Misallocation and Welfare Implications of Entrepreneurial Networks

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Abstract

We explore misallocation and welfare implications of a Roy model of entry into entrepreneurship at a given destination, extended to incorporate social network externalities. These externalities take the form of productivity-enhancing and/or cost-reducing spillovers which are restricted to agents belonging to a specific social network (in contrast to a pure agglomeration model where all entering firms benefit equally from spillovers). The set of agents is partitioned into multiple social networks with varying intra-network spillover intensities. After entering, firms select capital size and produce a common good with downward sloping market demand, taking industry price as given. If spillover intensities positively covary with the population size of each network, equilibria feature productive misallocation: networks with stronger spillovers are characterized by higher entry rates, lower marginal revenue products, and lower TFP of marginal entrants. Factor allocation among entrants is efficient, while entry rates are inefficiently low. First best aggregate surplus can be implemented via network-specific entry subsidies, which may aggravate productive misallocation. Consequently standard measures of productive misallocation based on across-firm dispersion of marginal revenue products are not a reliable measure of welfare in this setting.

1 Introduction

A large literature on endogenous growth (Lucas (1988), Romer (1986)) and urban economics (Henderson (1974)) is based on the existence of productivity or learning spillovers across firms. Contemporary arguments for 'soft industrial policy' or 'place-based policies' are primarily based on such agglomeration spillovers across entrepreneurs located in close physical proximity (Harrison and Rodriguez-Clare (2010), Rodrik (2004), Stiglitz (2017)). Empirical evidence of such spillovers has been provided by a number of authors, mainly in the context of developed countries (Bloom et al. (2013), Combes et al. (2012), Greenstone et al. (2010), Moretti (2004)).

In the context of developing countries, the literature on industrial clusters and trading relationships stresses the importance of social networks which help overcome problems of trust and cooperation faced by small and medium size entrepreneurs in accessing credit, insurance, knowhow and reliable input supply in environments with weak market and state institutions (Casella and Rauch (2002), Dai et al. (2021), Fafchamps (2001), Gupta et al. (2022), McMillan and Woodruff (1999), Munshi (2011), Munshi (2014)). These network relationships generate inter-firm productivity or cost-reducing spillovers whose domain is restricted to firms owned by entrepreneurs belonging to a social network defined by ethnicity or social origin. The key distinction between network and agglomeration effects is that the latter are location rather than network specific, i.e., agglomeration effects represent spillovers that benefit all entrepreneurs at a common location, irrespective of social identity/origin. Empirical evidence of network-specific spillovers is provided for caste networks in India (Banerjee and Munshi (2004), Munshi (2011), Gupta et al. (2022)) and hometown networks in China (Dai et al. (2023)).

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Despite growing evidence of inter-firm spillovers, their implications for productive misallocation and welfare are not well understood. The existence of spillovers imply a departure from a first-best environment where standard theorems of welfare economics do not apply. In this second-best setting, productive misallocation may not be a reliable indicator of welfare effects of government policies or external shocks. The purpose of this note is to study the implications of social-network-based spillovers for misallocation and welfare.

The model (based on Munshi (2011) and Dai et al. (2023)) abstracts from other sources of distortions such as scale economies or market power. It extends a static Roy occupation choice model where agents of varying individual ability choose between becoming an entrepreneur in an industry in a given location, and an alternative occupation which forms an outside option. The set of agents is partitioned into different social networks of varying degrees of cohesiveness. More cohesive networks exhibit higher rates of intra-group cooperation resulting in higher productivity spillovers and/or cost reductions. Outside option payoffs depend only on individual ability. There are no direct cross-network spillovers, and agents are price-takers. However the model incorporates a form of 'congestion costs' via price effects: entrepreneurs produce a common good for a market with a downward sloping demand curve. Hence increased entry of entrepreneurs from a given network lowers returns for all other entrepreneurs by lowering the product price. We study noncooperative Nash equilibria of this static model where each agent decides whether to enter, and capital size conditional on entering to maximize his own profit, taking as given the decisions of all other agents.

The main results are the following. If the population size of each network covaries positively with cohesiveness, equilibria exhibit productive misallocation. More cohesive networks exhibit: (a) higher rates of entry, (b) lower TFP of marginal entrants and (c) lower (common value of) marginal revenue product (MRP). This is because higher spillovers makes entry more attractive for agents belonging to a more cohesive network, which lowers the entry threshold for ability, representing a form of adverse selection. Despite the dispersion in MRP, capital allocation turns out to be efficient.[1] On the other hand, entry rates are inefficiently low owing to the externality across agents in the same network which each individual agent ignores in the decentralized Nash equilibrium. A first-best allocation can be achieved by a network-specific entry subsidy, which is increasing in the cohesiveness of the subsidy (owing to the stronger externality in a more cohesive network). Compared to the laissez faire equilibrium, such subsidies raise welfare as well as the MRP-dispersion misallocation measure (since they raise inter-network dispersion of MRP). Therefore the model provides a justification for industrial policies that aggravate adverse selection (and inter-network inequality) by discriminating in favor of networks that are already advantaged in the laissez faire equilibrium.

2 Model

The set of agents (which has an aggregate measure normalized to 1) is partitioned into I distinct networks. Let $\beta_i \in (0,1)$ denote the measure of network $i = 1, \ldots, I$. Agents in each network are distinguished by their individual ability ω, distributed according to a common (strictly increasing and smooth) cdf F over support $[\underline{\omega}, \bar{\omega}]$. An agent of ability ω decides between a traditional occupation which generates a return of $\omega^\sigma, \sigma \in (0,1)$, and becoming an entrepreneur by setting up a firm that produces a homogenous good according to a Cobb-Douglas production function $T_{1i}\omega^{1-\alpha}[\frac{1}{\alpha}K^\alpha]$ where $\alpha \in (0,1)$ and K denotes scale of production. This entrepreneur incurs production cost $\frac{r}{T_{2i}}K$. T_{1i}, T_{2i} denote productivity-enhancing and cost-reducing spillovers respectively in network i. Both types of spillovers are smoothly increasing in $\beta_i n_i$ the number of firms that enter from network i (where n_i denotes the fraction of network i agents that become entrepreneurs), and in θ_i the (exogenous) cohesiveness of the network:

$$T_{ji} = T_j(\beta_i n_i, \theta_i), j = 1, 2. \tag{1}$$

[1] This owes to differences in underlying assumptions between this model and Hsieh and Klenow (2009): here the aggregate amount of capital or the set of firms is not fixed.

Examples of spillover functions are $T_j[1+\beta_i n_i]^{\theta_i}$ or $T_j g_j(\theta_i \beta_i n_i)$ where g_j is strictly increasing and $g_j(0) > 0$. In these examples spillovers are strictly increasing in each argument (size βn_i or cohesiveness θ_i) provided the other argument is strictly positive, so we assume the same is true for the more general specification (1).

If there is just a single network, the model reduces to one of pure agglomeration. We are interested in the case of multiple networks with varying cohesiveness. Note that we place no restrictions on the functional forms of the spillover functions or the ability distribution. However, to highlight the role of differences in cohesiveness of different networks per se, we have assumed this is the sole parameter that distinguishes one network from another. In particular, different networks have the same ability distribution and outside options.

The good is sold on a market with a downward sloping demand curve, represented by a smooth strictly decreasing price function $p(Q)$ satisfying $p(0) > 0$, where Q denotes aggregate quantity of the good produced. Each agent is infinitesimal, so ignores the effects of his own decisions on the market price. Price effects represent the sole source of a congestion (or negative cross-agent) effect in the model. Additional sources of congestion effects operating via factor prices that rise with factor demand can be added to the model, but these would not alter any of the results.

Each agent decides independently whether or not to become an entrepreneur, and on the scale of production conditional on entry. We study Nash equilibria of this static model.[2]

Conditional on becoming an entrepreneur, anticipating market price P and network spillovers T_{1i}, T_{2i}, an agent in network i with ability ω would select production scale $K = K(\omega; P, T_{1i}, T_{2i})$ to maximize

$$PT_{1i}\omega^{1-\alpha}\frac{1}{\alpha}K^{\alpha} - \frac{r}{T_{2i}}K \tag{2}$$

It is evident that

$$K(\omega; P, T_{1i}, T_{2i}) = \omega[\frac{PT_i^*}{r}]^{\frac{1}{1-\alpha}} \tag{3}$$

and the resulting payoff would be

$$\Pi_i^e(\omega; P, T_{1i}, T_{2i}) = \omega T_i P^{\frac{1}{1-\alpha}}\zeta \tag{4}$$

where

$$T_i^* \equiv T_{1i}T_{2i}, T_i \equiv T_{1i}^{\frac{1}{1-\alpha}}T_{2i}^{\frac{\alpha}{1-\alpha}}, \zeta \equiv r^{-\frac{\alpha}{1-\alpha}}[\frac{1-\alpha}{\alpha}] \tag{5}$$

Consequently, the agent would decide to enter if (4) exceeds the outside option ω^{σ}, which reduces to the condition that

$$\omega \geq \omega^*(P, T_i) \equiv [\zeta P^{\frac{1}{1-\alpha}}T_i]^{-\frac{1}{1-\sigma}} \tag{6}$$

This implies an entry rate of

$$n_i(P, T_i) = 1 - F(\omega^*(P, T_i)) \tag{7}$$

and aggregate output produced by network i agents of

$$Q_i(P, T_i) = [\frac{P}{r}]^{\frac{\alpha}{1-\alpha}}T_i\int_{\omega^*(P,T_i)}^{\bar{\omega}}\omega dF(\omega) \tag{8}$$

A Nash equilibrium is thus represented by entry rates $(n_1, \ldots, n_I)$ and price P satisfying

$$n_i = 1 - F(\omega^*(P, T(\beta_i n_i, \theta_i)) \tag{9}$$

$$P = p(\sum_i \beta_i Q_i(P, T(\beta_i n_i, \theta_i)) \tag{10}$$

where $T(\beta_i n_i, \theta_i) \equiv [T_1(\beta_i n_i, \theta_i)]^{\frac{1}{1-\alpha}}[T_2(\beta_i n_i, \theta_i)]^{\frac{\alpha}{1-\alpha}}$.

[2] Most empirical papers (e.g., Munshi (2011), Gupta et al. (2022), Dai et al. (2023)) studying network effects estimate dynamic versions of this model with multiple cohorts of agents making entry decisions at different dates, with spillovers depending on lagged size of networks). The results derived here would extend to the dynamic setting as well.

3 Nash Equilibrium

A Nash equilibrium can be solved sequentially in the following two steps. At the first step, fix any price P and derive the equilibrium entry rate $n_i(P;\theta_i)$ for each network conditional on that price, which solves the single equation (9). Given P, the right hand side (RHS) of (9) is smooth and increasing in n_i, mapping the unit interval to itself. So equilibrium entry rates always exist for any given P, but there may be multiple equilibria.[3] In that case select a locally stable equilibrium entry rate $n_i(P;\theta_i)$, i.e., where the slope of the RHS of (9) with respect to n_i is smaller than one.[4] It is evident that the selected equilibrium entry rate is increasing in both P and θ_i, since the RHS of (9) is increasing in either of these variables for any fixed n_i.

Given the selected equilibrium entry rate function $n_i(P;\theta_i)$ for each network, at the second step we can derive the equilibrium price by solving the single equation

$$P = p(\sum_i \beta_i Q_i(P, T(\beta_i n_i(P;\theta_i), \theta_i)) \tag{11}$$

Note that the RHS of (11) is decreasing in P, since Q_i is increasing in P and T_i, and the latter is increasing in n_i which is turn is increasing in P. Hence (11) has a unique fixed point.[5]

Most results of interest can be derived from studying equilibrium entry rates conditional on a price P (at which entry rates are positive). Our first result concerns productive misallocation in the case where cohesiveness and population size positively co-vary across networks.

Proposition 1 *Consider two networks i, k with*

$$\beta_i \geq \beta_k, \theta_i \geq \theta_k \tag{12}$$

and at least one of these inequalities is strict. Consider any price P satisfying $\omega^*(P, T(0,\theta_k)) < \bar{\omega}$, at which network k has a positive entry rate. Then at this price, network i has:

(a) a lower entry threshold for ability, and a higher entry rate

$$\omega^*(P,\theta_i) < \omega^*(P,\theta_k) \tag{13}$$

$$n_i(P,\theta_i) > n_k(P,\theta_k) \tag{14}$$

(b) a lower TFP for the marginal entrant, and

(c) a lower (common) MRP.

Proof: If n_k^* denotes $n_k(P,\theta_k)$ which is positive by assumption, (12) implies

$$1 - F(\omega^*(P, T(\beta_i n_k^*, \theta_i)) > n_k^* = 1 - F(\omega^*(P, T(\beta_k n_k^*, \theta_k)) \tag{15}$$

Since the equilibrium selection is locally stable, it follows that $n_i^* \equiv n_i(P,\theta_i) > n_k^*$. Hence (14) follows. Moreover $\beta_i n_i^* > \beta_k n_k^*$, which implies $T_i > T_k$. (13) then follows from (6), thereby establishing (a).

Let $TFP_i^m = [\omega_i^*]^{1-\alpha} T_{1i}$ denote the TFP of the marginal entrant in network i, where $\omega_i^* = \omega^*(P,\theta_i)$ and $T_{1i} = T_1(\beta_i n_i^*, \theta_i)$. Since the marginal entrant is indifferent between entering and not, the profit of the marginal entrant in network i equals $[\omega_i^*]^\sigma$. Since $\omega_i^* < \omega_k^*$, the profit of the marginal entrant in network i is smaller. From (4) it follows that

$$\omega_i^* T_i = [TFP_i^m]^{\frac{1}{1-\alpha}} T_{2i}^{\frac{\alpha}{1-\alpha}} < [TFP_k^m]^{\frac{1}{1-\alpha}} T_{2k}^{\frac{\alpha}{1-\alpha}} \tag{16}$$

[3] The equilibrium is unique if ability follows a log-uniform distribution, which is assumed in many empirical applications.

[4] By standard arguments, such a locally stable equilibrium function exists generically.

[5] A fixed point exists for the following reason. Let $\mathcal{P}(P)$ denote the RHS of (11) for a given set of $(\theta_1,\ldots,\theta_I)$. Entry and hence supply would be zero at a zero price. So $\mathcal{P}(0) = p(0) > 0$ while $\mathcal{P}(\infty) < \mathcal{P}(0) = p(0) < \infty$.

Since $T_{2i} > T_{2k}$ it follows that $TFP_i^m < TFP_k^m$.

Finally (c) follows from the fact that the MRP of all firms in network i equals the marginal cost $\frac{r}{T_{2i}}$ of firm scale. ■

This result focuses on the case where more cohesive networks have a larger population size.[6] A special case is where all networks have the same population size but vary in cohesiveness. More cohesive networks are characterized by larger spillovers, resulting in higher TFP and lower cost for their members. This implies higher rates of entry into entrepreneurship and a lower ability threshold for entry. Marginal entrants from such networks have lower individual ability but benefit from larger productivity spillovers. Part (b) of Proposition 1 shows that the former effect dominates: the marginal entrant has lower TFP overall. This is a form of adverse selection, suggesting productive misallocation insofar as replacing a marginal entrant from a more cohesive network by a marginal non-entrant from a less cohesive one might raise aggregate productivity. Such an assessment is flawed because it ignores the spillover effects on intra-marginal entrants. The next section carries out an explicit welfare analysis of policies that affect entry rates.

Part (c) examines implications for the Hsieh and Klenow (2009) measure of misallocation: the dispersion of marginal revenue product (MRP) across firms. Since all firms in the same network face the same cost of expanding scale, MRP is equalized within the network. However more cohesive networks achieve larger cost-reducing spillovers and therefore end up with a lower MRP. So MRP varies across networks of varying cohesiveness, suggesting a misallocation of factors across firms belonging to different networks.

4 Welfare Analysis

We turn now to a welfare analysis, by studying the first-best allocation problem for a benevolent social planner that directly controls entry and firm scale decisions to maximize social welfare. Specifically, the planner selects an ability threshold $\hat{\omega}_i \in [\underline{\omega}, \bar{\omega}]$ for network i agents and firm scale $\hat{K}_i(\omega) \geq 0$ for those who enter, to maximize aggregate surplus (which ignores payments between firms and consumers as these neutralize each other):

$$\mathcal{U} \equiv \sum_i \beta_i \left[\int_{\underline{\omega}}^{\hat{\omega}_i} \omega^\sigma dF(\omega) - \frac{r}{\hat{T}_{2i}} \int_{\hat{\omega}_i}^{\bar{\omega}} \hat{K}_i(\omega) dF(\omega) \right] + V(Q) \tag{17}$$

where V denotes consumer utility from consuming the good produced by firms, Q denotes aggregate quantity of the good produced which is given by:

$$Q = \sum_i \beta_i \frac{\hat{T}_{1i}}{\alpha} \int_{\hat{\omega}_i}^{\bar{\omega}} \omega^{1-\alpha} \hat{K}_i(\omega)^\alpha dF(\omega) \tag{18}$$

and

$$\hat{T}_{ji} = T_j(\beta_i[1 - F(\hat{\omega}_i)], \theta_i), j = 1, 2 \tag{19}$$

This welfare optimization problem can be broken down into two steps. First, given entry thresholds $\hat{\omega}_i$ for different networks $i = 1, \ldots, I$ select firm scale optimally for entrants. Letting P denote V' the marginal utility of the good, this requires $K = \hat{K}_i(\omega)$ be chosen to maximize

$$P\hat{T}_{1i}\omega^{1-\alpha}\frac{1}{\alpha}K^\alpha - \frac{r}{\hat{T}_{2i}}K \tag{20}$$

implying

$$\hat{K}_i(\omega) = \omega[\frac{P\hat{T}_i^*}{r}]^{\frac{1}{1-\alpha}} \tag{21}$$

[6]Dai et al. (2023) provide empirical evidence from China that rural areas with higher population density are characterized by higher levels of local trust and social interaction. Moreover firms owned by entrepreneurs from higher population density rural hometowns exhibit higher TFP spillovers and revenue growth resulting from entry of new firms from the same origin.

where $\hat{T}_i^* \equiv \hat{T}_{1i}\hat{T}_{2i}$. This takes the same form as firm scales in the decentralized market equilibrium (3), with the productivity and cost spillovers corresponding to the entry thresholds chosen by the planner. It follows that factor allocation in the market equilibrium conditional on the set of active firms is efficient. In this sense there is no factor misallocation from a welfare standpoint. Owing to the presence of cost-reducing spillovers the social cost of expanding firm scale is lower in more cohesive networks: hence welfare optimality requires these firms to expand to a point where their MRPs are smaller.

At the second stage entry thresholds are chosen for each network, with firm scales adjusted according to (21). The first-order condition for $\hat{\omega}_i$ yields:

$$\hat{\omega}_i^\sigma - [P\hat{T}_{1i}\hat{\omega}_i^{1-\alpha}\frac{1}{\alpha}\hat{K}_i(\hat{\omega}_i) - \frac{r}{\hat{T}_{2i}}\hat{K}_i(\hat{\omega}_i)] = s_i \tag{22}$$

where

$$s_i \equiv \frac{P}{\alpha}\frac{\partial \hat{T}_{1i}}{\partial n_i}\int_{\hat{\omega}_i}^{\bar{\omega}} \omega^{1-\alpha}\hat{K}_i^\alpha(\omega)dF(\omega) + \frac{r}{\hat{T}_{2i}^2}\frac{\partial \hat{T}_{2i}}{\partial n_i}\int_{\hat{\omega}_i}^{\bar{\omega}} \hat{K}_i^\alpha(\omega)dF(\omega) \tag{23}$$

which is strictly positive as long as $\hat{\omega}_i < \bar{\omega}$, i.e., there is a positive entry rate for network i. In a market equilibrium the left-hand-side of (22) equals zero, as the marginal entrant is indifferent between entering and not, from the standpoint of own-profit. However, entrants ignore the spillover benefits generated by their entry on other entrants from their own network, represented by the term s_i. Hence the market equilibrium is characterized by too little entry. The first-best welfare optimum can be achieved with an entry subsidy s_i for network i. It follows that the welfare optimal entry threshold $\hat{\omega}_i$ will be smaller than in the market equilibrium. A sufficient (but not necessary) condition for the optimal entry subsidy to be positive for network i is that the entry rate for this network is positive in the market equilibrium. We summarize these results in the following Proposition.

Proposition 2 *The first-best welfare optimum can be achieved with entry subsidies that are positive for any network with a positive entry rate and positive spillovers. Hence entry rates are inefficiently low in laissez faire Nash equilibrium if there exists at least one network with a positive entry rate and positive spillovers. Factor allocation among active firms is efficient.*

Observe that optimal entry subsidies which raise welfare may at the same time aggravate commonly used measures of productive misallocation. To see this, consider an example where there are two groups of agents of equal size ($\beta_1 = \beta_2 = \frac{1}{2}$), and only group 1 constitutes a social network featuring spillovers. Specifically, network 1 has $\theta_1 > 0$ and T_{11}, T_{21} are increasing in n_1, while $\theta_2 = 0$ and T_{21}, T_{22} are independent of n_2 and lower than T_{11}, T_{21} respectively for any $n_1 > 0$. Also suppose the market equilibrium involves positive entry rates for both groups. From Proposition 1, group 1 features a higher entry rate and a lower MRP. The optimal subsidy for group 1 is positive, while it is zero for group 2. The subsidies will raise entry from group 1 and lower entry from group 2 (owing to a drop in P), and will increase the gap in MRP as well as TFP of the marginal entrant between the two groups.

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