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Abstract

The O-Ring theory provides a framework for analyzing the effects of team production on the emergence of firms in the New Economy. Given risk-aversion of the potential team members, the productive advantage of perfect ability matching in teams suffices to establish an equilibrium which separates Old and New Economy. In particular, it is not necessary to assume that firms in the New Economy possess exclusive access to a superior production technology. It must only be true that individual abilities can be observed in partnerships which self-manage production and consequently distribute the surplus among the team members. At the same time, abilities remain private information of the employees in "managed" firms organized on behalf of a profit-maximizing residual claimant.

Keywords: New Economy, O-Ring Theory, Ability Matching, Partnership Firms.

JEL-Classification: D2, L2, M2.

1 Motivation

The New Economy is widely associated with the emergence of new firms and production facilities in high-tech industries. In particular, this includes the computer, information and communications (IC), and bio-technology industries. However, discussing business strategies in the Internet, Finckelstein (2001) notes that New Economy companies face much the same problems as Old Economy firms. In fact, due to long-standing reputation the latter often possess a competitive advantage in marketing their services. Also, Fabel and Lehmann (2001) show that the adverse selection problem is actually reinforced by electronic trade. This is seen to compensate the lower costs of information gathering in such markets.

Taking a technological perspective, Gordon (2000) and Taylor (2001) review economic historical statistics. Compared to previous industrial revolutions, the arrival of these new technologies does not appear to have accelerated productivity growth significantly[1]. However, Rajan and Zingales (2000, 2001) emphasize that the new technologies induce a fundamental shift of power from financial to human capital. In fact, the innovations themselves originate from human capital rather than from inanimate assets. Hence, the allocation of the decision rights within the firm becomes the prime issue. Corporate venturing for new opportunities then results in a subdivision of the corporate physical assets.

Following the same basic argument, Baily and Lawrence (2001) also conclude that the emergence of New Economy firms reflects outsourcing decisions of human capital-intensive productions. Moreover, this line of literature agrees that - while financial innovations have made this development possible - the recent experience of financial volatility now adversely affects the New Economy firms. Consequently, reintegration constitutes a means to overcome these problems. In contrast, Holmstrom and Kaplan (2001) emphasize that, once the critical assets have been identified following a wave of disintegration, merger and acquisitions again follow even in sound financial environments.

All of the above theories of New Economy firm emergence stress the importance of stock ownership or stock option plans as a motivation device for the process of disintegration. Audretsch and Thurik (2001) conclude that the change from "managed" to "entrepreneurial" firms constitutes the single most important characteristic of New Economy companies. In fact, Holderness et al. (1999) show that the increase in managerial stock ownership has been very significant over the past two decades.

Then, Zingheim and Schuster (2000) again emphasize that the increased

[1] On the other hand, Mokyr (2001) finds that such discrete productivity gains cannot be confirmed for any of the historic technological revolutions. Hence, focussing on technological change alone and ignoring institutional issues generally fails in explaining economic growth.

necessity to compensate poor employee stock performance in cash has induced additional financial problems for the New Economy firms. Weinberg (2001) further notes that the New Economy managers are to a large extend recruited from Old Economy firms where they formerly received preferential treatment as high-potential employees. Thus, the decreasing performance of their stock or stock option plans gives rise to motivation problems.

These two stylized facts of New Economy firm emergence - namely, human capital-intensity of production and partnership-like compensation schemes - define the fundamental assumptions of the current study. Moreover, rather than proposing an entirely new theoretical framework, the analysis only applies the basic O-Ring production theory introduced by Kremer (1993). This model captures the effect of human-capital as a necessary input in team-work.

With risk-averse individuals, organizing the firm as a partnership can be shown to induce inefficiencies. On the other hand, managed firms in the Old Economy cannot verify an individual employee's quality. Hence, there always exists at least one - and at most one efficient - equilibrium in which part of the economic activities are outsourced to New Economy partnerships.

However, all equilibria are characterized by an inherent instability. Once an equilibrium is established, Old Economy firms will find it profitable to recruit employees from New Economy firms again. At the same time, integrating all activities in Old Economy firms does not constitute an equilibrium. Thus, both the emergence of New Economy firms and the volatility of these firms in equilibrium can be explained without reference to exogenous financial shocks. In fact, the model can be verified to constitute a pure labor market analysis.

2 O-Ring production with risk-neutral workers

2.1 The basic framework

The following theoretical framework modifies the basic O-Ring model introduced by Kremer (1993) only marginally. Thus, consider the expected revenue function

$$R = pF(k,n)\left[\prod_{i=1}^{n} q_i\right] n \tag{1}$$

where k refers to physical capital input and n denotes the number of tasks involved in a particular firm's production. The output price p reflects the value of the New Economy output - typically an intermediate service or commodity - produced relative to the price of an Old Economy output good. For analytic convenience, this relative price is normalized to equal unity. Hence, $p = 1$ in the following.

Further, $q_i \in]0,1[$, $i = 1,...,n$, denotes the ability of the employee, respectively team member assigned to task i. Ability directly corresponds to the individual probability of perfect task performance. More precisely, if the individual assigned to task i malperforms, the team as a whole cannot produce positive output. This occurs with probability $[1 - \prod_{i=1}^{n} q_i]$. Further, the probability q_i constitutes individual characteristic of the particular team member assigned to task i.

Thus, (1) reflects a typical team production function. The output of the team depends on the performance of each team member. Only the fact that output is completely destroyed upon malperformance of a single team member may be considered as an extreme assumption. Intuitively, $F(k,n)$ then defines output per team member given that all members perform perfectly. It increases with physical capital employed and the number of tasks involved in production. Hence, increasing n implies a technological change towards the production of a more sophisticated variant of the New Economy service good. For convenience, let $F(k,n) = [k]^{\alpha}\,[n]^{(1-\alpha)}$ in the following.

Firms in the New Economy offer services which often replace a formerly integrated production of intermediate goods in Old Economy firms. New Economy ICT firms customize standard accounting software, prepare Internet presentations, or optimize server-client networks for Old Economy firms, for instance. In bio-technology the New Economy firms frequently constitute R&D spin-offs founded and controlled by former employees of a pharmaceutical firm. Hence, in principle these services can be - and, in less sophisticated variants, are still - produced in Old-Economy firms as well.

The employees of Old Economy firms or partners in New Economy firms, respectively, stem from a particular pool of professional specialists in the economy. For simplicity, abilities are distributed uniformly over the interval $]0,1[$. Thus, $N(q) = \bar{n} \geqq 0$ members of the pool of professionals share the ability q. Also, let $V \geqq 0$ denote the wage-income associated with Old Economy employment. Finally, the analysis abstracts from explicitly considering the labor-leisure trade-off. Hence, given voluntary participation in a firm, all individuals supply one unit of labor inelastically.

2.2 Profit maximization with observable worker quality

To begin with, the potential New Economy employees, respectively team members are taken to be risk-neutral. In order to construct the benchmark-case for further analysis also assume that individual abilities are publicly observable. Moreover, the reservation wage V - defining the relative benefit of participating in New Economy production - is exogenous.

Then, consider the standard profit-maximizing firm in the New Economy.

Its residual claimant solves

$$Max_{(\{q_i\},n,k)} \qquad R(\{q_i\},n,k) - \sum_{i=1}^{n} w(q_i) - rk \tag{2}$$

where $w(q_i)$, $i = 1,..,n$, denotes the age income offered to the employee assigned to task i and r refers to the rental rate of capital in perfectly competitive capital market equilibrium. The optimal choice of employee quality in task i can easily be assessed by investigating the respective first-order condition

$$F(k,n)\left[\prod_{j\neq i} q_j\right] n = \frac{dw(q_i)}{dq_i} \tag{3}$$

Clearly, the LHS of (3) is monotonically increasing in $\left[\prod_{j\neq i} q_j\right]$. Hence, firms which have hired the highest quality employees for the first $(n-1)$ tasks, will always bid more in order to fill the n-th position in the team. This implies that a firm which has decided to recruit the top-quality employee for one task will recruit only such top-qualities for all tasks. Similarly, a firm which has decided to begin hiring by recruiting some medium quality professional cannot compete successfully for higher quality individuals when filling other positions. However, it will succeed in attracting other employees of the same quality when competing with firms which have started hiring lower quality employees.

Thus, O-Ring production yields the characteristic feature that firms will hire employees of identical quality in all of their team positions. Since the productivity of the team is always governed by the lowest quality employee hired, this constitutes an optimal recruitment strategy. In labor market equilibrium, (3) can therefore be restated as

$$F(k,n)q^{(n-1)}n = \frac{dw(q)}{q} \tag{4}$$

Recalling that $F(k,n) = k^{\alpha}n^{(1-\alpha)}$, the first-order conditions with respect to k and n can be derived as

$$\alpha k^{(\alpha-1)}n^{(1-\alpha)}q^n n = r \tag{5}$$

and

$$(1-\alpha)k^{\alpha}n^{-\alpha}q^n n + k^{\alpha}n^{(1-\alpha)}q^n + k^{\alpha}n^{(1-\alpha)}q^n nlog(q) = w(q) \tag{6}$$

when the process of attracting employees has established an equilibrium. In the following let superscript "*" indicate the respective values of variables

in such competitive labor market equilibrium with profit maximizing firms. Then, (5) implies

$$k^* = \left(\frac{\alpha q^{n^*}}{r}\right)^{\frac{1}{1-\alpha}} (n^*)^{\frac{2-\alpha}{1-\alpha}} \tag{7}$$

and inserting from (7) into (6) reveals

$$\begin{aligned} \frac{dw^*(q)}{dq} &= \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} (n^*)^{\frac{1}{1-\alpha}} q^{\left(\frac{n^*}{1-\alpha}-1\right)} n^* \\ \Longrightarrow \quad w^*(q) &= (1-\alpha)\left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} (n^*)^{\frac{1}{1-\alpha}} q^{\left(\frac{n^*}{1-\alpha}\right)} + c \end{aligned} \tag{8}$$

Again, in competitive labor market equilibrium the constant of integration c must obviously equal zero. In the limit, it reflects the wage-offer of New Economy firms hiring professionals of quality $q = 0$ in order to fill all of its team positions. Such firms would produce zero output with certainty then. Thus, they cannot offer positive wage-income in equilibrium. With $c = 0$, (8) then implies

$$n^* w^*(q) = (1-\alpha)(k^*)^{\alpha}(n^*)^{(1-\alpha)} q^{n^*} n^* = (1-\alpha)R^* \tag{9}$$

since $\alpha\left[\frac{2-\alpha}{1-\alpha}\right] + (1-\alpha) = \frac{1}{(1-\alpha)}$. This proves that the total wage-bill in each New Economy firm equals the share $(1-\alpha)$ of revenue. Moreover, according to (5) the rental payment for capital rk^* amounts to the share α of revenue in each of these firms. Thus, residual profits equal zero.

In a final step, New Economy firms will be founded, if

$$w^*(q) \geqq V \tag{10}$$

for some $q \in]0,1[$. By virtue of (8) $w^*(q)$ is monotonically increasing in q. Hence, assume that $lim_{q\to 1} w^*(q) > V > lim_{q\to 0} w^*(q) = 0$. Then, $q^* \in]0,1[$ - defined by $w^*(q^*) = V$ - characterizes the competitive labor market equilibrium. All professionals exhibiting abilities $q > q^*$ will be employed in New Economy firms, while individuals of quality $q \leqq q^*$ will prefer employment in the Old Economy.

Also, the size of such New Economy firms can now be verified to be determined by the quality of their production teams. Inserting from (8) into (6) reveals

$$\frac{1}{n^*} = -log(q) \tag{11}$$

2.3 Risk-neutral partnerships

While incomes do not vary within the firms, (8) emphasizes that small differences in team abilities yield rather large income differentials across firms. However, contrasting with the assumption of profit maximization utilized above, firms in the New Economy are often seen to constitute partnerships. If not organized as formal partnerships, they typically distribute a large fraction of their economic profit among their employees via stock or stock option plans. Hence, it may appear more appropriate to assume that New Economy firms are self-managed by the members of the production team. In this case, they rather maximize surplus per team member. Thus, they solve

$$Max_{(\{q_i\},n,k)} \quad \frac{R(\{q_i\},n,k)-rk}{n} \tag{12}$$

Note, however, that

$$\frac{d^2\left[R(\{q_i\},n,k)/n\right]}{dq_i d\left[\prod_{j\neq i} q_j\right]} > 0 \tag{13}$$

as well. Hence, suppose two professionals each found such a partnership firm - one characterized by higher ability than the other. The founder with higher ability will always be able to offer a more attractive partnership for other high ability professionals. This remains to be true as the production teams grow by attracting even more partners. In labor market equilibrium firms will therefore again consist only of partners sharing an identical ability level.

Replacing $[\prod_{i=1}^{n} q_i]$ by q^n when solving (12), differentiating with respect to capital k restates the optimality condition (5). The first-order condition with respect to the number of tasks n then reveals

$$(1-\alpha)k^{\alpha}n^{-\alpha}q^n + k^{\alpha}n^{(1-\alpha)}q^n nlog(q) + \frac{rk}{n^2} = 0$$

$$\Longrightarrow \quad [1+nlog(q)] = 0 \tag{14}$$

upon substituting from (5). Again, the optimal choice of technology yields team size $n^*(q)$. Obviously, this also implies that the capital demanded by the firms is given by k^*.

Recall that the total wage bill in the profit maximizing case always equal the share $(1-\alpha)$ of expected revenue. With risk-neutral team members, the wage for employees in the profit-maximizing firm must therefore equal the expected surplus net of capital rental payments. This obviously equals the

individual expected income generated in a partnership or self–managed firm. Hence, given the results above, the ability level q^* also satisfies

$$(1-\alpha)\left[k^*(q^*)/n^*(q^*)\right]^\alpha \left[(q^*)^{n^*(q^*)} n^*(q^*)\right] = V \tag{15}$$

Given the particular O-Ring team production function (1), these equivalence results should be obvious. Rewarding factor inputs according to their marginal revenue implies that expected residual profits equal zero. In this case, the institutional structure of the firm only determines the way in which income is distributed. Note that the optimal size of the production team increases with team quality. Hence, teams of superior ability produce more sophisticated variants of the New Economy commodity or service. In equilibrium there exists a multitude of New Economy firms offering services of different sophistication.

Note that - due to (11) and (14) - firm size increases with team quality. Recalling that the distribution of abilities over the pool of professionals is uniform, there exist $\int_{q^*}^{1} \left[\frac{\bar{n}}{n^*(q)}\right] dq$ New Economy firms in equilibrium. If agents are risk-neutral, these firms can be either maximizing residual profits or be organized as partnerships. The number of firms characterized by a particular team quality then also increases with decreasing team quality. It therefore follows that small increases in the Old Economy wage-income V induce the closing of a rather large number of New Economy firms[2].

3 Risk-averse members of production teams

3.1 The characterization of inefficient partnerships

Let the members of the economy's pools of professionals now be risk-averse. Hence, they maximize their expected utility. Instantaneous preferences are characterized by a utility function $U(c)$, with $U'(c) > 0$ and $U''(c) < 0$ for incomes c. Of course, given that the New Economy firms are organized as profit maximizing firms all results of the previous section can be retained. However, assume all New Economy firms must be organized as partnerships or labor-managed firms. They will now solve

$$EU = \left[\prod_{i=1}^{n} q_i\right] U(Y + F(k,n) - \frac{rk}{n}) + \left(1 - \left[\prod_{i=1}^{n} q_i\right]\right) U(Y - \frac{rk}{n}) \tag{16}$$

[2]Alternatively, suppose that the pdf of abilities single-peaked. Given nomally or log-normally distributed abilities - as often assumed - this result is even reinforced as long as the New Economy attracts professionals with above-average abilities. However, in this case a small increase in the relative attractiveness of Old Economy jobs also induces a rather significant migration of professionals from the New into the Old Economy.

Introducing exogenous income $Y > 0$ in (16), the analysis will exclusively focus on interior solutions. Such solutions can be ensured by assuming that $U(c)$ satisfies the usual Inada-conditions.

If it is ever beneficial to found such firms, they will consist of teams of individuals characterized by identical abilities again. This follows from the fact that $\partial EU/\partial \left[\prod_{j\neq i} q_j\right] > 0$ for $F(k,n) > 0$. Thus, high ability individuals will always find it more attractive to join firms already consisting of higher quality team members in the first $(n-1)$ tasks. Replacing $[\prod_{i=1}^{n} q_i]$ by q^n in (16) then yields the first-order conditions

$$q^{\tilde{n}}U'(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})\left[\alpha\tilde{k}^{(\alpha-1)}\tilde{n}^{(1-\alpha)}-\frac{r}{\tilde{n}}\right]=(1-q^{\tilde{n}})U'(Y-\frac{r\tilde{k}}{\tilde{n}})\frac{r}{\tilde{n}} \tag{17}$$

and

$$\begin{aligned} & -q^{\tilde{n}}log(q)\left[U(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})-U(Y-\frac{r\tilde{k}}{\tilde{n}})\right] \\ = \; & q^{\tilde{n}}U'(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})\left[(1-\alpha)\tilde{k}^{\alpha}\tilde{n}^{-\alpha}+\frac{r\tilde{k}}{\tilde{n}^2}\right] \\ & +(1-q^{\tilde{n}})U'(Y-\frac{r\tilde{k}}{\tilde{n}})\frac{r\tilde{k}}{\tilde{n}^2} \end{aligned} \tag{18}$$

Substituting from (17) into (18) yields

$$-log(q)\frac{U(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})-U(Y-\frac{r\tilde{k}}{\tilde{n}})}{U'(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})}=\tilde{k}^{\alpha}\tilde{n}^{-\alpha} \tag{19}$$

By virtue of Jensen's inequality it then follows that

$$-log(q)\tilde{n}<1 \tag{20}$$

Thus, partnerships managed by risk-averse team members are *ceteris paribus* smaller than risk-neutral partnerships. Rearranging (17) and substituting for r from (5) above, it also follows

$$\begin{aligned} & \tilde{k}^{(\alpha-1)}\tilde{n}^{(1-\alpha)}\tilde{n}q^{\tilde{n}} \\ = \; & (k^*)^{(\alpha-1)}(n^*)^{(1-\alpha)}n^*q^{n^*}\left[q^{\tilde{n}}+(1-q^{\tilde{n}})\frac{U'(Y-\frac{r\tilde{k}}{\tilde{n}})}{U'(Y+F(\tilde{k},\tilde{n})-\frac{r\tilde{k}}{\tilde{n}})}\right] \end{aligned} \tag{21}$$

Now, note that the function $g(n) = nq^n$ entails a unique maximum, given $q \in]0,1[$. The maximizing value of n is characterized by $n = -1/log(q)$. Obviously, this is exactly the team size chosen by firms managed by risk-neutral partners. They will always choose a technology maximizing expected team output for a given output per worker. Thus, $n^*q^{n^*} > \tilde{n}q^{\tilde{n}}$, $\forall q \in]0,1[$.

Risk-averse partners not only require an income sufficient to cover their share of capital costs. In addition, they must be compensated for the risk of unsuccessful production. Consequently, the cost of attracting partners is higher than in the risk-neutral case. This implies that the size of production team falls short of maximizing expected team output.

Also, due to decreasing marginal utilities, the last term on the RHS of (21) is greater than one. Hence, $n^* > \tilde{n}$ implies $(k^*/n^*) > (\tilde{k}/\tilde{n})$ and $k^* > \tilde{k}$. Let $\tilde{w}(q)$ then denote the certainty equivalent income of such risk-averse partners self-managing a firm of team quality q. Hence, $\tilde{w}(q) = U^{-1}(EU(q, \tilde{n}, \tilde{k}))$. Risk-averse partnerships must obviously ensure a team quality $q > q^L > 0$ in order to generate a certainty equivalent income exceeding Y. It is also immediately clear that

$$\begin{aligned} \tilde{w}(q) &< \tilde{k}^{\alpha}\tilde{n}^{(1-\alpha)}\tilde{n} - \frac{r\tilde{k}}{\tilde{n}} \qquad (22) \\ &< (k^*)^{\alpha}(n^*)^{(1-\alpha)}n^*q^{n^*} - \frac{rk^*}{n^*} = w^*(q) \end{aligned}$$

where the second inequality follows from the allocative distortions associated with maximizing expected utility. This implies that only individuals of ability $q \geqq \tilde{q}$, where $\tilde{q}$ is defined by $\tilde{w}(\tilde{q}) = V$, will found New Economy partnership firms. The inequalities (22) then yield $\tilde{q} > q^*$.

Finally, note that

$$\frac{\partial EU(q, \tilde{n}, \tilde{k}))}{\partial q} = \tilde{n}q^{(\tilde{n}-1)}\left[U(Y + F(\tilde{k}, \tilde{n}) - \frac{r\tilde{k}}{\tilde{n}}) - U(Y - \frac{r\tilde{k}}{\tilde{n}})\right] > 0 \quad (23)$$

Thus, suppose that - given the Old Economy income opportunity V - there exist risk-averse partnerships consisting of professionals sharing ability $q = \tilde{q} < 1$ which offer an expected utility $EU(\tilde{q}, \tilde{n}(\tilde{q}), \tilde{k}(\tilde{q})) = U(Y + V)$. Then, founding such partnerships is dominant for all individuals characterized by $q > \tilde{q}$.

Without further proof the following can therefore be summarized:

Proposition 1 *Ceteris paribus, risk-aversion induces less firms founded as New Economy partnerships. The firms actually founded produce less sophisticated services with inefficiently small teams. Moreover, capital input and capital per team member is inefficiently low.*

Else, the equilibrium with risk-averse partnerships shares the properties derived above already. Small variations in team quality again induce large income differentials between the partnerships. Also, a small increase in the relative attractiveness of Old Economy jobs induces a rather large reduction of the number of New Economy firms. Due to smaller firm sizes, the latter effect can be even verified to be reinforced by introducing risk-aversion.

3.2 Endogenous separation of Old and New Economy

So far, the analysis does not address the existence of the New Economy *per se*. As noted above, firms in the New Economy often constitute Old Economy spin-offs. More generally, they offer professional services to Old Economy firms and consumers which in principle can be, previously have been, and - to some extend - are still produced in the Old Economy as well. Thus, suppose that Old Economy firms possess access to the basic technology and can be taken to maximize profits. On first sight, the inefficiencies associated with New Economy partnerships then appear to preclude competitive New Economy production.

However, this conclusion hinges on the fact that Old and New Economy firm managements are equally qualified to verify the different professionals' abilities. According to the O-Ring theory, successful production requires the coordination of - typically complex and human capital intensive - tasks and cooperation within the team. Given this production environment, the verification of the team members abilities will plausibly be enhanced if the evaluation is carried out by the team members themselves. Upon verification it can then be necessary to dismiss team members. Moreover, optimal recruiting necessarily requires the possibility to observe individual abilities.

Hence, these residual decision rights should optimally be allocated to the team members. The motivation to select appropriately must then stem from obtaining the residual income as well. Thus, despite the inefficiencies associated with partnerships of risk-averse production team members, this organizational form may dominate. In particular, this will hold if the possibility to verify abilities yields significant improvements in expected revenue. In the following, it will - for analytic tractability - be assumed that within such partnerships the abilities of the team members can be observed perfectly. In contrast, Old Economy firm managements acting on behalf of a profit-maximizing ownerships cannot observe or verify the abilities of their employees at all.

Thus, Old Economy firms recruit employees from the remaining pool of professionals who do not prefer to join a partnership of risk-averse team members sharing identical abilities. Suppose that such individuals are characterized by abilities $0 \leqq q < q^U$. Given the assumption that abilities are distributed uniformly, random recruiting in the Old Economy implies that the expected quality of an employee in each task is given by $E\{q \,|0 < q < q^U\} = \frac{1}{2}q^U$. The respective expected profit maximization problem can therefore be stated as

$$Max_{\{n,k\}} \quad F(k,n)n\left[\frac{q^U}{2}\right]^n - nV - rk \tag{24}$$

The first-order conditions then yield

$$r = \alpha(k^o)^{(\alpha-1)}(n^o)^{(1-\alpha)}n^o\left[\frac{q^U}{2}\right]^{n^o} \tag{25}$$

and

$$\begin{aligned} V &= log(\frac{q^U}{2})(k^o)^\alpha(n^o)^{(1-\alpha)}n^o\left[\frac{q^U}{2}\right]^{n^o} \\ &\quad +(1-\alpha)(k^o)^\alpha(n^o)^{-\alpha}n^o\left[\frac{q^U}{2}\right]^{n^o} + (k^o)^\alpha(n^o)^{(1-\alpha)}\left[\frac{q^U}{2}\right]^{n^o} \end{aligned} \tag{26}$$

where the superscript "o" denotes the respective optimal values. According to (25), the capital rental payments account for the share α of expected revenue. Thus, in competitive equilibrium for Old Economy firms

$$V^o(q^U) = (1-\alpha)(k^o)^\alpha(n^o)^{(1-\alpha)}\left[\frac{q^U}{2}\right]^{n^o} \tag{27}$$

Substituting from (27) into (26) then implies

$$log(\frac{q^U}{2})n^o + 1 = 0 \tag{28}$$

Hence, profit maximization again yields maximum team output - in this case, given the average quality team member, however. Investigating the possibility of an equilibrium with endogenous separation of Old and New Economy, the following can then be obtained:

Proposition 2 *Suppose that the team members are risk-averse. Also, the management of profit-maximizing firms cannot observe individual abilities. Then, there always exist teams of high-ability professionals which prefer founding ability-matching partnerships over participating in a profit-maximizing Old Economy firm which selects abilities randomly. Moreover, there always exists a unique efficient equilibrium which separates the Old from the New Economy.*

Proof. Note that (17) and (18) imply that $lim_{q\to 1}[\tilde{n}(q)] = n^*(q)$ and $lim_{q\to 1}\left[\tilde{k}(q)\right] = k^*(q)$. Then, also $lim_{q\to 1}[EU(q,\tilde{k}(q),\tilde{n}(q))] = U(Y + w^*(q))$.

On the other hand, $lim_{q^U\to 0}n^o = n^*$ and $lim_{q^U\to 0}k^o = k^*$ and therefore $lim_{q^U\to 0}V(q^U) = w^*(q^U)$. Hence, very low ability individuals will never prefer to found risk-averse partnerships. Yet, due to (28), $U(Y + V(q^U)) < U(Y + w^*(q^U))$, for all $q^U > 0$.

Obviously, q^U characterizes the ability of the marginal professional recruited by Old Economy firms. Hence, it must be true that - as ability approaches one - the utility of such a marginal Old Economy employee falls short of the expected utility associated with founding a partnership in which all individuals share the same ability.

Clearly, for general utility functions $U(c)$ it cannot be ensured that both $EU(q, \tilde{k}(q), \tilde{n}(q))$ and $U(Y + V^o(q^U))$ cross only once as q and q^U approach unity. Then, assume that there exist multiple equilibria satisfying $EU(\tilde{q}_k, \tilde{k}(\tilde{q}_k), \tilde{n}(\tilde{q}_k)) = U(Y + V^o(\tilde{q}_k))$, with $k = 1, 2, 3, .., K$. Let these equilibria be ordered such that $\tilde{q}_1 < \tilde{q}_2 < ... < \tilde{q}_K$. It must be true that $K \in \{1, 3, 5...\}$. This follows since $U(Y + V^o(q))$ exceeds $EU(q, \tilde{k}(q), \tilde{n}(q))$ as q approaches zero and the reverse holds for q in the proximity of one.

Hence, $EU(q, \tilde{k}(q), \tilde{n}(q)) \geqq U(Y + V^o(q^U))$ for all $q, q^U \geqq \tilde{q}_K$. Then, the equilibrium characterized by $EU(\tilde{q}_K, \tilde{k}(\tilde{q}_K), \tilde{n}(\tilde{q}_K)) = U(Y + V^o(\tilde{q}_K))$ constitutes the unique efficient equilibrium. This follows from the fact that both $EU(q, \tilde{k}(q), \tilde{n}(q))$ and $U(Y + V^o(q^U))$ are monotonically increasing in q and q^U, respectively. Moreover, Old Economy firms offer wage-income $V^o(q^U)$ for all employees - not only the marginal high ability employees characterized by $q = q^U$. Thus, $U(Y + V^o(\tilde{q}_K)) > EU(q, \tilde{k}(q), \tilde{n}(q))$, for all $q < \tilde{q}_K$. ■

In every equilibrium k, Old Economy firms hire randomly from the pool of professionals characterized by $q \in]0, \tilde{q}_k]$. Firms in the New Economy constitute partnerships of individuals sharing identical abilities. The team quality of such firms ranges over the interval $]\tilde{q}_k, 1[$ then. According to the Proposition above, at least on such equilibrium and exactly one efficient equilibrium exists.

Thus, given risk-aversion of the potential team members, the productive advantage of perfect ability matching in teams suffices to establish an equilibrium which separates Old and New Economy. In particular, it is not necessary to assume that firms in the New Economy possess exclusive access to a superior production technology. It must only be true that individual abilities can be observed in partnerships which self-manage production and consequently distribute the surplus among the team members. At the same time, abilities remain private information of the employees in "managed" firms organized on behalf of a profit-maximizing residual claimant.

4 Concluding comments

Recent discussions often refer to a perceived "volatility" of New Economy firms. Section 2 has emphasized that the O-Ring approach can account for rather large variations in the income claims derived from New Economy jobs. At the same time, a small change in the production technology or market environment which increases the attractiveness of Old Economy occupations

implies a rather significant reduction in the number of New Economy firms.

The marginal New Economy firm constitutes a relatively small low ability team. Hence, the result only requires that high abilities are not overrepresented in the population of professionals. Risk-aversion of the professionals who are in principle qualified for such jobs *ceteris paribus* reinforces this tendency. It reduces the size of New Economy firms which are organized as partnerships or, more generally, significantly assign residual decision rights and income claims to the members of the production team.

Moreover, the O-Ring theory can actually motivate this organizational firm design. The quality of ability matching is decisive for the productive advantage of New Economy firms. Thus, the fundamental residual decision rights associated with hiring and firing should be allocated to the informed team members. Residual income claims then provide the motivation to carry out this selection task.

INSERT FIGURE 1 ABOUT HERE !

Further, with risk-averse professionals founding New Economy partnership firms, there exists an endogenous equilibrium separating the Old and the New Economy. The outsider residual claimants organizing Old Economy firms cannot observe individual abilities, while the insider partners of New Economy firms - being involved in the team production themselves - can. However, the partnership organization induces inefficient factor use.

Thus, given that all firms have access to the same production technology, strict dominance of one of firm organizations cannot hold. Moreover, multiple equilibria cannot be ruled out and introduce still another source of New Economy firm volatility. However, there always exists a unique efficient equilibrium in which high ability professionals found partnerships and low ability individuals find employment in the Old Economy.

For convenience, figure 1 depicts a situation with only one such equilibrium[3]. It should be noted that this equilibrium - and also every other equilibrium which may arise under more general conditions - is inherently unstable. Thus, suppose that the equilibrium separating Old and New Economy at ability level $\tilde{q}$ has been established. Then, Old Economy firms also know that the New Economy partnerships consist of professionals characterized by superior ability.

Thus, knowledge concerning whether or not the economy is in equilibrium is informative for individual decision-makers in Old-Economy firms. In equilibrium perfect ability matching in New Economy partnerships implies that - given the O-Ring framework - such firms produce services of differing degrees of sophistication. Team ability and - hence, individual ability

[3]This can be ensured if the utility function is characterized by constant relative risk-aversion and income Y approaches zero, for instance.

- becomes verifiable as the mirror-image of product quality. Even without being able to observe individual abilities, Old Economy firms will therefore find it profitable to integrate such partnerships.

Since there always exist partnerships which do not succeed in generating positive surplus, such integration may even be rather easily achieved. However, once the integration by Old Economy firms has led to the extinction of a sufficient number of New Economy firms, new partnerships of professionals will be founded again. The complete integration of the New Economy does not constitute an equilibrium.

As this situation is approached, strong incentives to disintegrate - by outsourcing or "corporate venturing" - arise again. This and the inherent instability of all New Economy equilibria appears to fit the stylized facts surrounding recent discussions of the emergence of a New Economy and the "volatility" of the firms involved rather well.

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Figure 1: The separation of Old and New Economy in equilibrium