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Proofs of Statements and Experimental Instructions

EC.1. Proofs of Statements

Proof of Proposition 1: Suppose the entrepreneur produces until period n and raises capital by issuing short-term equity. Let α^* represent investors' equilibrium profit share in period n and let p^* represent the good's price in period n. Now consider a type-F entrepreneur's period n decision: his payoff from producing a low quality good is $(1-\alpha^*)p^*$, which is higher than his payoff from producing a high quality good, $(1-\alpha^*)(p^*-c)$. Therefore, the entrepreneur's best response is to produce low quality. Next consider equilibria in which the entrepreneur finances his investment with traditional equity. Let δ^* represent investors' equilibrium profit share and let p^* represent the product's price in period n. The entrepreneur's payoff from producing a low quality good in period n is $(1-\delta^*)p^*$, which is higher than his payoff from producing a high quality good, $(1-\delta^*)(p^*-c)$. Once again, it follows that the entrepreneur's best response is to produce low quality. Finally, consider equilibria where the entrepreneur finances production internally. The entrepreneur's period n payoff from producing a low quality good is p^*-I which is greater than p^*-c-I, his payoff from producing high quality. This concludes our proof. □

LEMMA EC-1. In any equilibrium, once it is common knowledge that the entrepreneur is type-F, consumers will only pay u_l for the good.

Proof of Lemma ec-1: If the entrepreneur produces low quality in every period, the consumers' best response is to pay u_l. Moreover, if consumers pay u_l in each period, the entrepreneur's best response is to produce low quality. This establishes that there is an equilibrium for a subgame following the revelation that the entrepreneur is type-F in which consumers pay u_l in every period.

Now we establish the uniqueness of this outcome. Consider the case where the entrepreneur relies on internal financing. Arguments that are virtually identical to those we employ in the proof of Proposition 1 establish that, if the entrepreneur's future payoff is not sensitive to his quality choice, his best response is to produce low quality. Moreover, given the entrepreneur will produce low quality, the consumers' best response is to pay u_l. Now consider the possibility that the price of the good varies over time. The entrepreneur can only be induced to produce high quality and the consumer to pay more than u_l when the entrepreneur expects to incur a sufficiently large drop in his payoff if he produces low quality. It is clear from the proof of Proposition 1 that the entrepreneur will produce low quality in period n and consumers will pay u_l in period n. Thus in period $n-1$, the entrepreneur can produce low quality without incurring any change in his future expected payoff, and because producing low quality is his best response to any price p^* in period $n-1$, the entrepreneur will produce low quality. It is clear that the consumers' best response in period $n-1$ is to pay u_l. By induction, it is clear that the entrepreneur will not produce high quality in any period subsequent to the revelation that he is type-F. Moreover, consumers will pay only u_l in every period. A simple extension of this argument establishes the desired result in the cases where the entrepreneur employs either short-term or traditional equity financing. □

Proof of Proposition 2: First, we show that (8) is a necessary and sufficient condition for a reputation equilibrium when the entrepreneur finances internally. Then we demonstrate that, when (8) is satisfied, the reputation equilibrium with internal financing is unique. We conclude the proof by establishing our claims regarding the reputation equilibrium when the entrepreneur employs traditional equity financing.

Internal financing Let $Y^+ = u_h - c - I$ and $\bar{Y} = \bar{p} - I$. Suppose that the entrepreneur has only produced high quality until there are $k > 1$ periods remaining. Then the entrepreneur's expected payoff from producing high quality goods until the final period equals

$$(k-1)\,Y^+ + \bar{Y}. \tag{ec-1}$$

In contrast, if he switches to producing low quality in period $n-k$, the entrepreneur will be identified as F. From Lemma ec-1 it follows that he will not be able to profitably undertake the project in any future period. Consequently, the present value of his payoffs through period n equals $Y^+ + c$. It follows that producing high quality goods in all periods before n is a best response if and only if

$$\min_{1<k\le n}\left[(k-1)\,Y^+ + \bar{Y}\right] > Y^+ + c. \tag{ec-2}$$

First note that (ec-2) must be satisfied for period $n-1$, i.e., $k=2$. In this case (ec-2) reduces to (8), establishing that (8) is a necessary condition for a reputation equilibrium. To see that (8) is sufficient for the existence of a reputation equilibrium, note that the left hand side of (ec-2) is increasing in k since $Y^+ > 0$ by Assumption (3). Thus, (ec-2) is satisfied whenever (8) is satisfied. This, concludes our sufficiency proof when the entrepreneur finances internally.

Now we establish uniqueness by means of a contradiction. Suppose there exists an equilibrium where type-F produces low quality prior to period n. Note that, so long as type-H earns a profit in every period, in any equilibrium in which type-F randomizes before period n it must be the case that the posterior probability of H conditioned on high quality output in all remaining periods must be greater than π. For this reason, even though low quality is a strictly dominant strategy for type-F in period n, it must be the case that the probability of high quality production must be more than π. Thus, the equilibrium price in period n, $p^* > \bar{p}$. Let ρ^* represent the equilibrium period n probability of type-H on which consumers base their purchase price.

For type-F to be willing to defect from high quality production in period $n-1$, the gain from defection must be at least as large as the cost of defection, i.e., $p^* - c - I \le 0$. Note however, that because $p^* > \bar{p}$, this contradicts our maintained assumption (8). Thus, type-F will not defect from high quality production in period $n-1$. Now consider period $n-2$. Once again, the entrepreneur will only opt for low quality production if the gain from producing low quality more than offsets the loss of future profits, i.e., $Y^+ + p^* - c - I \leq 0$. Note however that, this condition is violated because (8) is satisfied demonstrating that, once again, type-F will not defect from high quality production in period $n-2$. Now note that, based on the argument we have just employed, while the gain from deviating from high quality production remains unchanged at c as we move backward in time, the cost of deviating increases so long as (8) is satisfied. Thus, when defection from high quality production is not optimal in period $n-2$, it will not be optimal in any period earlier than $n-2$. Consequently, there cannot exist an equilibrium where type-F will defect from high quality production prior to period n.

Traditional equity financing Suppose the entrepreneur employs traditional equity financing and has only produced high quality until there are $k > 1$ periods remaining. Then the entrepreneur's expected payoff from producing high quality goods until the final period equals

$$(1-\delta)[(k-1)(Y^+ + I) + (\bar{Y} + I)]. \tag{ec-3}$$

In contrast, if he switches to producing low quality in period $n-k$, the entrepreneur will be identified as F. From Lemma ec-1 it follows that he will not be able to profitably undertake the project in any future period. He will however be able to enjoy a $1-\delta$ share of the uninvested capital $(k-1)I$. Therefore, the present value of his payoffs through period n equals $(1-\delta)[(Y^+ + I + c) + (k-1)I]$. It follows that producing high quality goods in all periods before n is a best response if and only if

$$\min_{1<k\leq n}(1-\delta)\left[(k-1)(Y^+ + I) + (\bar{Y} + I)\right] > (1-\delta)[(Y^+ + I + c) + (k-1)I], \tag{ec-4}$$

or equivalently,

$$\min_{1<k\leq n}\left[(k-1)Y^+ + \bar{Y}\right] > Y^+ + c. \tag{ec-5}$$

The above condition is equivalent to (ec-2). Therefore, (8) is both necessary and sufficient for a reputation equilibrium with traditional equity financing. The proof of the uniqueness of this equilibrium follows from a minor extension of the uniqueness proof for internal financing after noting that the terms of the equity financing are fixed at time 0 ensuring that the entrepreneur has to give up a fixed share of both the benefits and costs of defecting to producing low quality goods. □

Proof of Proposition 3: Suppose that the entrepreneur has only produced high quality until there are period $k > 1$ periods remaining. Then the entrepreneur's expected payoff from producing high quality goods until the final period equals

$$(k-1)(1-\alpha^{+})(Y^{+}+I) + (1-\bar{\alpha})(\bar{Y}+I). \tag{ec-6}$$

In contrast, if he produces a low quality, the entrepreneur will be identified as F. Thus, because Lemma ec-1 establishes that in any period revenue can only equal u_l, if $u_l < I$ investors will refuse to finance the project while if $u_l = I$, they will demand 100% of the equity. In either case the entrepreneur's expected future payoff is 0. Consequently, the present value of his payoffs through period n equals $(1-\alpha^{+})(Y^{+}+I+c)$. Producing high quality for all periods before n is a best response if and only if

$$\min_{1<k\leq n}\left[(k-1)(1-\alpha^{+})(Y^{+}+I) + (1-\bar{\alpha})(\bar{Y}+I)\right] > (1-\alpha^{+})(Y^{+}+I+c). \tag{ec-7}$$

First note that (ec-7) must be satisfied for period $n-1$, i.e., $k = 2$. In this case (ec-7) reduces to (9), establishing that (9) is a necessary condition for a reputation equilibrium. Next note that the left hand side of (ec-7) is increasing in k since $(1-\alpha^{+})(Y^{+}+I) = Y^{+} > 0$. Thus, (ec-7) is satisfied for all periods when (9) is satisfied, establishing sufficiency.

We conclude the proof by establishing the uniqueness of this equilibrium. For a mixed strategy equilibrium, let α_t^* represent the equilibrium level of α in period t; let ρ_t^* represent the period t posterior probability that the entrepreneur is type-H; let p_t^* represent the equilibrium price in period t. Note that, so long as type-H earns a profit in every period, in any equilibrium in which type-F randomizes before period n it must be the case that $\rho_n^* > \pi$ and $p_n^* > \bar{p}$. Because, in equilibrium, α is decreasing in the probability of high quality production, it must be the case that in period n,

$$\alpha_n^* < \bar{\alpha}, \tag{ec-8}$$

and in any mixed strategy equilibrium

$$\alpha_{n-1}^* > \alpha^{+}. \tag{ec-9}$$

Thus, (ec-8) and $p_n^* > \bar{p}$ imply that

$$(1-\alpha_n^*)\,p_n^* > (1-\bar{\alpha})\,\bar{p}, \tag{ec-10}$$

and (ec-9) implies that

$$(1-\alpha_{n-1}^*)\,c < (1-\alpha^{+})\,c. \tag{ec-11}$$

Randomization in period $n-1$ requires that

$$(1-\alpha_n^*)\,p_n^* - (1-\alpha_{n-1}^*)\,c \leq 0. \tag{ec-12}$$

However, as (ec-10) and (ec-11) show, (ec-12) cannot be satisfied if (9) is satisfied. Thus, type-F will not randomize in period $n-1$. This implies that in period $n-1$, type-F must follow the pure strategy of producing high quality.

Now consider period $n-2$. Randomization in period $n-2$ requires that

$$(1-\alpha^{+})\,(p^{+}-c)+(1-\alpha^{*}_{n})\,p^{*}_{n}-(1-\alpha^{*}_{n-2})\,c\le 0. \tag{ec-13}$$

However, because, in equilibrium, α is decreasing in the probability of high quality production $(1-\alpha^{*}_{n-2})\,c<(1-\alpha^{+})\,c$. Further, because $p^{*}_{n}>\bar{p}$ and $\alpha^{*}_{n}<\bar{\alpha}$

$$(1-\alpha^{+})\,(p^{+}-c)+(1-\alpha^{*}_{n})\,p^{*}_{n}>(1-\alpha^{+})\,(p^{+}-c)+(1-\bar{\alpha})\bar{p}, \tag{ec-14}$$

and because, as we have just demonstrated, when (9) is satisfied

$$(1-\alpha^{+})\,(p^{+}-c)+(1-\bar{\alpha})\,\bar{p}>(1-\bar{\alpha})\,\bar{p}. \tag{ec-15}$$

Thus (ec-13) cannot be satisfied when (9) is satisfied. This establishes that F will not randomize in period $n-2$. The case for $t<n-2$ follows by induction. Thus, when (9) holds, there will not exist an equilibrium where type-F defects to low quality in any period $t<n$. □

Proof of Proposition 4: First note that, if the entrepreneur finances internally or employs traditional equity financing, producing high quality for all periods before n is a best response if and only if (ec-2) is satisfied. Similarly, if the entrepreneur is restricted to short-term equity finance, producing high quality for all periods before n is a best response if and only if (ec-7) is satisfied. Thus, to show that the set of parameters that supports reputation equilibria with short-term equity finance contains the set of parameters that supports reputation equilibria with internal finance and traditional equity financing, we have to demonstrate that (ec-7) is satisfied whenever (ec-2) is satisfied, i.e.,

$$(1-\bar{\alpha})\,(\bar{Y}+I)-(1-\alpha^{+})\,c>\bar{Y}-c, \tag{ec-16}$$

for all $k<n$. For this condition to hold, we need to show that

$$\alpha^{+}\,c>(\bar{\alpha}(\bar{Y}+I)-I). \tag{ec-17}$$

Now note that

$$\frac{\alpha^{+}\,c}{I}=\frac{c}{u_h-c} \tag{ec-18}$$

$$\frac{\bar{\alpha}(\bar{Y}+I)-I)}{I}=\frac{c\,\pi}{\pi\,u_h+(1-\pi)\,u_l-\pi\,c}. \tag{ec-19}$$

Because

$$\pi(u_h-c)-(\pi\,u_h+(1-\pi)\,u_l-\pi\,c)=-(1-\pi)\,u_l \tag{ec-20}$$

we see that

$$\alpha^+ c > (\bar{\alpha}(\bar{Y} + I) - I) \tag{ec-21}$$

must hold which implies, *a fortiori* that (ec-17) holds. □

Proof of Proposition 5: If condition (8) is satisfied then by Propositions 2 and 3 equilibrium production strategies and thus expected firm payoffs are the same, i.e.,

$$x_t^f(q_t^*, \tau) = x_t^*(\tau) = \begin{cases} p^+ - c & \text{if } t < n \\ \bar{p} - c & \text{if } t = n \text{ and } \tau = H \\ \bar{p} & \text{if } t = n \text{ and } \tau = F \end{cases} \quad f = \text{TEq}, \text{STEq}, \text{ or INT}. \tag{ec-22}$$

Let X^* represent total expected payoffs at date 0:

$$X^*(\tau) = \sum_{t=1}^{n} x_t^*(\tau). \tag{ec-23}$$

Let $V^f(\tau)$ represent the total expected value of claims issued to outsiders by type-τ conditioned on the information available at date 0 given financing plan f and given the equilibrium product quality strategy; let $v_t^f(\tau)$ represent the expected value of payments to outsiders at date t by type-τ conditioned on date 0 information and financing form f. Then. the equilibrium expected payoff at date 0 to type-τ under external financing regime f can be expressed as

$$X^*(\tau) - V^f(\tau) = X^*(\tau) - n\,I + (n\,I - V^f(\tau)). \tag{ec-24}$$

If the firm finances internally the expected equilibrium date 0 payoff to insiders is given by

$$X^*(\tau) - V^f(\tau) = X^*(\tau) - n\,I. \tag{ec-25}$$

Since the cash flows to H types are always smaller than the cash flows to F types, and in expectation claim value always equals the funds required for investment, claims issued by F types will always be overvalued, i.e. for both financing regimes

$$I - V^f(H) > 0. \tag{ec-26}$$

Comparing (ec-26) and (ec-25) we see that the payoff to type-F is always higher under external finance that it is under internal finance. Next we compare traditional with short-term equity. From (ec-25) we see that type-H will prefer the plan that produces the greatest overvaluation it its claim, $n\,I - V^f(\tau)$. To determine overvaluation first note that

$$V^f(\tau) = \sum_{t=1}^{n} v_t^f(\tau). \tag{ec-27}$$

The fact that the capital market is competitive implies that

$$\pi\,V^f(F) + (1-\pi)V_f(H) = n\,I. \tag{ec-28}$$

(ec-28) implies that undervaluation gain to H is given by

$$nI - V^f(H) = (1-\pi)\,(V^f(F) - V^f(H)). \tag{ec-29}$$

In the reputation equilibrium, cash flow for the two types are the same in the first $n-1$ periods. Thus, from (ec-27) we see that the mispricing gain is given by

$$(1-\pi)\,(V^f(F) - V^f(H)) = (1-\pi)\,(v^f_n(F) - v^f_n(H)). \tag{ec-30}$$

Next note that

$$(1-\pi)\,(v_n^{\mathrm{TEq}}(F) - v_n^{\mathrm{TEq}}(H)) = (1-\pi)\,\pi\,\bar{\alpha}c \tag{ec-31}$$

$$(1-\pi)\,(v_n^{\mathrm{STEq}}(F) - v_n^{\mathrm{STEq}}(H)) = (1-\pi)\,\pi\,\delta c. \tag{ec-32}$$

Thus, the overvaluation gain to F will be larger under short-term equity if and only if $\delta < \bar{\alpha}$. Next note that, in fact, $\delta < \bar{\alpha}$. This follows from simple computation; the value of $\bar{\alpha}$ is given by (6). The value of δ is computed from the competitive market condition for traditional equity, (7), using the equilibrium behavior in the reputation formation equilibria. Thus δ is fixed by the following equation

$$n\,I = \delta\left((n-1)(p^+ - c) + (\bar{p} - \pi\,c)\right). \tag{ec-33}$$

Thus,

$$\delta = \frac{I}{\frac{n-1}{n}(p^+ - c) + \frac{1}{n}(\bar{p} - \pi\,c)} < \frac{I}{\bar{p} - \pi\,c} = \bar{\alpha}. \tag{ec-34}$$

□

Proof of Proposition 6: The existence and uniqueness of the equilibria follows directly from Propositions 2 and 3. The product and capital market prices follow directly from the equilibrium outcomes described in these propositions. □

Proof of Proposition 7: First we will establish that no equilibria in pure strategies exist. Then we will establish our claim regarding pooling equilibria.

Note that, given (10), there cannot exist equilibria where type-F only produces low quality or switches from producing low quality to producing high quality. We now demonstrate that, given (11), there cannot exist equilibria in which type-F switches from high quality to low quality. Combined with Proposition 1 this ensures that there cannot exist any equilibria where type-F produces high quality.

Suppose there exists an equilibrium where, type-F produces high quality until period $t \le n$, and then switches to producing low quality. Also suppose that type-H continues to produce. Given that consumers will price the product based on their priors in period t, it follows from (11) that type-H

will find production uneconomic. This contradiction proves that there cannot exist an equilibrium in which type-H produces in the period in which type-F is expected to switch to low quality. Now suppose that there exists an equilibrium where, type-F produces high quality until period $t \le n$, and then switches to producing low quality. Also suppose that type-H does not produce in period t. Then in period t the product will be priced at u_l. However, from (10) it follows that production is uneconomic for type-F. Thus, there cannot exist such equilibria. It follows that the only potential equilibria are ones where type-F produces high quality until some period t and then ceases production. However, these equilibria are ruled out by Proposition 1.

Now we will establish our claim regarding pooling equilibria. First we show that consumer prices are consistent with rational expectations: Given that only type-F is capable of producing low quality and given that type-F never produces high quality after producing low quality, the consumer belief that all goods produced subsequent to the production of low quality are low quality is consistent with rational expectations. Moreover, such a belief supports the prices specified following the first instance of low quality production. Now, consider prices when low quality has not been produced in a previous period. First consider period 1. Because the entrepreneur is producing high quality with probability 1, the consumer's belief that the market is producing high quality with probability 1 is consistent with rational expectations and justifies the price specified in the equilibrium. In period 2, if type-F produces high quality with probability 3/5 and type-H with probability 1, given the prior that the entrepreneur is type-H is 3/4, the probability of high quality production in period 2 must equal 0.90. This implies a price of $u_h(0.90) + u_l(0.10) = 940$, the price specified in the equilibrium. Now consider the last period; Bayes rule implies that consumers assesses the likelihood that an entrepreneur producing high quality in periods 1 and 2 is type-F at

$$\frac{\frac{1}{4} \times \frac{3}{5}}{\frac{1}{4} \times \frac{3}{5} + \frac{3}{4}} = \frac{1}{6}. \tag{ec-35}$$

Thus, rational expectations requires that consumers offer

$$\frac{5}{6}u_h + \frac{1}{6}u_l = 900, \tag{ec-36}$$

exactly the price specified in the equilibrium.

Next we show that, given consumer offers, type-F's strategies are sequentially rational. First consider the last period, period 3. In this period low quality is clearly optimal for type-F. Moreover, if the entrepreneur has ever failed to produce high quality in a previous period, then the price that will be offered for his goods, which equals 400 (u_l) is less than the production cost of 500, hence the entrepreneur's payoff is maximized by shutting down as specified in the equilibrium. It only remains to consider quality decisions of type-F given that he has never failed to produce high quality in a previous period. First consider period 2. In period 2, high quality production costs $c+I=900$ while low quality production costs $I=500$. Thus, switching to low quality will yield a gain of $c=400$. The cost of low quality is that profits from period 3 production will be lost. These profits equal the period 3 price less the cost of low quality production, i.e., they equal $900-I=400$. Thus, type-F is indifferent between high and low quality. This payoff structure rationalizes the equilibrium strategy of randomizing in period 2. Now consider period 1. Producing low quality in period 1 saves the entrepreneur $c=400$ in operating costs. The loss is the foregone profit from producing in periods 2 and 3, which equals $940-500=440$ Thus, producing high quality in period 1, as specified in the equilibrium is rational for type-F. □

Proof of Proposition 8: The existence and uniqueness of the equilibria follows directly from Proposition 3. The product and capital market prices follow directly from the equilibrium outcomes described in Proposition 3. □

Proof of Proposition 9: First note that if production occurs in period $t>1$, the market price must at least equal 900 for entrepreneurs that produce high quality in all previous periods. We establish this result by means of a contradiction. Suppose the period t price is less than 900 if an entrepreneur produced high quality in all prior periods. Because the price is lower than the production cost for type-H, type-H will not produce. This implies that the price must be $400=u_l$. However, at this price, because $400<I$, even type-F will not produce. Further, by Proposition 1, type-F will have produced low quality in period $t-1$ as it was his last period of production.

For a price of 900 or above to satisfy rational expectations, there must be no more than a $\frac{1}{6}$ probability that the low quality is produced. Consider a candidate equilibrium and let, σ_t be the likelihood that type-F produces low quality at date $t=1,2$ given that he has never failed in the past to produce high quality. Bayes rule implies that, for the likelihood of low quality (conditioned on no failure to produce high quality in the past) to at least equal $\frac{1}{6}$ in periods 1, 2, and 3, given that the prior probability of an entrepreneur being type-F is $\frac{3}{4}$ as is assumed by Parameterization 3, the following inequalities must be satisfied:

$$\frac{3\sigma_1}{4}\leq\frac{1}{6} \tag{ec-37}$$

$$\frac{3(1-\sigma_1)\sigma_2}{4\left(\frac{3(1-\sigma_1)}{4}+\frac{1}{4}\right)}\leq\frac{1}{6} \tag{ec-38}$$

$$\frac{3(1-\sigma_1)(1-\sigma_2)}{4\left(\frac{3}{4}(1-\sigma_1)(1-\sigma_2)+\frac{1}{4}\right)}\leq\frac{1}{6} \tag{ec-39}$$

$$\sigma_1\in[0,1] \tag{ec-40}$$

$$\sigma_2\in[0,1]. \tag{ec-41}$$

However, no solution to this system of inequalities exists. Thus, there exists no equilibrium in which production occurs.

At the same time note that an equilibrium does exist in which production fails in all periods. To see this note that if, in period 3, consumers offer a price less than 900, production will cease because type-H will lose from producing. So to show that an equilibrium exists in which no production occurs we need only rationalize a price less than 900 at all nodes of the game. After low quality production, a price of less than 900 can always be rationalized by the belief that the good is being offered by type-F who will produce low quality. The problem is how to rationalize low prices after high quality production.

Bayes rule implies that, for the likelihood of low quality (conditioned on no failure to produce high quality in the past) to be greater than $\frac{1}{6}$ in periods 1, 2, and 3, given that the prior probability that an entrepreneur is type-F is $\frac{3}{4}$ as given in Parameterization 3, the following inequalities must be satisfied:

$$\frac{3\sigma_1}{4} > \frac{1}{6} \tag{ec-42}$$

$$\frac{3(1-\sigma_1)\sigma_2}{4\left(\frac{3(1-\sigma_1)}{4}+\frac{1}{4}\right)} > \frac{1}{6} \tag{ec-43}$$

$$\frac{3(1-\sigma_1)(1-\sigma_2)}{4\left(\frac{3}{4}(1-\sigma_1)(1-\sigma_2)+\frac{1}{4}\right)} > \frac{1}{6} \tag{ec-44}$$

$$\sigma_1 \in [0,1] \tag{ec-45}$$

$$\sigma_2 \in [0,1]. \tag{ec-46}$$

This system of equations has many solutions, e.g., $\sigma_1 = \frac{3}{8}$ and $\sigma_2 = \frac{5}{16}$. Given this pattern of randomization by type-F, rational prices are less than 900. This implies that type-H cannot profit from production at any node, thus production fails and there is no output at any date or history of the game. □

Proof of Proposition 10: Let p_t represent the equilibrium price in period t for output from "unrevealed entrepreneurs," entrepreneurs who have never failed to produce high quality. Let q_t represent the probability in period t that an unrevealed entrepreneur produces low quality. Let σ_t be the probability that type-F produces low quality in period $t = 1,2,3$ even when he is unrevealed. Let α_t represent the fraction of the entrepreneur's cash flow demanded by the investor in exchange for providing financing. Next note that, at unrevealed nodes, rational expectations on the part of consumers is satisfied if and only if

$$p_t = p(q_t), \quad t = 1,2,3. \tag{ec-47}$$

The competitive capital market and rational expectations for investors is satisfied if and only if

$$\alpha_t = \alpha(q_t) \quad t = 1, 2, 3. \tag{ec-48}$$

Bayes rule is satisfied if and only if (given the prior probability of type-F is 3/4)

$$q_1 = \frac{3}{4}\,\sigma_1, \tag{ec-49}$$

$$q_2 = \frac{3\,(1-\sigma_1)\,\sigma_2}{4\left(\frac{3}{4}\,(1-\sigma_1) + \frac{1}{4}\right)}, \tag{ec-50}$$

$$q_3 = \frac{3\,(1-\sigma_1)\,(1-\sigma_2)}{4\left(\frac{3}{4}\,(1-\sigma_1)\,(1-\sigma_2) + \frac{1}{4}\right)}. \tag{ec-51}$$

Randomization is a best response for an unrevealed type-F in both period 1 and period 2 if and only if

$$((1-\alpha_t)\,(p_t - c) + (1-\alpha_{t+1})\,p_2) - (1-\alpha_t)\,p_t = 0, \quad t = 1, 2 \tag{ec-52}$$

In period 3, the strategy of always producing low quality ($\sigma_3 = 1$) is clearly the unique best response for type-F.

We aim to verify the existence of an equilibrium with the following properties: at all revealed histories of the game, histories subsequent to a failure of the entrepreneur to produce high quality, consumers price the good at $u_l = 400$. At all such histories, the investor refuses to provide funding. At unrevealed histories, the actions of consumers, entrepreneurs and capitalists are defined as follows: First, let x^* represent the unique real number in the interval (0, 1) which solves the equation

$$-42450 + 376491\,x - 1298865\,x^2 + 2377271\,x^3 - 2535761\,x^4 + 1591842\,x^5 - 547880\,x^6 + 80000\,x^7 = 0; \tag{ec-53}$$

and let y^* represent the unique real number in the interval (0, 1) which solves the equation

$$-3804480 + 21742776\,y - 57235260\,y^2 + 91050246\,y^3 - 91564373\,y^4 + 56230563\,y^5 - 18789162\,y^6 + 2753440\,y^7 = 0. \tag{ec-54}$$

Define candidate actions at unrevealed histories as follows:

$$\begin{aligned}
&\sigma_1^* = \frac{4}{3}\,x^*, \quad \sigma_2^* = y^*, \quad \sigma_3^* = 1\\
&q_1^* = \frac{3}{4}\,\sigma_1^*, \quad q_2^* = \frac{3\,(1-\sigma_1^*)\,\sigma_2^*}{4\left(\frac{3}{4}\,(1-\sigma_1^*) + \frac{1}{4}\right)}, \quad q_3^* = \frac{3\,(1-\sigma_1^*)\,(1-\sigma_2^*)}{4\left(\frac{3}{4}\,(1-\sigma_1^*)\,(1-\sigma_2^*) + \frac{1}{4}\right)}\\
&p_t^* = 400\,q_t^* + 1000\,(1-q_t^*) \quad t = 1, 2, 3\\
&\alpha_t^* = \frac{5}{2(3-q_t^*)} \quad t = 1, 2, 3.
\end{aligned} \tag{ec-55}$$

A numerical approximation to this exact solution is given by

$$\begin{aligned}
&\sigma_1^* = 0.364, \sigma_2^* = 0.589, \sigma_3^* = 1.000,\\
&q_1^* = 0.273, q_2^* = 0.387, q_3^* = 0.440,\\
&p_1^* = 836.367, p_2^* = 768.055, p_3^* = 736.244,\\
&\alpha_1^* = 0.917, \alpha_2^* = 0.957, \alpha_3^* = 0.976.
\end{aligned} \tag{ec-56}$$

The reader can verify that (ec-55) satisfies the equilibrium conditions, (ec-47), (ec-48), (ec-49), (ec-50), (ec-51), (ec-52). Verification can be effected either by substituting the exact solution (ec-55) into a symbolic algebra programming language, e.g., Mathematica, or by substituting the approximate solution, (ec-56) into the same equations in which case the equalities will only be approximately satisfied. □

EC.2. Debt Financing

In the existing model, the entrepreneur has perfect information regarding the firm's future cash flows, and knows that the firm will either default with probability 0 or with probability 1. Under the standard absolute priority assumption, the entrepreneur will never issue debt if he knows the probability of default is 1, ensuring that he will only issue debt when the default probability is 0. If the firm never defaults, then the value of the debt claim will be independent of the entrepreneur's private information ensuring that his actions will not affect the value of outsiders' claims. It follows that the value of debt will not vary with product quality choices. Therefore, when the entrepreneur does not face uncertainty about default, short-term debt finance will not affect product quality. Consequently, for interesting results, there must be uncertain default. Therefore, we present a modified model with a production shock that includes this possibility and demonstrate that our results are robust to this change. The modification we make generates the necessary uncertainty in the most tractable manner possible.

Until he incurs a production shock, a high quality, type-H, entrepreneur can only produce high quality (h) goods and a flexible, type-F, entrepreneur has the option of producing either high or low quality (l) goods each period. The production shock is observed by consumers and investors and, thus, its occurrence is common knowledge. Once the entrepreneur experiences a shock, regardless of his type, he is unable to produce high quality output in the current period and all future periods. The production shock is stochastic and, regardless of the entrepreneur's type, occurs with probability $1-\theta$ in each period. The production shock occurs after the entrepreneur's production choice and the investment for the period have been made but before production occurs. Therefore, the possibility of a production shock ensures that payments to outsiders are risky conditioned on the entrepreneur's information and production choice.

To ensure that the expected increase in a consumer's utility from improved product quality exceeds the incremental cost of producing high quality, we restrict attention to

$$c < \theta(u_h - u_l). \tag{ec-57}$$

To ensure that high quality production has a positive NPV so long as investors and consumers believe that the probability of a high quality product is no lower than π, their prior probability that the entrepreneur is type H, i.e., we assume that

$$\theta\,\bar{p} + (1-\theta)\,u_l - c - I > 0. \tag{ec-58}$$

The entrepreneur can employ internal financing, short-term equity financing, or short-term debt financing. If the entrepreneur has not experienced a production shock in the current or past periods, the price consumers pay for the good can be represented by $p(\rho, q)$, where

$$p(\rho, q) = \rho\,u_h + (1-\rho)\,(q\,u_h + (1-q)\,u_l). \tag{ec-59}$$

Let $p^+ = p(\rho, 1) = u_h$ ($\bar{p} = p(\pi, 0)$) continue to denotes the price consumers pay when they assess probability π to the entrepreneur being type H and believe that type F will (will not) produce high quality.

If investors and consumers believe that the entrepreneur is type H with probability ρ and will produce high quality with probability q contingent on being type F, investors will demand a profit share of

$$\alpha(\rho, q) = \frac{I}{\theta\,p(\rho, q) + (1-\theta)\,u_l - (1-(1-\rho)\,(1-q))\,c}, \tag{ec-60}$$

when the entrepreneur raises short-term equity, and a promised repayment $D(\rho, q)$, where

$$D(\rho, q) = \frac{I - (1-\theta)[u_l - (1-(1-\rho)\,(1-q))\,c]}{\theta} > u_l, \tag{ec-61}$$

when the entrepreneur issues short-term debt. Thus, so long as investors and consumers share the belief that the entrepreneur is type H with probability $\rho \geq \pi$, the entrepreneur will default on his debt obligation if he incurs a production shock but will be able to replay his debt in full if he does not incur a production shock. Investors will not finance the entrepreneur if they believe that consumers will pay u_l for the good as the investment has a negative NPV.

Let $\alpha^+ = \alpha(\pi, 1)$ ($\bar{\alpha} = \alpha(\pi, 0)$) continue to denote the investors' profit share when both consumers and investors assess probability π to the entrepreneur being type H and believe that type F will (will not) produce high quality. Similarly, let $D^+ = D(\pi, 1)$ ($\bar{D} = D(\pi, 0)$) denote the investors' promised payment when both consumers and investors assess probability π to the entrepreneur being type H and believe that type F will (will not) produce high quality.

Despite the modification to our model, as we demonstrate in the following propositions, there continue to exist reputation equilibria where the entrepreneur produces high quality until period n or until he suffers a production shock. Reputation equilibria are supported by internal, short-term equity and, short-term debt financing. External short-term financing supports reputation equilibria over a larger parameter set than internal financing.

PROPOSITION EC.1. *If the entrepreneur employs internal finance, there exists a reputation equilibrium in which only high quality is produced until period n or until a production shock is observed, if and only if*

$$\theta\,[\theta\,\bar{p}+(1-\theta)\,u_l-I]-c>0. \tag{ec-62}$$

Further, this reputation equilibrium is the only equilibrium supported by parameter values satisfying (ec-62).

Proof of Proposition EC.1: First, we show that (ec-62) is a necessary and sufficient condition for a reputation equilibrium. We conclude the proof by demonstrating that, when (ec-62) is satisfied, the reputation equilibrium is the unique equilibrium.

Let $Y^+=\theta\,u_h+(1-\theta)\,u_l-c-I$ and $\bar{Y}=\theta\,\bar{p}+(1-\theta)\,u_l-I$. Suppose that the entrepreneur has not experienced a production shock and has only produced high quality until period $n-k-1$. Then, in period $n-k$, by producing high quality until the final period the entrepreneur's expected payoff equals

$$\sum_{j=0}^{k-1}\theta^j Y^+ +\theta^k\,\bar{Y}. \tag{ec-63}$$

In contrast, if he switches to producing low quality in period $n-k$, the entrepreneur will be identified as F. Thus, he will not be able to profitably undertake the project. Consequently, the present value of his payoffs through period n equals $Y^+ + c$. It follows that producing high quality for all periods before n is a best response if and only if

$$\min_{1\le k<n}\left[\sum_{j=1}^{k-1}\theta^j Y^+ +\theta^k\,\bar{Y}\right]>c. \tag{ec-64}$$

First note that (ec-64) must be satisfied for period $n-1$. However, in this case (ec-64) reduces to (ec-62), establishing that (ec-62) is a necessary condition for a reputation equilibrium.

To see that (ec-62) is sufficient for the existence of a reputation equilibrium, note that the left hand side of (ec-64) is increasing in k if and only if

$$\begin{aligned}&Y-(1-\theta)\,\bar{Y}\\ &=\theta\,p^+ +(1-\theta)\,u_l-c-I-(1-\theta)\;[\theta\,\bar{p}+(1-\theta)\,u_l-I]>0.\end{aligned} \tag{ec-65}$$

However, noting that $p^+ = \bar{p} + (1-\pi)(u_h - u_l)$, it follows that

$$\begin{aligned} &\theta\, p^+ + (1-\theta)\, u_l - c - I - (1-\theta)\, [\theta\, \bar{p} + (1-\theta)\, u_l - I] \\ &= \theta\, [\theta\, \bar{p} + (1-\theta)\, u_l - I] - c + \theta\, (1-\pi)\, (u_h - u_l) > 0. \end{aligned} \tag{ec-66}$$

This result follows because (ec-62) is satisfied and the last set of terms in this expression is positive. Thus, (ec-65) is satisfied whenever (ec-62) is satisfied. This, concludes our sufficiency proof because it establishes that (ec-64) is satisfied whenever (ec-62) is satisfied.

Now we establish uniqueness by means of a contradiction. Suppose there exists an equilibrium where type F produces low quality prior to period n. Note that, so long as type H earns a profit in every period, in any equilibrium in which type F randomizes before period n it must be the case that the posterior probability of H conditioned on high quality output in all remaining periods must be greater than π. For this reason, even though low quality is a strictly dominant strategy for type F in period n, it must be the case that the probability of high quality production must be more than π. Thus, the equilibrium price in period n, $p^* > \bar{p}$. Let ρ^* represent the equilibrium period n probability of type H on which consumers base their purchase price.

For type F to be willing to defect from high quality production in period $n-1$, the gain from defection must be at least as large as the cost of defection, i.e., $\theta\,(\theta\, p^* + (1-\theta)\, u_l - I) - c \le 0$. Note however, that because $p^* > \bar{p}$, this contradicts our maintained assumption (ec-62). Thus, type F will not defect from high quality production in period $n-1$. Now consider period $n-2$. Once again, the entrepreneur will only opt for low quality production if the gain from producing low quality more than offsets the loss of future profits, i.e., $\theta\, Y^+ + \theta^2\,(\theta\, p^* + (1-\theta)\, u_l - I) - c \le 0$. Note however that, because (ec-62) is satisfied,

$$\begin{aligned} &\theta\, Y^+ + \theta^2\,(\theta\, p^* + (1-\theta)\, u_l - I) - \theta\,(\theta\, p^* + (1-\theta)\, u_l - I) \\ &\theta\, p^+ + (1-\theta)\, u_l - c - I - (1-\theta)\, [\theta\, p^* + (1-\theta)\, u_l - I] \\ &= \theta\, [\theta\, p^* + (1-\theta)\, u_l - I] - c + \theta\, (1-\rho^*)\, (u_h - u_l) > 0. \end{aligned} \tag{ec-67}$$

Thus,

$$\theta\, Y^+ + \theta^2\,(\theta\, p^* + (1-\theta)\, u_l - I) > \theta\,(\theta\, p^* + (1-\theta)\, u_l - I) > c, \tag{ec-68}$$

demonstrating that, once again, type F will not defect from high quality production in period $n-2$. Now note that, based on the argument we have just employed, while the gain from deviating from high quality production remains unchanged at c as we move backward in time, the cost of deviating increases so long as (ec-62) is satisfied. Thus, when defection from high quality production is not optimal in period $n-2$, it will not be optimal in any period earlier than $n-2$. Consequently, there cannot exist an equilibrium where type F will defect from high quality production prior to period n. □

Proposition EC.2. *(i) Suppose that the entrepreneur finances production by raising capital from outside investors in exchange for a share of the period's profits (i.e., by using short-term equity), a reputation equilibrium in which only high quality is produced until period n or until a production shock is observed exists if and only if*

$$\theta\,(1-\bar{\alpha})\,[\theta\,\bar{p}+(1-\theta)\,u_l]-(1-\alpha^+)\,c>0. \tag{ec-69}$$

Further, this reputation equilibrium is the only equilibrium supported by parameter values satisfying (ec-69)*.*

(ii) Suppose that the entrepreneur finances production by issuing single-period debt to outside investors, a reputation equilibrium in which only high quality is produced until period n or until a production shock is observed exists if and only if

$$\theta\,(\bar{p}-\bar{D})-c>0. \tag{ec-70}$$

Further, this reputation equilibrium is the only equilibrium supported by parameter values satisfying (ec-70)*.*

Proof of Proposition EC.2: First, we establish our claims regarding external equity financing. Then we establish our claims regarding outside short-term debt financing.

Equity financing Suppose that the entrepreneur has only produced high quality until period $n-k-1$. In period $n-k$, by producing high quality until the final period the entrepreneur's expected payoff equals

$$\sum_{j=0}^{k-1}\theta^j\,(1-\alpha^+)\,(Y^++I)+\theta^k\,(1-\bar{\alpha})\,(\bar{Y}+I). \tag{ec-71}$$

In contrast, if he switches to producing low quality in period $n-k$, the entrepreneur will be identified as F. Thus, revenue can only equal $u_l\le I$ and investors will either refuse to finance the project or demand 100% of the equity. In either case the entrepreneur's expected future payoff is 0. Consequently, the present value of his payoffs through period n equals $(1-\alpha^+)\,(Y^++I+c)$. Producing high quality for all periods before n is a best response if and only if

$$\min_{1<k<n}\left[\sum_{j=1}^{k-1}\theta^j\,(1-\alpha^+)\,(Y^++I)+\theta^k\,(1-\bar{\alpha})\,(\bar{Y}+I)\right]>(1-\alpha^+)\,c. \tag{ec-72}$$

First note that (ec-72) must be satisfied for period $n-1$. However, in this case (ec-72) reduces to (ec-69), establishing that (ec-69) is a necessary condition for a reputation equilibrium. Next note that the left hand side of (ec-72) is increasing in k if and only if

$$\begin{aligned}&(1-\alpha^+)\,(Y+I)-(1-\theta)\,(1-\bar{\alpha})\,\bar{Y}\\ &=(1-\alpha^+)(\theta\,p^++(1-\theta)\,u_l-c)-(1-\theta)(1-\bar{\alpha})(\theta\,\bar{p}+(1-\theta)\,u_l)>0.\end{aligned} \tag{ec-73}$$

Note that

$$\begin{aligned}(1-\alpha^{+})(\theta\,p^{+}+(1-\theta)\,u_l-c)-(1-\theta)(1-\bar{\alpha})(\theta\,\bar{p}+(1-\theta)\,u_l)\\ =\theta\,(1-\bar{\alpha})(\theta\,\bar{p}+(1-\theta)\,u_l)-(1-\alpha^{+})c\\ +(1-\pi)\left[\theta\,(u_h-u_l)-c\,\bar{\alpha}\frac{u_l}{u_l+\theta\,(u_h-u_l)-c}\right]>0.\end{aligned} \tag{ec-74}$$

This follows because (ec-69) is satisfied and the last set of terms is positive as $\theta\,(u_h-u_l)-c>0$ by assumption (ec-57) and $\bar{\alpha}<1$ by assumption (ec-58). Thus, (ec-72) is satisfied for all periods when (ec-69) is satisfied.

Now we establish uniqueness. For a mixed strategy equilibrium, let α_t^* represent the equilibrium level of α in period t; let ρ_t^* represent the period t posterior probability that the entrepreneur is type H; let p_t^* represent the equilibrium price in period t. Note that, so long as type H earns a profit in every period, in any equilibrium in which type F randomizes before period n it must be the case that $\rho_n^*>\pi$ and $p_n^*>\bar{p}$. Because, in equilibrium, α is decreasing in the probability of high quality production, it must be the case that in period n,

$$\alpha_n^*<\bar{\alpha}, \tag{ec-75}$$

and in any mixed strategy equilibrium

$$\alpha_{n-1}^*>\alpha^{+}. \tag{ec-76}$$

Thus, (ec-75) and $p_n^*>\bar{p}$ imply that

$$(1-\alpha_n^*)\,(\theta\,p_n^*+(1-\theta)\,u_l)>(1-\bar{\alpha})\,(\theta\,\bar{p}+(1-\theta)\,u_l), \tag{ec-77}$$

and (ec-76) implies that

$$(1-\alpha_{n-1}^*)\,c<(1-\alpha^{+})\,c. \tag{ec-78}$$

Randomization in period $n-1$ requires that

$$\theta\,(1-\alpha_n^*)\,(\theta\,p_n^*+(1-\theta)\,u_l)-(1-\alpha_{n-1}^*)\,c\leq 0. \tag{ec-79}$$

However, as (ec-77) and (ec-78) show, (ec-79) cannot be satisfied if (ec-69) is satisfied. Thus, type F will not randomize in period $n-1$. This implies that in period $n-1$, type F must follow the pure strategy of producing high quality.

Now consider period $n-2$. Randomization in period $n-2$ requires that

$$\theta\,(1-\alpha^{+})\,(\theta\,p^{+}+\,(1-\theta)\,u_l-c)+\theta^2\,(1-\alpha_n^*)\,(\theta\,p_n^*+(1-\theta)\,u_l)-(1-\alpha_{n-2}^*)\,c\leq 0. \tag{ec-80}$$

However, because, in equilibrium, α is decreasing in the probability of high quality production $(1-\alpha^*_{n-2})\,c < (1-\alpha^+)\,c$. Further, because $p^*_n > \bar{p}$ and $\alpha^*_n < \bar{\alpha}$

$$\begin{aligned}&\theta\,(1-\alpha^+)\,(\theta\,p^+ + (1-\theta)\,u_l - c) + \theta^2\,(1-\alpha^*_n)\,(\theta\,p^*_n + (1-\theta)\,u_l)\\ &> \theta\,(1-\alpha^+)\,(\theta\,p^+ + (1-\theta)\,u_l - c) + \theta^2\,(1-\bar{\alpha})\,(\theta\,\bar{p} + (1-\theta)\,u_l),\end{aligned} \tag{ec-81}$$

and because, as we have just demonstrated, when (ec-69) is satisfied

$$\begin{aligned}&\theta\,(1-\alpha^+)\,(\theta\,p^+ + (1-\theta)\,u_l - c) + \theta^2\,(1-\bar{\alpha})\,(\theta\,\bar{p} + (1-\theta)\,u_l)\\ &\qquad > \theta\,(1-\bar{\alpha})\,(\theta\,\bar{p} + (1-\theta)\,u_l).\end{aligned} \tag{ec-82}$$

Thus (ec-80) cannot be satisfied when (ec-69) is satisfied. This establishes that F will not randomize in period $n-2$. The case for $t < n-2$ follows by induction. Thus, when (ec-69) holds, there will not exist an equilibrium where type F defects to low quality in any period $t < n$.

Debt financing Let $X^+ = \theta\,(p^+ - c - D^+)$ and $\bar{X} = \theta\,(\bar{p} - \bar{D})$. Suppose that the entrepreneur has only produced high quality until period $n-k-1$. Then, in period $n-k$, by producing high quality until the final period the entrepreneur's expected payoff equals

$$\sum_{j=0}^{k-1} \theta^j X^+ + \theta^k\,\bar{X}. \tag{ec-83}$$

In contrast, if he switches to producing low quality in period $n-k$, the entrepreneur will be identified as F. Thus, because revenue can only equal $u_l \leq I$, investors will either refuse to finance the project or demand 100% of the project's cash flow. In either case the entrepreneur's expected future payoff is 0. Consequently, the present value of his payoffs through period n equals $X^+ + \theta\,c$. Thus, producing high quality for all periods before n is a best response if and only if

$$\min_{1\leq k<n}\left[\sum_{j=1}^{k-1} \theta^j X^+ + \theta^k\,\bar{X}\right] > \theta\,c. \tag{ec-84}$$

First note that (ec-84) must be satisfied for period $n-1$. However, in this case (ec-84) reduces to (ec-70), establishing that (ec-70) is a necessary condition. Next note that the left hand side of (ec-84) is increasing in k if and only if

$$X^+ - (1-\theta)\,\bar{X} > 0. \tag{ec-85}$$

However this condition is always satisfied because

$$\begin{aligned}X^+ - (1-\theta)\,\bar{X} &= \theta\,(p^+ - c - D^+) - (1-\theta)\,\theta\,(\bar{p} - \bar{D})\\ &= \theta\,[\theta\,(\bar{p} - \bar{D}) - c] + (1-\pi)\,[\theta\,(u_h - u_l) - (1-\theta)\,c]\\ &> \theta\,[\theta\,(\bar{p} - \bar{D}) - c] + (1-\pi)\,[\theta\,(u_h - u_l) - c] > 0,\end{aligned} \tag{ec-86}$$

where the last inequality follows because (ec-70) is satisfied and assumption (ec-57) ensures that the last term is positive.

Now we establish, uniqueness. For a mixed strategy equilibrium, let D_t^* represent the equilibrium level of D in period t; let ρ_t^* represent the equilibrium period t probability assessed to the entrepreneur being type H. Let p_n^* represent the equilibrium price in period n. Note that, so long as type H earns a profit in every period, in any equilibrium in which type F randomizes starting in period k it must be the case that $\rho_t^* > \pi$ for all $t > k$. Thus, $\rho_n^* > \pi$. Because, in equilibrium, $p(\rho, 0) - D(\rho, 0)$ is increasing in ρ, it must be the case that in period n,

$$\theta\,(p_n^* - D_n^*) > \theta\,(\bar{p} - \bar{D}). \tag{ec-87}$$

Randomization in period $n-1$ requires that

$$\theta\,(p_n^* - D_n^*) - c \le 0. \tag{ec-88}$$

However, as (ec-87) shows, (ec-88) cannot be satisfied if (ec-70) is satisfied. Thus, no equilibrium exists in which type F randomizes in period $n-1$. This implies that type F must follow the pure strategy of producing high quality in period $n-1$.

Now consider period $n-2$. Randomization in period $n-2$ requires that

$$\theta(p^+ - c - D^+) + \theta^2\,(p_n^* - D_n^*) - c \le 0. \tag{ec-89}$$

However, because, in equilibrium, $\theta\,(p_n^* - D_n^*) > \theta\,(\bar{p} - \bar{D})$,

$$\theta(p^+ - c - D^+) + \theta^2\,(p_n^* - D_n^*) > \theta(p^+ - c - D^+) + \theta^2\,(\bar{p} - \bar{D}), \tag{ec-90}$$

and because, as we have just demonstrated, when (ec-70) is satisfied,

$$\theta(p^+ - c - D^+) + \theta^2\,(\bar{p} - \bar{D}) > \theta\,(\bar{p} - \bar{D}). \tag{ec-91}$$

Thus (ec-89) cannot be satisfied when (ec-70) is satisfied. This establishes that F will not randomize in period $n-2$. The case for $t < n-2$ follows by induction. Thus, when (ec-69) holds, there will not exist an equilibrium where type F defects to low quality in any period $t < n$. □

PROPOSITION EC.3. *(i) The parameter set that supports reputation equilibria when the entrepreneur employs internal finance is a subset of the set of parameters that supports reputation equilibria when the entrepreneur employs external equity finance. (ii) The parameter set that supports reputation equilibria when the entrepreneur employs internal finance is a subset of the set of parameters that supports reputation equilibria when the entrepreneur employs external debt finance.*

Proof of Proposition EC.3: First note that, if the entrepreneur is restricted to internal finance, producing high quality for all periods before n is a best response if and only if (ec-64) is satisfied. Similarly, if the entrepreneur is restricted to external equity finance, producing high quality for all periods before n is a best response if and only if (ec-72) is satisfied. Thus, to show that the set of parameters that supports reputation equilibria with external equity finance contains the set of parameters that supports reputation equilibria with internal finance, we have to demonstrate that (ec-72) is satisfied whenever (ec-64) is satisfied, i.e.,

$$\theta^k (1-\bar{\alpha}) (\bar{Y}+I) - (1-\alpha^+) c > \theta^k \bar{Y} - c, \tag{ec-92}$$

for all $k < n$. For this condition to hold we need to show that

$$\alpha^+ c > \theta (\bar{\alpha}(\bar{Y}+I) - I). \tag{ec-93}$$

Now note that

$$\frac{\alpha^+ c}{I} = \frac{c}{u_l(1-\theta)+u_h\theta - c} \tag{ec-94}$$

$$\frac{\bar{\alpha}(\bar{Y}+I)-I}{I} = \frac{c\pi}{u_l(1-\theta\pi)+u_h\theta\pi - c\pi}. \tag{ec-95}$$

Because

$$\pi\Big(u_l(1-\theta)+u_h\theta - c\Big) - \Big(u_l(1-\theta\pi)+u_h\theta\pi - c\pi\Big) = -u_l(1-\pi) \tag{ec-96}$$

we see that

$$\alpha^+ c > (\bar{\alpha}(\bar{Y}+I) - I) \tag{ec-97}$$

must hold which implies, *a fortiori* that (ec-93) holds.

Now note that, if the entrepreneur is restricted to external short-term debt finance, producing high quality for all periods before n is a best response if and only if (ec-84) is satisfied. Thus, to show that the set of parameters that supports reputation equilibria with external debt finance contains the set of parameters that supports reputation equilibria with internal finance, we have to demonstrate that (ec-84) is satisfied whenever (ec-64) is satisfied, i.e.,

$$\theta^k \bar{X} - \theta c > \theta^k \bar{Y} - c, \tag{ec-98}$$

or equivalently,

$$(1-\theta) c > \theta^k (\bar{Y} - \bar{X}). \tag{ec-99}$$

Note that

$$\bar{Y} - \bar{X} = (1-\theta) \pi c. \tag{ec-100}$$

Thus (ec-99) always holds. □

Proposition EC.4. *When* (ec-69) *is satisfied, there exist equilibria where entrepreneurs strictly prefer financing production with capital raised from outside investors.*

Proof of Proposition EC.4: The beliefs that support this equilibrium are as follows: If an entrepreneur ever fails to choose external finance, he must be type F. Given this belief, the price received by the entrepreneur for his product in all periods subsequent to using internal finance will be u_l. At this price, production is not profitable. Thus, as soon as an entrepreneur finances production himself, his continuation payoff falls to 0. Hence, always selecting external finance is the best response for the entrepreneur regardless of his type. Thus, an equilibrium exists in which external finance is used. □

EC.3. Experimental Instructions

Here, we present instructions for the internal and external financing treatments. Specific language for the internal treatments is set off in bold faced square brackets (i.e., [text]). Specific language for the external treatments is set off in bold face braces (i.e., **{**text**}**). The instructions here contain the specific numbers and percentages used in parameterization one. Numbers and percentages were changed as needed for parameterizations two and three.

INSTRUCTIONS

General

You are about to participate in an experiment in the economics of decision making. If you follow these instructions carefully and make good decisions, you might earn a considerable amount of money that will be paid to you in cash at the end of the experiment.

The experiment will consist of a series of separate decision making periods. Each period will consist of [two] **{**three**}** stages. During these stages, [two] **{**three**}** participants will be assigned to a group and engage in a series of decisions. The [two] **{**three**}** participants will be labeled **{**“Red,”**}** “Blue” and “Green.” In the following sections, we will discuss this process and show how each player’s payoff is determined. Then, we will discuss how you are assigned to groups.

The type of currency used in these games is francs. All trading and earnings will be in terms of francs. At the end of each period, you will receive franc payoffs that are yours to keep. At the end of the experiment, each franc will be worth $ ____ to you. Do not reveal this number to anyone. At the end of the experiment, your francs will be converted to dollars at this rate, and you will be paid in dollars. Notice that the more francs you earn, the more dollars you will earn.

Stages of the Game

During each of the [two] **{**three**}** stages of the game, one of the players will make a decision regarding the item that may be sold. These decisions will determine whether an item is available for sale and a sales price. We will explain what happens in the [two] **{**three**}** stages of this game in reverse order because it will make it easier for everyone to see what happens.

Stage [II] **{III}** Instructions

The Decision

In Stage [II] **{III}** the Green Player will make a decision that establishes a price for an item (which will be called the "Established Price") and may buy the item. If he or she does buy the item, it will be from the experimenter at a "Discounted Price" that is less than or equal to the Established Price.

If the Green Player buys the item, he or she will receive a "Redemption Value" from the experimenter for the item. There are two types of items: "Round" and "Square." The Redemption Value for the item depends on its type. Round items will be redeemed for 1000 francs. Square items will be redeemed for 400 francs. That is, Round items are worth 1000 francs to the Green Player while Square items are worth 400 francs. The type of the item will be determined by the Blue Player in Stage [I] **{II}** but the type will not be known by the Green player until after he or she establishes the price in Stage [II] **{III}**. We will discuss how the item type is determined later in the instructions.

Procedures

The Established Price and the Discounted Price for the item will be determined as follows. The Green Player will be asked to indicate the *highest* price he or she is willing to pay for the item. This will determine the Established Price. The Established Price must be greater than or equal to 400 and less than or equal to 1000. The Green Player indicates the Established Price, by filling out a green "Price Form" from his or her packet.

Below is a sample green Price Form:

Price Form

Period: _____ Player: _____ Group: _____

1. Highest price that I would be willing to pay for the item (Established Price, this number must be >= 400 and <=1000): _____

2. Random draw (Discounted Price): _____

3. Will I be buying the item if it is available for sale? ("Yes" if line 2 <= line 1 or "No" if line 2 > line 1) _____

The period, player and group will be filled in for you. Using the Price Form for the current period, place the highest price that you would be willing to pay for the item in line 1. This will become the Established Price of the item. We will discuss the rest of the form next.

The Discounted Price is determined as follows. After all Green Players have filled in line 1 on their Price Forms for the current period, the experimenter will draw a ticket from a box containing 601 tickets numbered 400-1000 that represent possible prices. If you are a Green Player, fill this number in on line 2 of your Price Form.

If the random draw is less than or equal to the price indicated by the Green Player, then the random draw will determine the Discounted Price. In this case, the Green Player will buy the item if it is available for sale at the price *indicated by the random draw* (the Discounted Price) from the experimenter and receive the redemption value. Thus, the price indicated by the Green Player defines the highest price that he or she will pay in exchange for the item.

If the random draw is greater than the price indicated by the Green Player OR the item is not made available for sale, then the Green Player will not buy the item. In this case, there is no Discounted Price, but the Established Price will remain the value indicated by the Green Player on line 1 of his or her Price Form. Thus, the Established Price will always be the *price indicated by the Green Player*.

If you are a Green Player mark whether you will be buying the item if it is available for sale or not on line 3 and turn the form into the experimenter. The information from the form will be used to help determine the payoffs for the players in the game.

Notes on this Procedure

Notice that it is in the best interest of the Green Player to be accurate; that is, the best thing he or she can do is be honest and state truthfully the highest price he or she is willing to pay for the item. If the price stated is too high or too low, then the Green Player is passing up opportunities that he or she would prefer.

For example, suppose you are a Green Player and you would be willing to pay up to 750 francs for the item, but instead you say that the most you would pay is 850 francs. (That is, you place 850 on line 1 instead of 750. As a result, the Established Price becomes 850.) If the ticket drawn at random is between the two prices (for example 800) you would have to pay 800 francs to buy the item if it is available for sale even though you would have preferred not to have purchased the item at that price. In this case, you would put 800 on line 2 and you would buy the item (because line 2 is less than line 1) at a Discounted Price of 800 francs, which is more than you wanted to pay for the item.

On the other hand, suppose that you would pay up to 750 francs, but instead you state your price as 650 francs. (That is, you place 650 on line 1 instead of 750. As a result, the Established

Price becomes 650.) If the ticket drawn at random is between the two prices (for example 700) you would not be allowed to buy the item if it is available for sale even though you would have preferred to purchase the item at the 700 franc price. In this case, you would put 700 on line 2 and you would not buy the item (because line 2 is greater than line 1).

In either case, it is in the Green Player's best interest to establish a price that equals the most he or she is actually willing to pay for the item.

Payoff Determination

The Green Player starts each period with 450 francs. The Green Player's payoffs are determined by (1) the initial endowment of 450 francs, (2) whether or not he or she bought the item, (3) the price of the item if he or she did buy it and (4) the redemption value for the item if he or she did buy it. Specifically, the Green Player's payoff will be:

Payoff = 450

+ Redemption Value (if Discounted Price <= Established Price and available for sale)

– Discounted Price (if Discounted Price <= Established Price and available for sale)

There are three possible outcomes:

(1) If the item is Round AND the Green Player buys it, he or she will receive 450 francs plus the 1000 franc redemption value minus the Discounted Price.

(2) If the item is Square AND the Green Player buys it, he or she will receive 450 francs plus the 400 franc redemption value minus the Discounted Price.

(3) If the Green Player does not buy the item, he or she will receive 450 francs.

For example, if the Discounted Price is 600 AND the Green Player buys the item, the payoff will be 450+1000-600=850 francs if the item is Round and 450+400-600=250 francs if the item is Square. If the Green Player does not buy the item, the Green Player's payoff is 450 francs. The Green Player can only buy the item if it is actually available for sale.

We will discuss Stage [I] **{II}** next. Before doing that, are there any questions about the Green Player's action in Stage [II] **{III}** and the Green Player's payoffs?

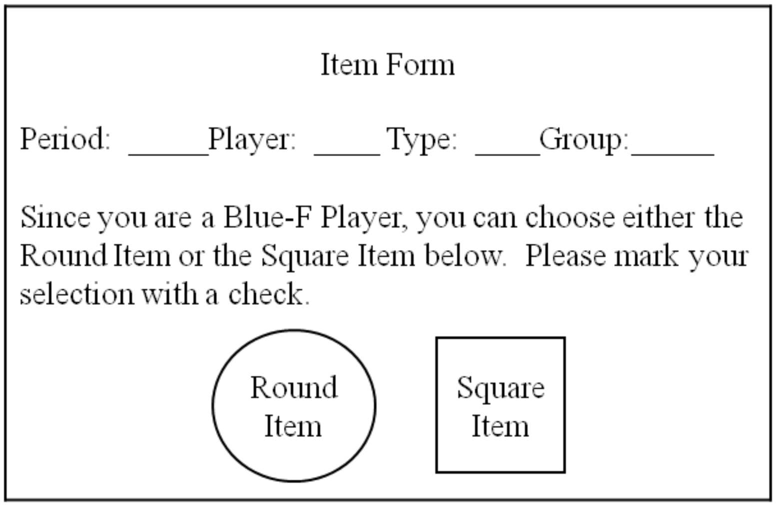
<u>Stage [I] **{II}**Instructions</u>

The Decision

In Stage [I] **{II}**, the Blue Player will make a decision that establishes the type of the item, either Round or Square. If it is made available for sale, this item will be sold to the experimenter at the Established Price determined by the Green Player in Stage [II] **{III}** (as discussed above). In turn, the experimenter may sell this item to the Green Player at the Discounted Price. As discussed above, the type of the item determines the value of the item to the Green Player. In addition, the type of the item determines a cost which reduces the profits on the sale of the item. Selling Round items entails a cost of 400 francs. Selling Square items entails zero cost.

Procedures

The type of the item will be determined as follows. There are two types of items: Round and Square. To determine the type of the item, the Blue Player will fill out a Blue Item Form. Below is a sample blue Item Form:


Item Form

Period: _____Player: ____ Type: ____Group:_____

Since you are a Blue-F Player, you can choose either the Round Item or the Square Item below. Please mark your selection with a check.

Round Item

Square Item

The period, player and group will be filled in for you. In addition, the form may have two choices available (like the form above) OR the form may ONLY allow you to choose the Round Item. If you are restricted to choosing only the Round Item, you will be called a "Blue-R Player" (for "restricted"). If you can choose either item, you will be called a "Blue-F Player" (for "flexible"). Your player type and available choices will be filled in on the Item Form for you. We will discuss how restrictions are determined later.

To determine the item type, mark your choice with a check in the shape chosen and turn it in to the experimenter. The information from the form will be used to help determine the payoffs for the players in the game. Whether or not you were restricted will not be revealed to the other players by the experimenter.

Payoff Determination

The Blue Player starts each period with 450 francs. The Blue Player's payoffs are determined by (1) the initial endowment of 450 francs, (2) the Established Price of the item, (3) the type of the item sold, (4) an "Established Percentage" of the profits on the sale of the item that the Blue Player must pay to the experimenter and (5) whether the item will be made available for sale. The Established Price is determined by the Green Player in Stage [II] **{**III**}** as discussed above. The Established Percentage and whether the item is made available for sale is determined [as follows: (1) if the profits on the sale of the item are more then 500 francs, the percentage will be set so that the Blue Player gives 500 francs to the experimenter or (2) if the profits on the sale of the item are less than 500 francs, the item will not be made available for sale.] **{**by the Red Player in Stage I and will be discussed later.**}** Specifically, the Blue Player's payoff will be:

[Payoff = 450 + (Established Price – Cost)x(1-Established Percentage) if made available for sale (i.e., the profits on the sale are greater than or equal to 500) or

= 450 + (Established Price – Cost) - 500 if made available for sale (i.e., the profits on the sale are greater than or equal to 500) or

Payoff = 450 if not made available for sale (i.e., the profits on the sale are less that 500).]

{ Payoff = 450 + (Established Price – Cost)x(1-Established Percentage) if made available for sale and

Payoff = 450 if not made available for sale**}**

The (Established Price – Cost) term determines the profits on the sale of the item. The Blue Player must give up the Established Percentage of these profits and, hence, keeps (1 – Established Percentage) of these profits. [If the item is made available for sale, the amount given up will equal 500 francs. If the profits on the sale of the item are less than 500 francs, the item will not be made available for sale.]

[For example, if the Established Price is 700 and the item is round, the profits on the sale of the item would be 700-400 = 300 francs and the item will not be made available for sale. This will leave the Blue Player with the initial 450 francs. If the item is square, the profits on the sale of the item will be 700-0 = 700 francs and the item will be made available for sale. The Established Percentage will be set at 500/700 = 72.43% of the profits. This will leave the Blue Player with a net payoff of 450 + 700x(1-0.7243) = 450 + 700 – 500 = 650 francs.]

{For example, if the Established Price is 700, the item is made available for sale and the Established Percentage is 75% of the profits, then the payoff will be 450 + (700-400)x(1-0.75) = 525 francs if the item sold is Round and 450 + 700x(1-0.75) = 600 if the item sold is Square.**}**

Notice that the Blue Player's earnings will not be affected in any way by whether the Green Player ends up buying the item from the experimenter and, if so, what the Discounted Price turns out to be. Only the Established Price and whether the item is made available for sale will determine earnings to the Blue Player. However, the Blue Player will not know what the Established Price is when he or she chooses the type of the item sold.

{We will discuss Stage I next. Before doing that, are there any questions about the Blue Player's actions in Stage II and the Blue Player's payoffs?

<u>Stage I Instructions</u>

The Decision

In Stage I, the Red Player will make a decision that (1) determines whether the item is made available for sale and, if so (2) establishes the percentage of profits on the sale of the item that the Blue Player must give up to the experimenter (which will be called the "Established Percentage") and may receive a different percentage of the profits on the sale. If he or she does receive a percentage of the profits on the sale, it will be from the experimenter at a “Marked-up Percentage” that is greater than or equal to the Established Percentage.

In order to receive the Marked-up Percentage of the profits on the sale of the item, the Red Player must give up 500 francs in exchange for the Marked-up Percentage. The Red Player’s decision determines whether he or she will give up the 500 francs and, if so, the minimum percentage of profits he or she will receive in exchange.

Procedures

Whether the item is made available for sale, the Established Percentage and the Marked-up Percentage of profits on the sale of the item will be determined as follows. The Red Player starts the period with 500 francs. The Red Player will be asked to indicate the *lowest* percentage of profits he or she is willing to take in exchange for the 500 francs. This will determine the Established Percentage. The Red Player indicates the Established Percentage, by filling out a red “Percentage Form” from his or her packet.

Below is a sample red Percentage Form:

Percentage Form

Period: _____ Player: _____ Group: _____

1. Smallest percentage of profits for which I would give up the initial 500 francs (Established Percentage): _____%

2. Random draw (Marked-up Percentage): _____%

3. Will I be receiving the Marked-up Percentage? (“Yes” if line 2 >= line 1 or “No” if line 2 < line 1) _____

Percentage Form

Period: _____
Group: _____

The Established Percentage is: _____%
(Fill in from line 1 above).

The period, player and group will be filled in for you. Using the Percentage Form for the current period, place the smallest percentage of profits for which you would give up the initial 500 francs in line 1 AND fill this number in on the bottom half of the form. If you would be unwilling to give up the 500 francs for any percentage of the profits on the sale, mark this line >100%. In this case the item will not be made available for sale. We will discuss the rest of the form next.

After all Red Players have filled in line 1 and the bottom part of their Percentage Forms for the current period, the experimenter will draw a ticket from a box containing 100 tickets numbered 1-100 that represent possible percentages of profits. The ticket 100 represents 100%, 50 represents 50%, 1 represents 1%, etc. If you are a Red Player, fill this number in on line 2 of your Percentage Form.

If the Red Player has marked >100% on his or her Percentage Form, the Red Player will keep the 500 francs regardless of the draw and the item will not be made available for sale.

If the random draw is greater than or equal to the percentage indicated by the Red Player on line 1 and the percentage indicated is less than or equal to 100%, then the Red Player will give up his or her 500 francs and receive the percentage of Profits on the Sale of the Item *indicated by the ticket draw* (the Marked-up Percentage). Thus, the percentage indicated by the Red Player defines the lowest percentage of profits that he or she will receive in exchange for the 500 francs.

If the random draw is less than the percentage indicated by the Red Player and this percentage is less than or equal to 100%, then the Red Player will not receive a percentage of the Profits on the Sale of the Item. He or she will keep the initial 500 francs for the period. In this case, there is no Marked-up Percentage, but the Established Percentage will remain the percentage indicated by the Red Player on line 1 of his or her Percentage Form. The item will be made available for sale and the Blue Player will pay the Established Percentage to the experimenter. Thus, the Established Percentage will always be the *percentage indicated by the Red Player*.

If you are a Red Player, you will put the Established Percentage on the bottom half of the Percentage Form. Also mark whether you will be giving up your 500 francs in exchange for the Marked-up Percentage or not on line 3. Then, turn it in to the experimenter. The bottom half of the form will be given to the Blue player before Stage II of the game. The overall information from the form will be used to help determine the payoffs for the players in the game.

Notice that, if the item is made available for sale, the Blue Player's earnings will not be affected in any way by whether the Red Player ends up giving up the initial 500 francs and, if so, what the Marked-up Percentage turns out to be. Only the Established Percentage will determine earnings to the Blue Player. The Blue Player will know what the Established Percentage is when he or she chooses the type of the item sold.

Notes on this Procedure

Notice that it is in the best interest of the Red Player to be accurate; that is, the best thing he or she can do is be honest and state truthfully the lowest percentage for which he or she would exchange the 500 francs. If the percentage stated is too high or too low, then the Red Player is passing up opportunities that he or she would prefer.

For example, suppose you are a Red Player and you would be willing to give up the 500 francs for 75% of the profit, but instead you say that the lowest amount for which you would give it up is 90%. (That is, you place 90% on line 1 instead of 75%. As a result, the Established Percentage becomes 90%.) If the ticket drawn at random is between the two (for example 85) you would keep the 500 francs even though you would have gladly given it up for 85% of the profit. In this case, you would put 85% on line 2 and you would keep the initial 500 francs (because line 2 is less than line 1).

On the other hand, suppose you are a Red Player and you would be willing to give up the 500 francs for 75% of the profit, but instead you say that the lowest amount for which you would give it up is 60%. (That is, you place 60% on line 1 instead of 75%. As a result, the Established Percentage becomes 60%.) If the ticket drawn at random is between the two (for example 65) you would be forced to give up the 500 francs for 65% of the profits even though, at this percentage, you would have preferred to keep the 500 francs. In this case, you would put 65% on line 2 and 65% would become the Marked-up Percentage. Thus, you would give up the 500 francs in exchange for 65% of the profit from the item sale (because line 1 is less than line 2), even though you would have preferred to keep the 500 francs.

In either case, it is in the Red Player's best interest to establish a percentage that equals the least he or she is actually willing to give up the 500 francs for.

Payoff Determination

The Red Player starts each period with 500 francs. The Red Player's payoffs are determined by (1) the initial endowment of 500 francs, (2) whether or not he or she gives up the 500 francs in exchange for a Marked-up Percentage of the profits on the sale of the item, (3) the Marked-up Percentage if he or she did give up the initial 500 francs and (4) the profits on the sale of the item if he or she did give up the initial 500 francs. Specifically, the Red Player's payoff will be:

Payoff = 500

- 500 (if Marked-up Percentage >= Established Percentage)

+ (Marked-up Percentage)x(Established Price-Cost) (if Marked-up Percentage >= Established Percentage)

There are three possible outcomes:

(1) If the item is Round AND the Red Player gives up the initial 500 francs, he or she will receive the Marked-up Percentage times (the Established Price minus 400).

(2) If the item is Square AND the Red Player gives up the initial 500 francs, he or she will receive the Marked-up Percentage times the Established Price.

(3) If the Red Player does not give up the initial 500 francs, he or she will receive 500 francs. For example, if the Established Price is 700, the Marked Up Percentage is 85% of the profits AND the Red Player gives up the initial 500 francs, then the payoff will be 0.85x(700-400) = 425 if the item sold is Round and 0.85x700 = 595 if the item sold is Square. If the Red Player keeps the initial 500 francs, then the Red Player simply receives 500 francs.

We will discuss how player types and groups are determined next. Before doing that, are there any questions about the Red Player's actions in Stage I and the Red Player's payoffs?}

[We will discuss how player types and groups are determined next. Before doing that, are there any questions about the Blue Player's actions in Stage I and the Blue Player's payoffs?]

Group and Player Type Determination

At the beginning of the experiment, you will be assigned a player type, {"Red,"} "Blue" or "Green." You will remain this type of player for the entire duration of the experiment. Every three periods, {one Red,} one Blue and one Green Player will be matched randomly to play the game and the players in each group will remain constant for three periods. Everyone will be re-assigned to new groups every third period. Thus, in periods 1 through 3, you will be with the same group. In period 4, you will be randomly re-assigned to new groups and these groups will remain constant in periods 4 through 6, etc. These groupings were determined randomly before the experiment began. For each group, Blue players are assigned a subtype: Blue-R or Blue-F. Subtype assignments remain constant for the duration of a group. Thus, Blue players keep their subtype throughout each group interaction (for three periods). Subtypes are re-assigned randomly each time groups are reassigned. On average, three quarters of the Blue Players will be Blue-R players and one quarter will be Blue-F players during each re-grouping and re-assignment. These types were assigned randomly before the experiment began.

End of Period Results

At the end of the period, you will receive an information and record sheet. The relevant actions taken by all payers in your group, the type of the item and your payoff will be given in this information and record sheet. You should record your payoff in the appropriate section of your profit sheet and receipt. Note that this sheet will NOT give the Blue Player type.

Summary of the Game

[Two] {Three} summary sheets are attached. Each shows actions in each of the [two] {three} stages of the game. One shows [how Blue Players payoffs are determined] {how Red Player payoffs are determined, one shows Blue Player payoffs} and one shows Green Player payoffs. The arrows show where the decisions of the Players and the random draws affect payoffs of each Player. The game proceeds as follows:

1. Players are randomly assigned to groups. All players start with and initial endowment of francs. The Blue Player's type (Blue-R or Blue-F) will be given on the Blue Player's Item Form.

[2. Stage I

a. The Blue Player must decide whether to sell a Round Item or a Square Item and check the choice on his or her blue Item Form. Type Blue-R Players must choose the Round Item. Type Blue-F Players can choose either the Round Item or the Square Item.

b. If a Blue Player sells the Round Item, the Profits on the sale of the Item would be the Established Price set by the Green Player minus 400.

c. If a Blue Player sells the Square Item, the Profits on the sale of the Item would be the Established Price set by the Green Player.

d. In either case, whether the item is made available for sale is determined by whether the Profits on the sale are greater than or equal to 500 francs.

i. If the profits are greater than or equal to 500 francs, the item is made available for sale; the Blue Player gives up the Established Percentage of the profits equaling 500 francs and keeps the rest, along with his or her initial 450 francs.

ii. If the profits are less than 500 francs, the item is not made available for sale; no costs are paid, no price is received and the Blue Player keeps his or her initial 450 francs.]

{2. Stage I

a. The Red Player decides the smallest percentage of profits for which he or she would give up the initial 500 francs. The Red Player will record this amount on his or her red Percentage Form. This determines the Established Percentage.

b. The experimenter draws a random number between 1% and 100% and the Red Player will record this amount on his or her red Percentage Form.

i. If the random draw is greater than or equal to the percentage indicated by the Red Player, the random draw becomes the Marked-up Percentage and the Red Player gives up his or her 500 francs in exchange for the Marked-up Percentage of the Profits on the Sale of the Item in Stage III. The Profits on the Sale of the Item are determined by the Item choice of the Blue Player and the Established Price set by the Green Player (see the Red Player Payoff Summary Sheet).

ii. If the random draw is less than the percentage indicated by the Red Player or if the Red Player indicates >100%, the Red Player will keep the initial 500 francs.

3. Stage II

a. The Blue Player will be given a portion of the Red percentage sheet that tells him or her the Established Percentage of Profits on the Sale of the Item that he or she must give up.

If it is >100%, then the item is not made available for sale. Otherwise, the Blue Player will keep the rest of the profits.

b. If the item is made available for sale (the Established Percentage $\leq$ 100%), the Blue Player must decide whether to sell a Round Item or a Square Item and check the choice on his or her blue Item Form. Type Blue-R Players must choose the Round Item. Type Blue-F Players can choose either the Round Item or the Square Item. If a Blue Player sells the Round Item, the Profits on the Sale of the Item are the Established Price set by the Green Player minus 400. If a Blue Player sells the Square Item, the Profits on the Sale of the Item are the Established Price set by the Green Player. In either case, the Blue Player gives up the Established Percentage of the profits determined by the Red Player in Stage I. (See the Blue Player Payoff Summary Sheet.)**}**

[3.] **{**4.**}** Stage [II] **{**III**}**

a. The Green Player decides the most he or she is willing to pay for the item if it is made available for sale. This determines the Established Price. The Green Player will record the Established Price on his or her green Price Form.

b. The experimenter draws a random number between 400 and 1000 and the Green Player will record this amount on his or her green Price Form.

i. If the random draw is less than or equal to the price indicated by the Green Player and the item is made available for sale, the Green Player will buy the item at the price determined by the random draw (the Discounted Price). If the item is Round and the Green Player buys it, he or she will receive a redemption value of 1000 francs. If the item is Square and the Green Player buys it, he or she will receive a redemption value of 400 francs. The item type is determined by the Blue Player in Stage [I] **{**II**}**. (See the Green Player Payoff Summary Sheet.)

ii. If the random draw is greater than the price indicated by the Green Player or it is not made available for sale, the Green Player will keep his or her initial 450 francs.

You are free to make as much money as you can according to these rules.

<u>End of Experiment Rules</u>

At the end of the experiment, add up your total earnings in francs and record this sum on your profit sheet. Multiply this amount by $ ___ to determine the amount of dollars you received. This is the amount of dollars you have earned in the experiment and will be paid to you in cash.

Are there any questions?