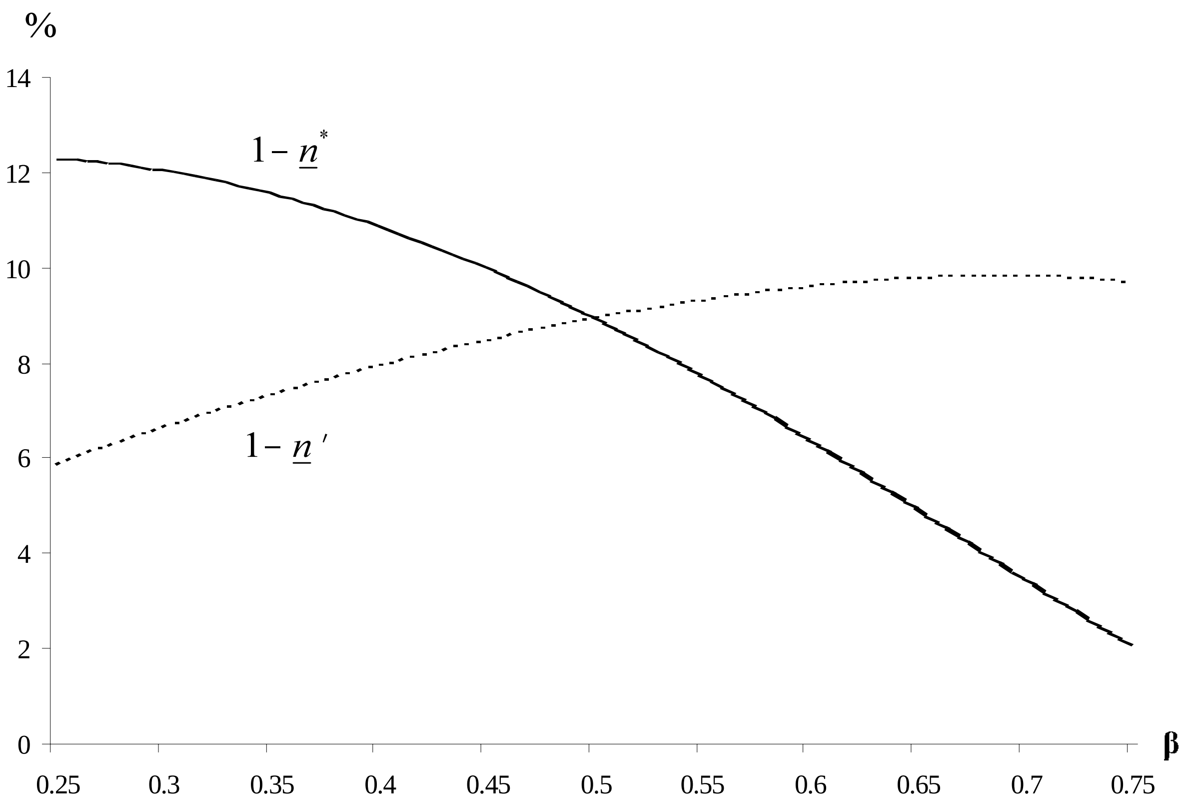

Figure 2:
Market-equilibrium versus welfare-maximizing population share of intermediaries

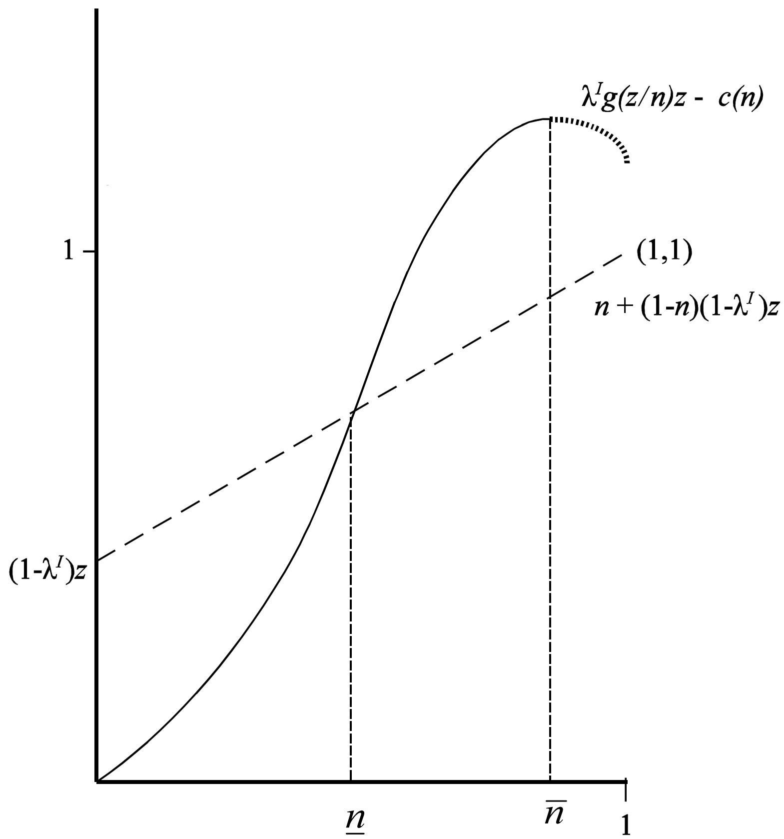

Figure 3:
Increasing marginal cost of network maintenance leading to maximum network size at $\bar{n}$