- 2-consumer model based on PS (JME)
- 2 financial systems
  - Unified (UB)
  - Separated (GSB)
- panic-based runs are sunspot-driven, PS(JPE), EK(EER)
Goals:

- Evaluate relative performances of UB, GSB, and autarky (A):
  - Consumer welfare
  - Run susceptibility
  - Disintermediation (i.e., bank is strictly inferior to autarky)

- Quantitative experiments:
  - Welfare gain (or loss) in terms of percent of endowment in moving from one regime to another.
Preview of Results:

- **UB**
  - not susceptible to panic-based runs
  - not susceptible to disintermediation
  - welfare non-strictly dominates GSB and A

- **GSB**
  - may be susceptible to runs
  - may be susceptible to disintermediation
  - calculated loss from GSB can be compared to costs of phenomena outside the model (e.g., moral hazard)
Consumption Opportunities

- Periods: \( T = 0, 1, 2 \)
- Impatient I
  - Best in \( T = 1, \bar{u} \)
  - In \( T = 2, \beta \bar{u}, 0 < \beta < 1 \)
- Patient P
  - Best in \( T = 2, \bar{u} \)
  - P never chooses \( T = 1 \) (or \( \beta \bar{u} \))
- Left over balances, \( u(\cdot) \).
  - \( u' > 0, u'' < 0 \)
The Model: Choice of investments

- Endowment $y \geq 1$
- $(1 - \gamma)$ is fraction of $y$ invested in $A$, illiquid
- $\gamma$ is fraction of $y$ invested in $B$, liquid
- Aggregate endowment, $2y$
- Aggregate liquidity, $2\gamma y$
- Return on $A$: 0 if harvested early, $R_A$ if harvested late
- Return on $B$: 1 if harvested early, $R_B$ if harvested late
- $\Delta = R_A - R_B > 0$
Intrinsic Uncertainty (Types)

- There are 2 possible realizations, R1 and R2:
  - R1: There is one I and one P.
  - R2: There are 2 P's.
  - \( \text{Prob}(R1) = q, \text{Prob}(R2) = (1 - q) \).
  - Given R1, the probability that a given consumer is I is \( \frac{1}{2} \).
- Types are realized in \( T = 1 \).
Sequential Service

- Positions in queue are equally probable.
- Second in queue sees what first in queue chooses.
- Second in line can walk away.
- Strategic complementarity for all parameters.
Extrinsic Uncertainty (Sunspots)

- Sunspots, our focus today, PS(JPE)

- Sunspots, future work, inspired by EK(EER), e.g.
Timing

- $T = 0$
  - Government chooses UB or GSB, always allowing A.
  - Bank chooses portfolio and designs contract
  - Consumer chooses to deposit or not.
  - If consumer chooses A, he determines his portfolio.
T=1 and T=2

- Analyzing dynamic problem right-to-left.
- Characterize the set of parameters for which the consumer withdraws if he is able.
- An impatient who is able to withdraw at $T=1$
  - prefers to withdraw in $T=1$ to $T=2$ iff
    \[
    \bar{u} + u(yR_A - R_A) > \beta \bar{u} + u(yR_A - R_A + R_B - 1). \tag{1}
    \]
  - prefers to withdraw in $T=1$ rather than defer iff
    \[
    \bar{u} + u(yR_A - R_A) > u(yR_A - R_A + R_B). \tag{2}
    \]
An impatient who is \textit{unable} to withdraw in $T = 1$, prefers $T = 2$ to deferring iff

$$\beta \bar{u} + u(yR_A - 1) > u(yR_A).$$

(3)

We analyze in our paper the set $Z$ of parameter values satisfying inequalities (1)-(3). $Z$ is the set of parameters in which liquidity would be chosen if types were known ex-ante.
Given the other parameter values, there is a critical value $\bar{u}_0$ such that for $\bar{u} > \bar{u}_0$ consumption opportunities are undertaken if the consumer is able to do so.

$(1/\bar{u}_0)$ serves as a measure of *ideal* resource efficiency.

If $\bar{u} < \bar{u}_0$, it is never worthwhile to hold the liquid asset.

In what follows next, we assume that the parameter values lie in the set $Z$.

Later we will analyze parameters outside $Z$. 
Autarky (A)

- $W_1^A > W_0^A$ iff $\bar{u} > \bar{u}_4$, where $W_i^A$ is expected utility when holding $i$ units of the liquid asset, where $\bar{u}_4$ is the critical value.
- $\bar{u}_0 < \bar{u}_4$. Holding the liquid asset ex-ante is more costly than holding it ex-post (after the types are known).
To satisfy the consumption opportunity, UB needs to hold 1/2 unit of liquid asset per depositor.

\[ W_{1/2}^{UB} > W_{0}^{UB} \text{ iff } \bar{u} > \bar{u}_1, \text{ where } \bar{u}_1 \text{ is the critical value.} \]

UB can pool the liquidity assets among the depositors. Therefore, it is less costly to satisfy the urgent consumption opportunity through UB than in autarky. That is, \( \bar{u}_1 < \bar{u}_4 \).
UB vs Autarky (A)

- $W_{1/2}^{UB} > W_1^A$ and $W_0^{UB} = W_0^A$.

- Let $W^{UB} = \max\{W_{1/2}^{UB}, W_0^{UB}\}$ and $W^A = \max\{W_1^A, W_0^A\}$, we have
  - $W^{UB} > W^A$ if and only if $\bar{u} > \bar{u}_1$.

- $\bar{u}_1$ is the threshold of $\bar{u}$ above which UB strictly dominates A.
GSB vs Autarky

- Compared to UB, GSB is restricted by:
  - bank runs
  - ICC requires the bank to hold more than $1/2$ unit of liquid asset per depositor.
- Bank runs make the expected utility of a depositor in GSB weakly decreasing in $s$.
- The minimum requirement of liquid asset holding makes GSB dominated by UB even if $s = 0$.
- Therefore, $W^{GSB}(s_0) < W^{GSB}(0) < W^{UB}$, where
  - $W^{GSB}(s)$ denotes the expected utility of a depositor when the sunspot-driven run probability is $s$.
  - $s_0$ denotes the threshold of $s$ beyond which the GSB switches to the run-proof contract.
GSB vs A

\[ W^{GSB}(s) > W^A_1 \text{ for all } s. \]

- This is because the lower bound of \( W^{GSB}(s) \) is \( W^{GSB}(s_0) \) in which the contract is run-proof. And in the run-proof contract, the per person liquid asset holding is strictly smaller than 1.

- Therefore, whether disintermediation occurs depends on the comparison between \( W^{GSB}(s) \) and \( W^A_0 \).
\( W^{GSB}(0) > W^A_0 \) if and only if \( \bar{u} > \bar{u}_2 \), where \( \bar{u}_2 \) is the critical value.

\( W^{GSB}(s_0) > W^A_0 \) if and only if \( \bar{u} > \bar{u}_3 \), where \( \bar{u}_3 \) is the critical value.

We have \( \bar{u}_2 < \bar{u}_3 \). Each of these two thresholds is larger than \( \bar{u}_1 \). This is because \( W^{GSB}(s_0) < W^{GSB}(0) < W^{UB} \).
Comparative Statics wrt $\bar{u}$

Disintermediation for GSB
(i.e., $W_{GB}(s) < W_{Autarky}$ for all $s \in [0,1]$)

Conditional Disintermediation for GSB depending on $s$
(i.e., $W_{GB}(s_0) < W_{Autarky} < W_{GB}(0)$)

Intermediation for GSB
(i.e., $W_{Autarky} < W_{GB}(s)$ for all $s \in [0,1]$)

Weak Intermediation for UB
(i.e., $W_{Autarky} = W_{UB}$)

Intermediation for UB
(i.e., $W_{Autarky} < W_{UB}$)
Numerical Example 1

- We calculate, for different values of $\bar{u}$, the fraction of endowment $y$ a consumer would pay to become a depositor at the UB.

- The parameters: $\beta = 0.6$, $q = 0.5$, $y = 1.1$, $R_A = 1.5$, $R_B = 1.3$, $u(c) = \frac{(c+1)^{1-\theta} - 1}{1-\theta}$, where $\theta = 2$.

- We calculate that $\bar{u}_0 = 0.4698$. We vary $\bar{u}$ from 0.5 to 1.5.
UB is non-redundant ($W^{UB} > W^A$) if and only if $\bar{u} > \bar{u}_1 = 0.7366$.

$W^{GSB}(0) > W^A_0$ if and only if $\bar{u} > \bar{u}_2 = 1.0862$.

$W^{GSB}(s_0) > W^A_0$ if and only if $\bar{u} > \bar{u}_3 = 1.1127$.

$W^A_1 > W^A_0$ if and only if $\bar{u} > \bar{u}_4 = 1.2857$. 
Numerical Example 1: Willingness to pay to move to UB
Numerical Example 2

- We plot the fraction of endowment that a consumer would pay to become a depositor of the UB.
- We fix $\beta = 0.5$. Other parameters are the same as the previous example.
- We vary $y$ from 1 to 2. It can be verified that, for $y$ in this range, the consumer will take advantage of the consumption opportunity if he is able to do so.
Numerical Example 2: Willingness to pay to move to UB
Numerical Example 3

- We plot the fraction of endowment that a consumer would pay to become a depositor in the UB.
- We fix $R_B = 1.3$. We vary $\Delta$ from 0.03 to 1.3.
- Other parameters remain the same as the previous example.
Numerical Example 3: Willingness to pay to move to UB