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Appendix A.

Proof of Lemma 1.

Consumers prefer the screening contract if

$$ln((1-\delta^c)w_{t+1}/2r_{t+1}) + ln(w_{t+1}/2) > ln\alpha w_t + ln(w_{t+1} - \alpha w_t r_{t+1})$$

$$ln\frac{(1-\delta^c)w_{t+1}}{2r_{t+1}\alpha w_t} > ln\frac{2(w_{t+1} - \alpha w_t r_{t+1})}{w_{t+1}}$$

$$\frac{(1-\delta^c)w_{t+1}}{2r_{t+1}\alpha w_t} > \frac{2(w_{t+1} - \alpha w_t r_{t+1})}{w_{t+1}}$$

$$(1-\delta^c)w_{t+1}^2 - 4r_{t+1}\alpha w_t w_{t+1} + 4\alpha^2 w_t^2 r_{t+1}^2 > 0$$

$$w_{t+1} > \frac{4r_{t+1}\alpha w_t \pm \sqrt{4^2 r_{t+1}^2 \alpha^2 w_t^2 - 4^2(1-\delta^c)\alpha^2 w_t^2 r_{t+1}^2}}{2(1-\delta^c)} = \frac{2r_{t+1}\alpha w_t(1 \pm \sqrt{\delta^c})}{(1-\delta^c)}, \text{ or}$$

(A1) $[(1-\delta^c)w_{t+1} - 2r_{t+1}\alpha w_t(1+\sqrt{\delta^c})]\ [(1-\delta^c)w_{t+1} - 2r_{t+1}\alpha w_t(1-\sqrt{\delta^c})] > 0.$

Recall that we have assumed that $w_{t+1}(1-\delta^c)/2r_{t+1}$ is greater than αw_t to raise the possibility of rationing in any income level. If $w_{t+1}(1-\delta^c)/2r_{t+1} > \alpha w_t$, it is obvious that $(1-\delta^c)w_{t+1}$ is always greater than $2r_{t+1}\alpha w_t(1-\sqrt{\delta^c})$. As a result, for (A1) to hold we only need the following condition

$$(1-\delta^c)w_{t+1} > 2r_{t+1}\alpha w_t(1+\sqrt{\delta^c}),$$

or

(A2) $w_{t+1} > \dfrac{2r_{t+1}\alpha w_t}{(1-\sqrt{\delta^c})}.$

Given this, it is clear that if $\dfrac{w_{t+1}}{w_t} < \dfrac{2\alpha}{(1-\sqrt{\delta^c})}r_{t+1}$, consumers will prefer the rationing contract, and if $\dfrac{w_{t+1}}{w_t} = \dfrac{2\alpha}{(1-\sqrt{\delta^c})}r_{t+1}$, they are indifferent between the rationing and screening contract.

Appendix B

Proof of Proposition 1.

To prove this proposition, first note that the relation $\rho_{t+1} > \dfrac{(1+\delta^e-\alpha)r_{t+1}}{\Omega(1-\alpha)}$ can be rewritten as

(A3) $\varepsilon < \dfrac{1-\alpha}{1+\delta^e-\alpha},$

which is derived by the fact that $r_{t+1} = \Omega\varepsilon\rho_{t+1}$. Therefore, for a given δ^e, if the screening is used by entrepreneurs at all, there must exist a upper bound of ε, which is equal to $(1-\alpha)/(1+\delta^e-\alpha)$. Otherwise, the screening contract will never be an equilibrium contract to entrepreneurs. Given this result, we see that $g^{s,r}$ is always greater than $g^{r,r}$. In addition, assume that parameters satisfy the following condition:

$(1-\theta)(n-1-\delta^{e}-\alpha)-2\theta\alpha(n+1)>0$.

Then, one can easily verify that both $g^{s,r}>g^{s,s}$ and $g^{r,r}>g^{r,s}$ are satisfied. Finally, the relationship between $g^{r,r}$ and $g^{s,s}$ can be derived by following comparison.

$$g^{s,s} - g^{r,r} =$$

$$\frac{2\theta(1-\theta)\Omega[1+(n-1-\delta^{e})\varepsilon]L^{1-\theta}}{(1-\theta)+2\theta L} - \frac{(1-\theta)[\alpha+(n-2\alpha)\varepsilon]\Omega}{L^{\theta}}$$

$$=\frac{(1-\theta)\Omega\{2\theta L[1+(n-1-\delta^{e})\varepsilon]-(1-\theta+2\theta L)[\alpha+(n-2\alpha)\varepsilon]\}}{(1-\theta+2\theta L)L^{\theta}}.$$

So, $g^{s,s}>g^{r,r}$, if $2\theta L[1+(n-1-\delta^{e})\varepsilon]-(1-\theta+2\theta L)[\alpha+(n-2\alpha)\varepsilon]>0$. That is, if

$$\text{(A4)}\quad \varepsilon<\frac{2\theta L(1-\alpha)-\alpha(1-\theta)}{(1-\theta)(n-2\alpha)+2\theta L(1-2\alpha+\delta^{e})}=\varepsilon^{*}$$

, then $g^{s,s}>g^{r,r}$. Given (A4), we see that ε^{*} is a decreasing function of δ^{e}. Of course, we have to assume that, for a δ^{e}, $\varepsilon^{*}<\bar{\varepsilon}=\frac{1-\alpha}{1+\delta^{e}-\alpha}$ is satisfied.

Appendix C

Proof of Proposition 1:

As discussed in the content, the first best contract for high-risk consumers is $C_{cH,t}=(q_{cH,t},R_{cH,t+1})=(\frac{w_{t+1}}{R_{cH,t+1}},\ \frac{\Omega\varepsilon\rho_{t+1}}{p_{H}})$. Given $R^{i}_{cL,t+1}=\frac{\Omega\varepsilon\rho_{t+1}}{p_{L}}$ and $q^{i}_{cL,t}=\frac{w_{t+1}}{R^{i}_{cL,t+1}}$, $i=r,s$, the alternative contract acceptable to low-risk consumers is determined by solving the follow program:
Select $(\phi^{c}_{t},\pi^{c}_{t})$ to maximize

$$\phi^{c}_{t}\{\pi^{c}_{t}q^{r}_{cL,t}+(1-\pi^{c}_{t})\beta p_{L}w_{t+1}\}+(1-\phi^{c}_{t})(1-\delta)q^{s}_{cL,t} \quad \text{(A1)}$$

Subject to:

$$q_{cH,t}=\frac{p_{H}w_{t+1}}{\Omega\varepsilon\rho_{t+1}}\geq\phi^{c}_{t}\pi^{c}_{t}q^{r}_{cL,t} \quad \text{(A2)}$$

$$0\leq\pi^{c}_{t}\leq 1,\ 0\leq\phi^{c}_{t}\leq 1. \quad \text{(A3)}$$

Equation (A2) is the incentive compatibility constraint for high-risk consumers. To solve this program, first, observe that (A2) is always bending as $\phi^{c}_{t}\pi^{c}_{t}q^{r}_{L,t}$ shows up in the objective function. Thus, (A2) can be rewritten as

$$\frac{p_H w_{t+1}}{\Omega\varepsilon\rho_{t+1}} = \phi_t^c \pi_t^c \frac{p_L w_{t+1}}{\Omega\varepsilon\rho_{t+1}} . \quad \text{(A2')}$$

Therefore,

$$\phi_t^c \pi_t^c = \frac{p_H}{p_L} . \quad \text{(A4)}$$

Substituting (A2') and (A4) into (A1), the objective function can be restated as

$$\frac{p_H w_{t+1}}{\Omega\varepsilon\rho_{t+1}} + \phi_t^c \beta p_L w_{t+1} - \beta p_H w_{t+1} + (1-\phi_t^c)(1-\delta)\frac{p_L w_{t+1}}{\Omega\varepsilon\rho_{t+1}} , \quad \text{(A1')}$$

which is linear function of ϕ_t^c. Therefore, if $\beta p_L w_{t+1} > (1-\delta)\frac{p_L w_{t+1}}{\Omega\varepsilon\rho_{t+1}}$, or equivalently $\beta > \frac{(1-\delta)}{\Omega\varepsilon\rho_{t+1}}$, the value of ϕ_t^c should be set as high as possible; i.e., ϕ_t^c =1. On the other hand, if $\beta < \frac{(1-\delta)}{\Omega\varepsilon\rho_{t+1}}$, ϕ_t^c should be as small as possible. According to (A4), the lowest value of ϕ_t^c can be found by setting π_t^c equal to *1*.

Appendix D.

Proof of Proposition 2:

Given $C_{eH} = (R_{eH,t}, q_{eH,t}) = (\Omega\varepsilon\rho / p_H, w_t)$, the alternative acceptable contract to low risk entrepreneurs can be derived by following program:

Select $(\phi_t^e, \pi_t^e, R_{eL,t}^r, q_{eL,t}^r, R_{eL,t}^s, q_{eL,t}^s)$ to maximize

$$\phi_t^e [p_L \pi_t^e (\Omega\rho_{t+1} - R_{eL,t}^r) q_{eL,t}^r + (1-\pi_t^e) Z] + (1-\phi_t^e)[p_L(\Omega\rho_{t+1}) - R_{eL,t}^s) q_{eL,t}^s] \quad \text{(A5)}$$

Subject to

$$\phi_t^e \pi_t^e (R_{eL,t}^r q_{eL,t}^r p_L - \Omega\varepsilon\rho_{t+1} q_{eL,t}^r) + (1-\phi_t)(R_{eL,t}^s p_L - (1+\delta)\Omega\varepsilon\rho_{t+1}) q_{eL,t}^s = 0 \quad \text{(A6)}$$

$$p_H(\Omega\rho - \frac{\Omega\varepsilon\rho_{t+1}}{p_H}) w_t \geq \phi_t^e \pi_t^e p_H(\Omega\rho_{t+1} - R_{eL,t}^r) q_{eL,t}^r \quad \text{(A7)}$$

$$0 \leq \phi_t \leq 1;\ 0 \leq \pi_t \leq 1;\ 0 \leq q_{eL,t}^r \leq w_t;\ 0 \leq q_{eL,t}^s \leq w_t;\ 0 \leq R_{eL,t}^r;\ 0 \leq R_{eL,t}^s \quad \text{(A8)}$$

We then can follow the analysis of Bose and Cothren (1996) to derive the following results. First, (A7) is always binding. Second, as $R_{eL,t}^s$ is not shown in (A7) and $R_{eL,t}^r$ is negative in (A7), it is optimal to set $R_{eL,t}^s$ =0 while set $R_{eL,t}^r$ as high as possible to satisfy (A6). Finally, it is clear $q_{eL,t}^r$ and $q_{eL,t}^s$ should be as large as possible because the objective function can be maximized by doing this. These observations will lead the following results.

$$q_{eL,t}^r = w_t,\ q_{eL,t}^s = w_t$$

$$\phi_t^e \pi_t^e = [p_L(1-\frac{\varepsilon}{p_H}) + \varepsilon(1-\phi_t^e)(1+\delta)] / (p_L - \varepsilon) .$$

$$R_{eL,t}^r = \Omega\varepsilon\rho_{t+1}[\frac{\phi_t^e \pi_t^e + (1-\phi_t^e)(1+\delta)}{\phi_t^e \pi_t^e p_L}] .$$

And the objective function can be derived as follows.

$$\phi_t^e \pi_t^e p_L \Omega\rho_{t+1} w_t - \phi^e \pi^e w_t p_L R_{eL,t}^r + \phi_t^e Z - \phi_t^e \pi_t^e Z + (1-\phi_t^e) p_L \Omega\rho_{t+1} w_t$$

$$=\phi_t^e\pi_t^e\Omega\rho_{t+1}w_t(p_L-\varepsilon)-(1-\phi_t^e)(1+\delta)\Omega\varepsilon\rho_{t+1}w_t+\phi_t^e Z-\phi_t^e\pi_t^e Z+(1-\phi_t^e)p_L\Omega\rho_{t+1}w_t$$

$$=\Omega\rho_{t+1}w_t[p_L(1-\frac{\varepsilon}{p_H})]+\phi_t^e Z-\frac{p_L(1-\frac{\varepsilon}{p_H})}{p_L-\varepsilon}Z-\frac{\varepsilon(1-\phi_t^e)(1+\delta)}{(p_L-\varepsilon)}Z+(1-\phi_t^e)p_L\Omega\rho_{t+1}w_t$$

$$=\Omega\rho_{t+1}w_t[p_L(1-\frac{\varepsilon}{p_H})]+\phi_t^e Z-\frac{p_L(1-\frac{\varepsilon}{p_H})}{p_L-\varepsilon}Z+(1-\phi_t^e)[p_L\Omega\rho_{t+1}w_t-\frac{Z\varepsilon(1+\delta)}{(p_L-\varepsilon)}] \qquad \text{(A5')}$$

From the objective function (A5'), we see that if $Z>\frac{(p_L-\varepsilon)}{p_L+\varepsilon\delta}\Omega\rho_{t+1}w_t p_L\equiv Z^*$, the optimal value of ϕ_t^e is equal to *1*; i.e., the rationing contract will be offered. On the other hand, if $Z<\frac{(p_L-\varepsilon)}{p_L+\varepsilon\delta}\Omega\rho_{t+1}w_t p_L\equiv Z^*$, ϕ_t^e should be set as small as possible. The smallest value of ϕ_t^e can be found by setting π_t^e equal to 1. Note that $\frac{(p_L-\varepsilon)}{p_L+\varepsilon\delta}$ is a decreasing function of δ if $p_L>\varepsilon$. Thus, the decrease of screening cost will induce entrepreneurs to use the screening contract.

Appendix E

Proof of Proposition 3:

Subtracting (10) from (15), we derive $\Delta Ents$ as

$$\Delta Ents=(1-\lambda)(1-\pi^e)w_t\Omega\,. \qquad \text{(A9)}$$

Similarly, the difference of resources available for financial intermediaries to produce capital in a rationing and screening entrepreneurial credit can be found by subtracting (9) from (13). Knowing that the capital output rate of financial intermediaries is $\Omega\varepsilon$, ΔFIs is derived as

$$\Delta Fis=(1-\lambda)[1+\delta(1-\phi_t^e)-\pi_t^e]w_t\Omega\varepsilon\,. \qquad \text{(A10)}$$

Thus, $\Delta Ents>\Delta Fis$ if

$$(1-\lambda)(1-\pi^e)w_t\Omega>(1-\lambda)[1+\delta(1-\phi_t^e)-\pi_t^e]w_t\Omega\varepsilon\,,$$

or,

$$(1-\pi_t^e)(p_L-\varepsilon)>\delta\varepsilon(1-\phi_t^e)\,. \qquad \text{(A11)}$$

Substituting π_t^e and ϕ_t^e (in proposition 2) into (A11), we derive

$$\delta[(\frac{p_L}{p_H}-1)-(\frac{1}{p_H}-1)\varepsilon]<(\frac{1}{p_H}-1)p_L\,.$$

Assume that $\varepsilon<(\frac{p_L}{p_H}-1)/(\frac{1}{p_H}-1)=\varepsilon^*$, we finally derive δ^* as

$$\delta^*=\frac{(p_L/p_H)-1}{(\frac{p_L}{p_H}-1)-(\frac{1}{p_H}-1)\varepsilon}\,. \qquad \text{(A12)}$$

Therefore, if $\delta<\delta^*$, $\Delta Ents>\Delta Fis$ and if $\delta>\delta^*$, $\Delta Ents<\Delta Fis$

Appendix F. The approaches and hypotheses of misspecification tests

1. Normality Assumption: We test normality assumption of skewness and kurtosis by using the test proposed by D'Agostino, Belanger, and D'Agostino (1990).

2. Functional Form: Total observations = *N*. Number of independent variables in the unrestricted model = *K*.

   Restricted model: $y = \beta X + u$,

   Unrestricted model: $y = \beta X + \tau\Psi + u$,

where Ψ is $\hat{y}^2$ in the RESET-type test and second-order polynomial terms in KG2 test (i.e., $x_i^2, x_j^2, x_i x_j$......). The null hypothesis is that $\tau = 0$. The test statistic is distributed as F(n_1 , n_2), where n_1 is the difference of the independent variables between the restricted and unrestricted models and $n_2 = N - K$. In addition, we substitute $CREDIT^2$ and $CREDIT^2 + CREDIT^3$ into Ψ , respectively, to see the relationship between the growth rate and *CREDIT*.

3. Homoskedasticity

   Restricted model: $u = \alpha$,

where *u* is residual in the original regression and α is constant.

   Unrestricted model: $u = \alpha + \tau\Psi + v$,

where $\psi = \hat{y}, \hat{y}^2$ in RESET-type test and second-order polynomial terms in the KG2 test. An F test is conducted to test the null hypothesis that $\tau = 0$.

4. Parameter Stability: We test whether the coefficients (conditional mean) and (conditional) variance change in two different sub-sample. In the period 1960-89, $T_1 = 45$ and $T_2 = 46$. For 1980s, $T_1 = 46$ and $T_2 = 47$. The null hypothesis is that the coefficients and variance in this two sub-sample are equal, respectively. The test statistic for the variance is $\frac{RSS_2}{RSS_1}\frac{T_1 - k}{T_2 - k}$ ~F($T_2 - k$, $T_1 - k$), where *k* is the number of independent variables in the regression. For the conditional mean, the test statistic is $\frac{RSS - RSS_1 - RSS_2}{RSS_1 + RSS_2}\frac{T - 2*k}{k}$ ~F($k, T - 2k$).

5. Joint misspecification test: Functional form, Independence, and Stability of Coefficients

   Restricted model: $y = \beta X + u$

   Unrestricted model: $y = \beta X + \phi_1\Psi_1 + \phi_2\Psi_2 + \phi_3\Psi_3 + v$.

Ψ_1 is for the functional form, i.e., $\hat{y}^2$; Ψ_2 is to test the independence, i.e., u_{t-1} ; and Ψ_3 is a trend to test the stability of coefficients. The null hypothesis is that $\phi_1 = \phi_2 = \phi_3 = 0$, and the test statistic is F (3, *n*-*k*).

Vita

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