Bank Competition, Information Choice and Inefficient Lending Booms

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Introduction

Motivation

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▶ these reforms have increased banking competition and are thought to have increased availability of credit
▶ but is it possible that competition has prompted *too much* lending?
  ▶ U.S. Senior Loan Officer Survey hints at a competition channel behind the 2003-2006 boom in residential mortgage lending

*Can more banking competition foster inefficient lending booms?*
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2. more competition reduces lenders’ incentives to screen their borrowers thoroughly

Both effects are procyclical.

Together, they match the stylized facts about lending booms quite well.
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**Informational Spillovers**
Assume for example the following legislation:

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The informed bank’s optimal response to threat of entry by informational free-riders:
- “poison the well” by making bad loans to prevent customer poaching
- approval of bad loans implies poor use of information from screening
  → choose less precise screening ex-ante

With more competition, these distortions become more pronounced.
Related Literature

**Literature on Competition and Credit Screening**

**Adverse Selection to Deter Entry**
- Dell’Ariccia et al. (1999)

**Competition in Banking and Information Choice**
- Hauswald and Marquez (2003), Hauswald and Marquez (2006)

**Theories of Lending Booms**

**Empirical Literature on Lending Procyclicality and Booms**
- Berger and Udell (2005), Lown and Morgan (2006)
Outline

Outline:

The Model

Planner’s Solution

Two Key Results about Equilibrium under Competition

Lending Cycles

Conclusions
The Model
Model (1)

**Heterogeneous Entrepreneurs:**
- two islands $j \in \{1, 2\}$
- each island has a continuum of mass 1 of wealthless entrepreneurs, indexed by $i \in [0, 1]$
- option to run risky project: invest one unit at time $t$, obtain in $t + 1$ a payoff

\[
X_i = \begin{cases} 
  R & \text{with probability } p_i \\
  r & \text{with probability } 1 - p_i
\end{cases}
\]  

(1)

- $p_i \sim U(\bar{p} - \frac{\epsilon}{2}, \bar{p} + \frac{\epsilon}{2})$, private knowledge
- no signaling or self-selection mechanisms available
Model (II)

Bank:
- one risk neutral bank on each island with unlimited access to funds at cost $\rho$
- lending abroad incurs extra cost $\gamma > 0$ per loan
- bank uses costless credit-worthiness test
- precision of the test is given by the bank's screening precision $\lambda \in [0, 1)$
- screening precision $\lambda$ is costly: convex cost function $c(\lambda)$ with $c(0) = 0$, $c'(\lambda) > 0$, $\lim_{\lambda \to 1} c(\lambda) = \infty$.
- screening works only for entrepreneurs on the same island
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- bank uses costless *credit-worthiness test* to assess borrower quality
- precision of the test is given by the bank’s *screening precision* $\lambda \in [0, 1)$:
  - test yields the true type $p_i$ with probability $\lambda$, otherwise random noise that is drawn from prior distribution
  - the bank does not know whether signal is informative or just noise, uses Bayesian updating of beliefs
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Model: Timing

**Timing:**

1. Each bank
   - chooses its screening precision $\lambda^j$ (observable to everyone),
   - pays screening cost $c(\lambda^j)$ and
   - observes private signal $\sigma_{i,\lambda}$ for every project $i \in [0, 1]$

2. both banks choose their domestic *loan portfolio* comprising of
   - a set $\mathcal{P}_j$ of projects to be offered a loan, and
   - state-contingent repayment terms $(D_i, d_i)$ for every project $i \in \mathcal{P}_j$.

3. each bank observes the domestic loan offers made on the other island and chooses whether and under which terms $(O_{i}^{j'}, \sigma_{i}^{j'})$ to offer outside credit to loan-approved entrepreneurs
   - ⇒ informational spillover

4. entrepreneurs choose loan offer with lowest expected repayment rate; if indifferent, they stay with the domestic bank.
Benchmark: The Planner’s Solution
Planner’s Solution

**Planner’s Problem:**
1. choose screening precision $\lambda$, pay $c(\lambda)$
2. observe signals, update beliefs, and
3. determine projects to be financed such that surplus is maximized.

**Solution:** by backward induction.

1. given posterior beliefs after observing the signal, find welfare-maximizing portfolio of projects to finance
2. choose screening precision $\lambda^*$ as to maximize total welfare
Dispersion of Posterior Beliefs

**Posterior beliefs:**
Bayesian updating of beliefs conditional on observing a signal realization $s_i$ yields

$$E[p_i|\sigma_i = s_i] = \lambda s_i + (1 - \lambda)\bar{p}$$

More screening precision generates more dispersion in posterior expectations (see Ganuza and Penalva, 2010):

$$E[p_i]$$

\[ \bar{p} + \frac{\varepsilon}{2} \]
\[ \bar{p} \]
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prior \hspace{5cm} posterior
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Planner’s Optimal Portfolio Choice

Finding the marginal project:

\[ \pi(q) = qR + (1-q)r - \rho = 0 \]

\[ \iff q = \frac{\rho - r}{R - r} \]

Reminder:

- \( R \) payoff upon project success
- \( r \) payoff upon project failure (liquidation)
- \( \rho \) Bank refinancing rate

\( q \) is **high** in recession, **low** in boom.

**Remark**

The planner’s optimal portfolio choice is to finance all projects for which

\[ E[p_i|s_i] > q \]
Planner’s Optimal Portfolio Choice (II)

**Credit Mass:** Size of the second-best portfolio is

\[
m^{SB}_\lambda = \begin{cases} 
0 & \text{if } q - \bar{p} \geq +\frac{\lambda \varepsilon}{2} \\
\bar{p} & < q < +\frac{\lambda \varepsilon}{2} \\
1 & \text{if } q - \bar{p} \leq -\frac{\lambda \varepsilon}{2}
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Which expression holds for given screening precision \( \lambda \) and cut-off \( q \)?
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The Planner’s Information Choice (I)

Optimal choice of screening precision:

$$\max_{\lambda} \quad \Pi^{SB}_{\lambda} - c(\lambda)$$

s.t. \quad \lambda \geq 0

Which cost function? Use \(c(\lambda) = c_0 \frac{\lambda}{1-\lambda}\) which gives closed-form solutions.

Optimal screening precision \(\lambda^*_SB(q)\) as function of economic state \(q\):

\[\begin{align*}
\lambda & \quad \lambda^*_SB(q) \\
0 & \quad \bar{p} \quad 1
\end{align*}\]
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Optimal screening precision \(\lambda_{SB}^*(q)\) as function of economic state \(q\):
Equilibrium under Competition:

Two Results
Again, I solve the problem by backward induction:

1. for given screening precision $\lambda$, I find the optimal portfolio as a function of competition.
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2. I find the profit-maximizing screening precision $\lambda_E^*$
Equilibrium (I): $\gamma \geq \frac{(R-r)\varepsilon}{2}$

Monopolist’s Problem

- for $\gamma \geq \frac{(R-r)\varepsilon}{2}$, each bank is always a monopolist on its island
- due to fixed project size, monopolist can extract entire project surplus $(R, r)$
- thus, maximization problem coincides with the planner’s problem
- monopolistic allocation is constrained *Pareto optimal* in this model!
- caution: with endogenous project size this would not be true
Equilibrium (II): $\gamma < \frac{(R-r)\varepsilon}{2}$

**Competition**
- if $\gamma < \frac{(R-r)\varepsilon}{2}$, for *some* values of $(q, \lambda)$ competition will matter.
- when is the incumbent safe from entry of competitors?

**Definition**
Let $\mathcal{P}$ be a loan portfolio, and denote the volume of loans in the portfolio as $|\mathcal{P}|$. Then, $\mathcal{P}$ is **noncontestable** if its gross surplus per loan is at most $\gamma$: $\Pi[\mathcal{P}] \leq \gamma|\mathcal{P}|$
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- if portfolio is *noncontestable* and all repayment terms are equal, there is no threat of entry
- for which $(q, \lambda)$ combinations is the monopolistic portfolio noncontestable?
Noncontestability: Intuition

Graphical Representation:

- let’s draw the set of all \((q, \lambda)\) for which the *monopolistic* portfolio is noncontestable:

\[
\left\{ (q, \lambda) \in [0, 1] \times [0, 1] : \frac{\Pi^M(q)}{m^M(\lambda)(q)} \leq \gamma \right\}
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- what happens under threat of entry, i.e. if the monopolistic portfolio is contestable?
Threat of Entry

What if the incumbent chooses some contestable portfolio?

- the outside lender can profitably undercut
- it poaches all loan-approved customers
- incumbent earns zero
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1. reduce repayment rates
2. change composition
Making a portfolio noncontestable

Assume $\mathcal{P}$ is a contestable portfolio of size $m$: $\Pi[\mathcal{P}] > \gamma m$. How can we make it noncontestable?

Via prices (repayment rates):
- construct portfolio $\mathcal{P}'$ with same projects but reduced repayments

Via compositional changes:
- do not lower repayments but add more projects to portfolio $\tilde{\mathcal{P}}$
- since they have negative NPV, average profit per project falls
- for some credit mass $\tilde{m} > m$, profit will be exactly $\Pi[\tilde{\mathcal{P}}] = \gamma \tilde{m}$

Note $\tilde{m} \gamma > m \gamma$ $\Rightarrow$ second strategy is more profitable
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$\Rightarrow$ second strategy is more profitable
Equilibrium under Competition

When is a noncontestable portfolio an equilibrium of the game?

In the paper I show:

Any portfolio $Q^*$ that maximizes surplus subject to noncontestability,

$$\max_{Q=(S,(D,d))} \Pi[Q]$$

s.t. $$\Pi[Q] \leq \gamma |Q|$$

and has the same repayment terms $(D, d)$ for all entrepreneurs is an equilibrium.
Equilibrium under Competition (II)

The equilibrium has three cases:

1. competition does not matter
   \[\Rightarrow\] monopolistic allocation, repayment terms \((R, r)\).
Equilibrium under Competition (II)

The equilibrium has three cases:

1. competition does not matter
   ⇒ monopolistic allocation, repayment terms \((R, r)\).

2. there is threat of entry, but by adding some negative NPV projects noncontestability can be restored
   ⇒ cross-subsidized excessive lending, repayment terms \((R, r)\).
Equilibrium under Competition (II)

The equilibrium has three cases:

1. competition does not matter
   ⇒ monopolistic allocation, repayment terms \((R, r)\).

2. there is threat of entry, but by adding some negative NPV projects noncontestability can be restored
   ⇒ cross-subsidized excessive lending, repayment terms \((R, r)\).

3. there is threat of entry, and even by financing all projects at terms \((R, r)\) the incumbent does not regain noncontestability
   ⇒ finance everyone, and reduce repayment terms such that \(\Pi = \gamma\).
Equilibrium Credit Mass

\[ m^E_\lambda(q, \gamma) = \begin{cases} 
1 & \text{if } 0 \leq \lambda \leq \frac{2(\bar{p} - q)}{\varepsilon} \text{ and } \bar{p} - \frac{\gamma}{R - r} < q < \bar{p} \\
0 & \text{if } 0 \leq \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} \\
\frac{1}{2} - \frac{q - \bar{p}}{\lambda \varepsilon} & \text{if } \frac{2|q - \bar{p}|}{\varepsilon} < \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} + \frac{4\gamma}{\varepsilon(R - r)} \\
& \text{if all } \lambda \in [0, 1) \text{ if } q \leq \bar{p} - \frac{\gamma}{R - r} 
\end{cases} \]
Equilibrium Credit Mass

\[ m^E_\lambda(q, \gamma) = \begin{cases} 
1 & \text{if } 0 \leq \lambda \leq \frac{2(\bar{p} - q)}{\varepsilon} \text{ and } \bar{p} - \frac{\gamma}{R-r} < q < \bar{p} \\
0 & \text{if } 0 \leq \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} \\
\frac{1}{2} - \frac{q - \bar{p}}{\lambda \varepsilon} & \text{if } \frac{2|q - \bar{p}|}{\varepsilon} < \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} + \frac{4\gamma}{\varepsilon(R-r)} \\
\end{cases} \]
Equilibrium Credit Mass

\[ m^E_\lambda(q, \gamma) = \begin{cases} 
1 & \text{if } 0 \leq \lambda \leq \frac{2(\bar{p} - q)}{\varepsilon} \text{ and } \bar{p} - \frac{\gamma}{R-r} < q < \bar{p} \\
0 & \text{if } 0 \leq \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} \\
\frac{1}{2} - \frac{q - \bar{p}}{\lambda \varepsilon} & \text{if } \frac{2|q - \bar{p}|}{\varepsilon} < \lambda \leq \frac{2(q - \bar{p})}{\varepsilon} + \frac{4\gamma}{\varepsilon(R-r)} \\
1 - \frac{2(q - \bar{p} + \frac{\gamma R}{R-r})}{\lambda \varepsilon} & \text{if } \frac{2(q - \bar{p})}{\varepsilon} + \frac{4\gamma}{\varepsilon(R-r)} < \lambda < 1 \text{ and } q > \bar{p} - \frac{\gamma}{R-r} 
\end{cases} \]
Equilibrium Credit Mass

\[
m^E_\lambda(q, \gamma) = \begin{cases} 
1 & \text{if } 0 \leq \lambda \leq \frac{2(\bar{p}-q)}{\epsilon} \text{ and } \bar{p} - \frac{\gamma}{R-r} < q < \bar{p} \\
0 & \text{if } 0 \leq \lambda \leq \frac{2(q-\bar{p})}{\epsilon} \\
\frac{1}{2} - \frac{q-\bar{p}}{\lambda \epsilon} & \text{if } \frac{2|q-\bar{p}|}{\epsilon} < \lambda \leq \frac{2(q-\bar{p})}{\epsilon} + \frac{4\gamma}{\epsilon(R-r)} \\
1 - \frac{2(q-\bar{p}+\frac{\gamma}{R-r})}{\lambda \epsilon} & \text{if } \frac{2(q-\bar{p})}{\epsilon} + \frac{4\gamma}{\epsilon(R-r)} < \lambda < 1 \text{ and } q > \bar{p} - \frac{\gamma}{R-r} \\
1 & \text{for all } \lambda \in [0, 1) \text{ if } q \leq \bar{p} - \frac{\gamma}{R-r}
\end{cases}
\]
The First Key Result

Finding 1:
Under threat of entry, equilibrium credit mass is inefficiently large.

Its excessiveness increases with bank competition.
Further Comparative Statics

Threat of entry makes credit more volatile:

▶ the sensitivity $\frac{\partial m_E}{\partial q}$ of credit to changes in $q$ is twice as high under threat of competition than under monopoly.

▶ the average default rate $D_{\lambda}(q)$ decreases in $q$: the best loans are made in recessions, the worst in booms

▶ the sensitivity $\frac{\partial D_{\lambda}}{\partial q}$ is independent of $\lambda$, but is twice as large under threat of competition than under monopoly.
Endogenous Screening Choice

**Gross Profit Function:**
\[ \Pi^E_\lambda = \gamma \cdot m^E_\lambda \] wherever competition is relevant, unchanged otherwise

**Optimal Screening Precision** \( \lambda^*_E \):
\[
\max_{\lambda} \quad \Pi^E_\lambda - c(\lambda) \\
\text{s.t.} \quad \lambda \geq 0
\]
The Second Key Result

Finding 2:

Screening precision $\lambda^*_E$ is chosen inefficiently low when there is threat of entry.

Marginal returns to screening

- are strictly lower under threat of entry, and
- are zero for $q < \bar{p} - \frac{\gamma}{R-r}$
Equilibrium Allocations

\[ \lambda_E^* \quad \text{Screening Precision} \]

\[ 0 \quad \bar{p} \quad 1 \]

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ \bar{p} \quad \bar{p} \quad 1 \]

\[ m_{\lambda^*}(q) \quad \text{Credit Mass} \]

\[ 0 \quad \bar{p} \quad 1 \]

\[ \bar{p} - \frac{\gamma}{R-r} \]
Equilibrium Allocations

\[ \lambda^*_E \quad \text{Screening Precision} \]

\[ m_{\lambda^*}(q) \quad \text{Credit Mass} \]

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ \bar{p} - \frac{\gamma}{R-r} \]
Equilibrium Allocations

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ \lambda^*_E \text{ Screening Precision} \]

\[ m_{\lambda^*}(q) \text{ Credit Mass} \]
Equilibrium Allocations

\[ \lambda^*_E \] Screening Precision

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ m_{\lambda^*(q)} \] Credit Mass

\[ \bar{p} - \frac{\gamma}{R-r} \]
Equilibrium Allocations

\[ \lambda_E^* \quad \text{Screening Precision} \]

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ m_{\lambda^*}(q) \quad \text{Credit Mass} \]

\[ \bar{p} - \frac{\gamma}{R-r} \]
Lending Cycles
Let’s play a simple dynamic version of the model:

- play a sequence of one-shot games: periods \( \{ t, t + 1, \ldots \} \)
- aggregate state \( q_{t+1} \) unknown ex-ante
- \( \bar{\lambda}_{t+1}^* \) is chosen \textit{before} knowing the actual realization of \( q_{t+1} \):

\[
\max_{\bar{\lambda}} \quad \int \Pi_{\bar{\lambda}}(q, \gamma) - c(\bar{\lambda}) \, dU(q)
\]

s.t. \( \bar{\lambda} \geq 0 \)
Lending Cycles (cont.)

Dynamic Model (cont.):

- I use the following stylized specification:

  \[ q_{t+1} = \begin{cases} 
  q_t & \text{with probability } \phi \\
  \sim U(\bar{p} - \frac{\varepsilon}{2}, \bar{p} + \frac{\varepsilon}{2}) & \text{with probability } 1 - \phi 
  \end{cases} \]

- special case \( \phi \to 1 \) restores the baseline model
- Let’s think of \( \phi \) as large but not quite 1, i.e. \( \phi = 0.8 \)
- the optimal screening precision choice problem becomes

\[
\max_{\bar{\lambda}_{t+1}} \left[ \phi \prod_{\bar{\lambda}_{t+1}}^E (q_t, \gamma) + (1 - \phi) \int_{\bar{p} - \frac{\varepsilon}{2}}^{\bar{p} + \frac{\varepsilon}{2}} \prod_{\bar{\lambda}_{t+1}}^E (q_{t+1}, \gamma) \varepsilon^{-1} dq_{t+1} \right] - c(\bar{\lambda}_{t+1}) \\
\text{s.t. } \bar{\lambda}_{t+1} \geq 0
\]
Dynamic Screening Choice

Ex-ante Optimal Screening Choice $\bar{\lambda}_{E,t+1}^*$
Dynamic Screening Choice

Ex-ante Optimal Screening Choice $\bar{\lambda}_{E,t+1}^{*}$

\[ \bar{\lambda}_{t+1}^{*} \]

\[ \bar{p} - \frac{\gamma}{R-r} \]

\[ q_t \]

\[ \bar{p} \]

1

0
Credit Contractions and Flight to Quality

- during boom, $\lambda_{E,t+1}^*$ is chosen low because good conditions are expected to persist and threat of competition depresses information acquisition incentives
- if actual realization $q_{t+1}$ takes some high value (i.e., boom is over), competition would ex-post not have been the problem
- but inefficiently low $\lambda_{E,t+1}^*$ now results in credit contraction
- due to impaired screening precision, only outstanding projects can be identified as credit-worthy $\Rightarrow$ flight to quality
Relation with Empirical Findings

Related Empirical Findings:

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- Micco and Panizza (2005): competition increases credit procyclicality
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Relation with Empirical Findings

Related Empirical Findings:

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Relation with Empirical Findings

Related Empirical Findings:

- Micco and Panizza (2005): competition increases credit procyclicality
- Dell’Ariccia et al. (2008): lending standards fall upon entry of large outside lenders
- Ioannidou et al. (2009), Jimenez et al. (2009): risk-taking when interest rates are low
- Foos et al. (2009): rapid loan growth but low average interest income, loan loss provisions spike three years ahead
Conclusions

- Informational spillovers can change the effect of competition on lending substantially
- Excessive lending booms occur due to a combination of low screening and cross-subsidized lending
- The model also explains credit contractions and flight-to-quality in recessions
- Suitable for integration in general equilibrium model to perform macroprudential analyses
- Directions of future research:
  - Empirical: screening choice under competition, lending standards
  - Theory: international lending booms and capital flows
Thank you!
Appendix: Closed Form Solutions (I)

Monopolistic case:

\[
\begin{align*}
\frac{c_0}{(\lambda - 1)^2} &= b - \frac{a}{\lambda^2} \\
a &= \frac{(R - r)(\bar{p} - q)^2}{2\varepsilon} \\
b &= \frac{(R - r)\varepsilon}{8} \\
\gamma &= a - b - c_0 \\
\phi &= 108a^2b - 108ab^2 - 108ab\gamma - 2\gamma^3 \\
\beta &= \frac{3\sqrt{a^2}}{3a\left(\phi + \sqrt{\phi^2 - 4\gamma^6}\right)^{1/3}} + \frac{\left(\phi + \sqrt{\phi^2 - 4\gamma^6}\right)^{1/3}}{3\sqrt{2a}} \\
\lambda_1^* &= \frac{1}{2} \sqrt{2 + \beta - \frac{4\gamma}{3a} - \frac{2(a - 2b - \gamma)}{a\sqrt{1 - \beta - \frac{2\gamma}{3a}}}} - \frac{1}{2} \sqrt{1 - \beta - \frac{2\gamma}{3a}} + \frac{1}{2} \\
\lambda_2^* &= \frac{1}{2} \sqrt{2 + \beta - \frac{4\gamma}{3a} + \frac{2(a - 2b - \gamma)}{a\sqrt{1 - \beta - \frac{2\gamma}{3a}}}} + \frac{1}{2} \sqrt{1 - \beta - \frac{2\gamma}{3a}} + \frac{1}{2}
\end{align*}
\]

whereby the correct solution is the root that lies in the \([0, 1]\) interval.
Appendix: Closed Form Solutions (II)

**Competitive case:**

\[ \lambda^*_c(q, \gamma) = \frac{1}{1 + \sqrt{\frac{c_0}{\delta}}} \]  

where \( \delta = 2\gamma \varepsilon^{-1}(q - \bar{p} + \frac{\gamma}{R-r}) \)
Appendix: Proof of equilibrium property (sketch)

Maximization subject to noncontestability constraint yields an equilibrium:

1. if portfolio $\mathcal{P}$ is noncontestable, and portfolio $\mathcal{Q}$ is noncontestable and symmetric, and its surplus is weakly higher, i.e. $\Pi[\mathcal{P}] \leq \Pi[\mathcal{Q}]$ then the incumbent can generate same or higher payoff for himself by choosing $\mathcal{Q}$ over $\mathcal{P}$.

2. for any noncontestable portfolio $\mathcal{P}$ there always exists a symmetric noncontestable portfolio $\mathcal{Q}$ that yields weakly higher surplus

3. so, search within the class of symmetric noncontestable portfolios yields an element for which payoff is maximal among all noncontestable portfolios $\Rightarrow$ equilibrium.