

# Demand Induced Fluctuations

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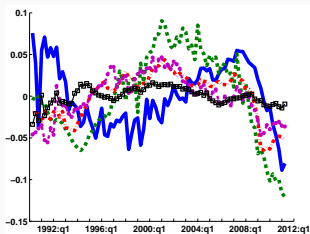
*Yale*

*Penn, UCL, CAERP*

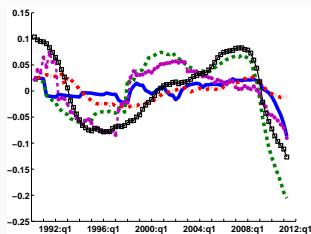
25th Years: PIER & “Frontiers of Business Cycle Research” Conference

May 5, 2019

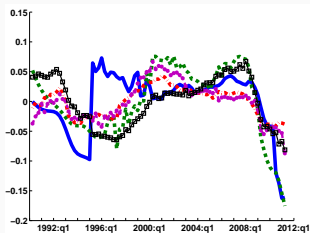
# CRISIS IN SOUTHERN EUROPE



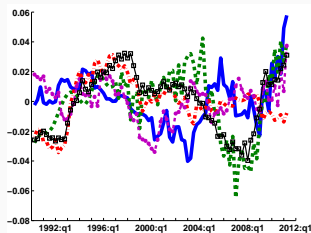
TFP



Employment



Consumption



NX/Output Ratio

— Greece    — Ireland    — Italy    - - - Portugal    -□-□- Spain

# MOTIVATION

- Conventional view of business cycles fluctuations
  - supply shocks dominate: TFP as the main driving force
  - demand shocks are dulled: prices move to accommodate production
- At odds with the financial crisis
  - hard to convince it was triggered by a drop of TFP
  - New Keynesian is attractive: prices less accommodating
- Here: resuscitate demand shocks by dropping a key assumption

$$Y \neq F(K, N)$$

- Instead:  $Y = \Psi(AD) F(K, N)$  AD is “Aggregate Demand”

Podologists need skills, pliers and  $\dots$  toes

- We build a quantitative model where a desire to save leads to a recession
  - triggered by shocks to discount factor, wealth, or the financial system
  - **without** price or wage rigidities (but if present, they amplify)
- We incorporate search and matching frictions in goods market
  - the measured Solow residual is a function of aggregate demand
- We show the recession displays the paradox of thrift
  - networth actually declines after collective effort to save

- A desire to save in frictionless models lead to a boom
  - employment increases due to wealth effects
  - investment increases as consumption drops
  - export increases as foreign demand is unaffected
- In our model
  - frictions in labor: static Euler equation does not work directly
  - exporting more is feasible, but takes time to expand
  - nominal rigidities amplifies, but not necessary
- New: depressed demand → **productivity endogenously** falls
  - this channel greatly contributes to the recession

# Part I: A Two-Period Endowment Economy

## GOODS MARKET FOR NONTRADABLE GOODS

- A continuum of varieties, each endowed with  $F_N$  unit of goods. Each variety has a continuum of seats/locations.
- Households value both varieties,  $I$ , and quantities,  $c_{Ni}$

$$\left[ \int_0^I c_{Ni}^{\frac{1}{\rho}} di \right]^{\rho} = c_N I^{\rho}$$

- Goods market subject to search and matching frictions
  - variety is found by exerting search effort  $d$ :  $I = d \Psi^d(Q^g)$
  - goods in an unmatched variety are wasted seat/location
- matching function  $M(D, 1)$ :  $\uparrow$  in aggregate search effort  $D$ 
  - prob (per search unit) of finding a variety:  $\Psi^d(Q^g) = \frac{M(D, 1)}{1}$
  - prob of a variety meeting a consumer:  $\Psi^f(Q^g) = \frac{M(D, 1)}{D}$

# HOUSEHOLD PROBLEM

- Preferences
  - today: like tradables ( $c_T$ ) and nontradables, dislike search
  - tomorrow: indirect utility as a function of bond  $V(b')$
- Household problem

$$\max_{c_T, I, c_N, d, b'} u(c_T, c_N I^p, d) + \beta V(b')$$

$$\text{s.t.} \quad c_T + p I c_N + b' = \pi_N + F_T$$
$$I = d \Psi^d(Q^g)$$

- Equilibrium:  $p$  adjust so that  $c_N = F_N$ ;  $\pi_N = p \Psi^f(Q^g) F_N$



# SHOCK TO DISCOUNT FACTOR

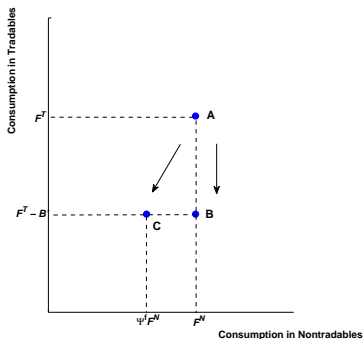
- What happened when  $\beta$  increases?
- Without goods market frictions
  - consumption of  $c_T$  drops, but  $p$  drops such that  $c_N = F_N$
  - number of varieties remain constant:  $I = 1$ ,  $\Psi^f(Q^g) = 1$
  - current output does **not** change

$$Y = F_T + p^* \Psi^f(Q^g) F_N = F_T + p^* F_N$$

- With goods market frictions
  - households reduce varieties and search less
    - without the variety margin, households search more in recession ([Bai, et al. 2011](#))
  - $\Psi^f(Q^g)$  decrease due to less search  $\rightarrow$  more idle varieties

$$Y = F_T + p^* \underbrace{\Psi^f(Q^g)}_{\downarrow} F_N$$

# SHOCK TO DISCOUNT FACTOR



- W/o goods market friction:  $A \rightarrow B$ , only a reduction of tradable cons
- With goods market friction:  $A \rightarrow C$ , also a reduction of nontradables

Next: embed this idea to a production economy

# Part II: A Production Economy Suitable for Empirical Analysis

# THE ENVIRONMENT: A REP AGENT SMALL OPEN ECONOMY

## PRODUCTION

- Two sectors that we call tradables, & nontradables
- The tradable sector has a measure one of firms and decreasing returns to scale.
- Adjustment costs to both capital and labor. Its output is used for exports, investment, and (part of) consumption.  $F^T(k, n)$ .
- Many varieties of nontradables.
- Each firm/variety has a measure one of locations, each location has its own production function  $F^N(k, n)$ .
- Locations may or may not be filled (get a customer). They produce only for consumption.
- Firms post prices before the location is filled.

## SEARCH GOODS MARKETS FOR NONTRADABLES.

- There is a large number of varieties. Agents need to search to find those varieties.
- Random search. There is a CRS matching function  $\Psi(1, D)$ .  
Market tightness is  $Q^g = \frac{1}{D}$ .
- Probability that a shopper finds a firm-variety:  $\Psi^d(Q^g) = \frac{\Psi}{D}$
- Probability that a firm finds a shopper is the measure of filled locations or of consumers buying the good:  $\Psi^f(Q^g) = \frac{\Psi}{1} = \Psi$ .
- Total sales of nontradables in units of the numeraire.

$$p I c_N = p \Psi^f(Q^g) F^N(k, n).$$

- Random search with market tightness:  $Q^e = \frac{V}{1-N}$ .
- Total vacancies:  $V = V_N + V_T$   
Employment:  $N = N_N + N_T$ .
- Job finding probability  $\Phi^e(Q^e)$
- Vacancy filling probability  $\Phi^f(Q^e)$
- Exogenous job destruction at rate  $\lambda$
- Wages (we explore various mechanisms)
  - Nash bargaining
  - Staggered wage contract
  - Constant labor share

## COLLAPSES TO A SIMPLE MACRO MODEL

- Aggregate State Variables.  $S = \{\theta, K_N, N_N, K_T, N_T, B\}$ .
  - Shocks
  - Capital in the nontradable sector
  - Labor in the nontradable sector
  - Capital in the tradable sector.
  - Labor in the tradable sector.
  - Net foreign asset position.
- Individual State Variables  $b, n$ .
  - Liquid wealth (bonds against the rest of the world,  $b$ )
  - Fraction of the household working  $n$ .
- No need to pose a Stock Market.

## CONSUMERS' PROBLEM

$$V(S, b, n) = \max_{c_N, c_T, I, d} u(c_N I^{\rho}, c_T, d, n) + \beta \mathbb{E}\{V(S', b', n')\} \quad \text{s.t.}$$

$$p(S) I c_N + c_T + b' = (1 + r)b + w(S)n + \pi_N(S) + \pi_T(S) \quad \text{BC}$$

$$I = d \Psi^d[Q^g(S)] \quad \text{SC}$$

$$n' = (1 - \lambda) n + \Phi^e[Q^e(S)] (1 - n) \quad \text{EC}$$

$$S' = G(S) \quad \text{RE}$$

No immediate possibility of working harder.



## NONTRADABLE FIRMS' CHOOSE PRICES $p^j$ AND INVESTMENTS

$$\Omega^{Nj}(S, k, n) = \max_{p^j, i, v} \Psi^f[Q^g(S)] C(p^j, S) p^j - w(S)n - i - v\kappa + E \left\{ \frac{\Omega^{Nj}(S', k', n')}{1+r} \right\} \quad \text{s.t.}$$

$$F^N(k, n) \geq C(p^j, S) = \left( \frac{p^j}{p(S)} \right)^{\frac{\rho}{1-\rho}} C(S)$$

$$k' = (1 - \delta)k + i - \phi^N(i, k)$$

$$n' = (1 - \lambda)n + \Phi^f[Q^e(S)]v$$

Capital and labor are predetermined, firms adapt demand by adjusting  $p^j$ .

## TRADABLE GOODS PRODUCTION: DRS & ADJUSTMENT COSTS

$$\Omega^T(S, k, n) = \max_{i, v} F^T(k, n) - w(S)n - i - v\kappa \\ - \phi^{T, n}(n, n') + E \left\{ \frac{\Omega^T(S', k', n')}{1+r} \right\}$$

subject to:

$$k' = (1 - \delta)k + i - \phi^{T, k}(i, k)$$

$$n' = (1 - \lambda)n + \Phi^f[Q^e(S)] v$$

These two properties will make it difficult to adjust both fast and a lot.

## REPRESENTATIVE NASH BARGAINING FOR WAGES

- Nash bargaining problem

$$w(S) = \max_w [V_n(S, b, n)]^\varphi \left[ \frac{N_N}{N} \Omega_n^N(S, K_N, N_N) + \frac{N_T}{N} \Omega_n^T(S, K_T, N_T) \right]^{1-\varphi}$$

- First order condition:

$$\varphi u_{c_T} [\chi \Omega_n^N(S, k_N, n_N) + (1 - \chi) \Omega_n^T(S, k_T, n_T)] = (1 - \varphi) V_n(S, b, n)$$

- In steady state, we have:

$$w = \varphi \left[ \chi \left( \Psi^f(Q^g) p F_n^N \frac{1}{\rho} + Q^e \kappa \right) + (1 - \chi) (F_n^T + Q^e \kappa) \right] + (1 - \varphi) \frac{S}{u_{c_T}}$$

Alternative Wage Determination

# Part III: Using the Model to Engineer Recessions

- Calibrate this economy to look like a modern economy.
- Construct recessions normalized to get 1% reductions in output by
  1. A (relatively) persistent increase to the discount rate  $\beta$ .
  2. A destruction of wealth (net foreign asset position.)
  - Opposite Effects to those in the standard growth model.
  - These shocks are a stand-in for whatever deteriorates the financial system.
- We then explore the properties of the recession generated.

# FIRST EXPERIMENT: PERSISTENT SHOCK TO DISCOUNT FACTOR

- Assume  $\beta_t = \beta \exp \theta_t^\beta$  it follows an AR(1) process:

$$\log \theta_t^\beta = \rho^\beta \log \theta_{t-1}^\beta + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma^\beta), \rho^\beta = .95$$

- We then pose an initial value for  $\varepsilon_0$  to reduce output 1%.
- Advantage: That induces a desire to increase saving *temporarily* and later to increase consumption. It makes it similar to a financial shock that increases the wealth to income target of the households.
- Disadvantage. If taken literally, it is silly, but we will not take it literally.

## OUTPUT IS IN TERMS OF TRADABLE GOODS

- Output in terms of the tradable goods is:

$$Y = p \Psi^f(Q^g) F^N(K_N, N_N) + F^T(K_T, N_T)$$

- Real output,  $Y$  is in base year prices (Use steady state,  $p^*$  instead of current  $p$ ).

## THREE WAGE PROTOCOLS:

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1. Standard Nash wage bargaining:
  - A large shock is needed: Nontradable firms decrease employment and vacancies but tradable firms increase employment and vacancies.
2. Staggered wage contract:
  - Employment and vacancies drop more. Tradable firms increase employment and vacancies mainly because the vacancy filling rate is higher.
3. Constant labor share:
  - Wage drops less and employment drops more compared with flexible Nash bargaining.



- Preferences  $u(c, d, n) = \frac{1}{1-\sigma} (c - \xi d)^{1-\sigma} - \varsigma n$

$$\text{where } c = \left[ \omega (c_N I_N^\rho)^{\frac{\eta-1}{\eta}} + (1-\omega) c_T^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

- Tech:

$$F^N(k, n) = z_N k^{\theta^N} n^{1-\theta^N}, \quad F^T(k, n) = z_T k^{\theta_k^T} n^{\theta_n^T}$$

- Matching technology

$$M^e(U, V) = \nu^e U^\mu V^{1-\mu}, \quad M^g(D, T) = \nu^g D^\alpha T^{1-\alpha}$$

- Capital adjustment cost in the nontradable goods sector

$$\phi^N(i, k) = \frac{\epsilon^N}{2} \left( \frac{i}{k} - \delta \right)^2 k$$

- Capital adjustment cost in the tradable goods sector

$$\phi^{T,k}(i, k) = \frac{\epsilon^{T,k}}{2} \left( \frac{i}{k} - \delta \right)^2 k$$

- Employment adjustment cost in the tradable goods sector

$$\phi^{T,n}(n', n) = \frac{\epsilon^{T,n}}{2} \left( \frac{n'}{n} - 1 \right)^2 n$$

## CALIBRATION: EXOGENOUSLY DETERMINED PARAMETERS

- A period is half a quarter.

Parameter	Value
Risk aversion, $\sigma$	2.0
Annual rate of return, $\beta$	$\frac{1}{\beta^8} - 1 = 4\%$
Labor matching elasticity, $\mu$	0.50
Elasticity of substitution bw tradables and nontradables, $\eta$	0.83
Price markup $\rho$	1.05

# CALIBRATION: ESTIMATED PARAMETERS

Target	Value	Parameter	Value
Share of tradables $\frac{F_T^*}{Y^*}$	0.3	$\omega$	0.91
Unemployment rate, $U^*$	7%	$\lambda$	0.05
Monthly job finding rate	45%	$\nu^e$	0.67
Occupancy Rate, $\frac{C_N^*}{F_N^*}$	0.81	$\nu^g$	0.81
Capital to output ratio $\frac{K^*}{Y^*}$	2.75	$\delta$	0.007
Labor Share in nontradables	0.6	$\theta_N$	0.67
Labor Share in tradables	0.6	$\theta_T^N$	0.64
Equal Role of $K$ and Land in Tradables,	$2\theta_T^K + \theta_T^N = 1$	$\theta_T^K$	0.18
Vacancy Posting to Output Ratio	0.037	$\varsigma$	0.80
Value of home production,	.5	$\varphi$	0.35
Output, $Y^*$	1	$z_N$	0.45
Relative price of nontradables, $p^*$	1	$z_T$	0.52
Market tightness in labor markets, $\frac{U^*}{V^*}$	1	$\kappa$	0.53
Market tightness in goods markets, $D^*$	1	$\xi$	0.02

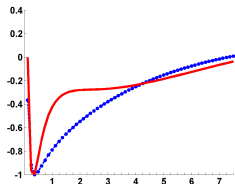
# CALIBRATION: DYNAMIC PARAMETERS

(DETERMINED AT RECESSION ANALYSIS TIME)

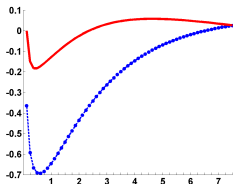
Target	Value	Parameter	Value
Response of nontradable investment	$\frac{\Delta I^N}{\Delta Y^N} = 4$	$\epsilon^N$	21.29
Response of tradable output	$\frac{\Delta Y^T}{\Delta Y} = -5$	$\epsilon^{T,n}$	9.84
Symmetry of tradable adjustment costs	$\epsilon^{T,k} = \epsilon^{T,n}$	$\epsilon^{T,k}$	9.84
Response of labor to output	$\frac{\Delta N}{\Delta Y} = .5$	$\alpha$	0.19

## RESULTS: I. SHOCK TO PATIENCE, HOUSEHOLDS INCREASE SAVINGS

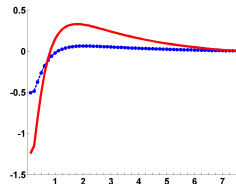
- Recall a shocks to  $\beta$ , that generates a 1% output drop in:
- Baseline economy: wages determined via Nash bargaining and relatively flexible tradable sector (tradable sector expands by 5%).
- We also look at many other economies:
  - Baseline with staggered wage contract: same dynamic parameters as the baseline economy, average wage contract duration is 1 year.
  - Baseline with high adjustment cost in tradable sector: (tradable sector expands by 1%).
  - Baseline economy with constant labor share:
  - No frictions either in labor markets.
  - No shopping (no frictions in goods markets)



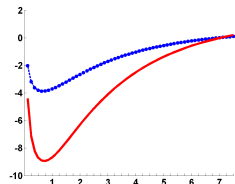
Real output



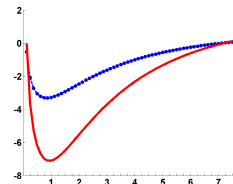
Solow residual



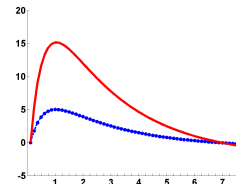
Employment



Consumption



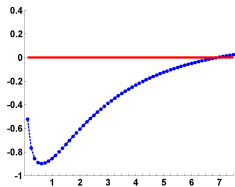
Output of nontradables



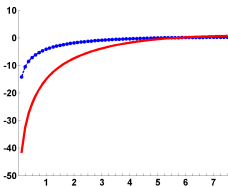
Output of tradables

●-●-●- Baseline economy

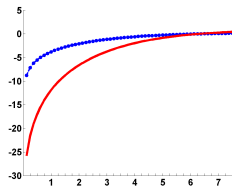
— Baseline without goods market friction



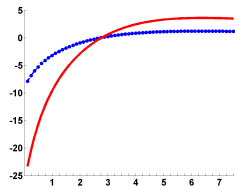
Number of varieties



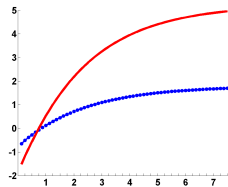
Price for nontradables



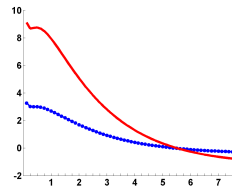
Wage



Investment



Wealth



Net export-output ratio

—●—●—●— Baseline economy

— Baseline without goods market friction



# STATISTICS FOR A 1% DROP IN OUTPUT FROM SHOCKS TO $\beta$

Model economy	Pref Shock	Employment	TFP	Cons
Baseline economy	<b>0.88</b>	-0.50	<b>-0.69</b>	-3.86
without goods market friction	<b>2.00</b>	-1.22	<b>-0.16</b>	-7.50
with very low adjustment costs	1.29	0.12	-1.80	-8.39
Frictionless markets (goods and labor)	<b>-0.48</b>	-1.77	0.00	4.18
Frictionless labor with goods market friction	<b>-0.53</b>	-1.96	0.10	4.50
+ staggered wage	0.55	-0.78	-0.50	-2.67
+ constant labor share	0.85	-0.51	-0.67	-3.75

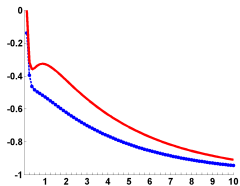
- Does Shopping Matter? Yes: Baseline economy without shopping.
- Without shopping, the required size of the shock is much larger.  
This is the main contribution of the paper.

- A recession can be triggered by a desired to save which generates (temporarily) the paradox of thrift.
- After consumers cut their consumption
  - Output, consumption, investment and employment decrease.
  - Prices for nontradables and wage rate (if set by bargaining) decrease.
- Technology is unchanged, but measured Solow residual decreases.
  - It becomes more difficult for the nontradable firms to find a shopper.
  - Tradable sector with decreasing returns to scale expands.
- The extent of the recessions depend on the rigidity of prices and the flexibility of factor reallocation.

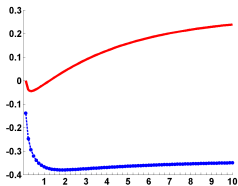
## RESULTS II: A WEALTH DESTRUCTION SHOCK:

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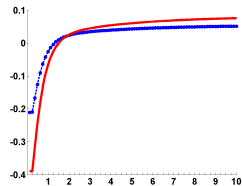
- This is our theory of the recession in Southern Europe. A permanent impoverishment.
- A wealth destruction shock that induces a 1% output drop.
- With Good Markets Frictions the size of the Wealth Shock is 9.5%
- Without, it 18.7%.
- Other versions yield similar relative properties



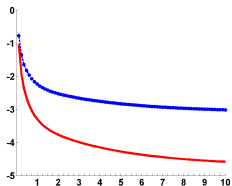
Real output



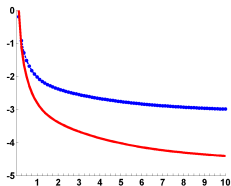
Solow residual



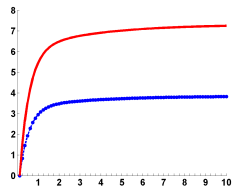
Employment



Consumption



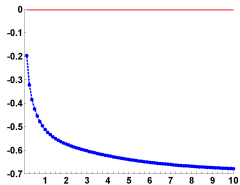
Output of nontradables



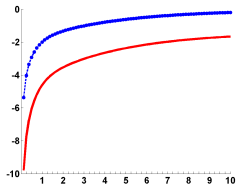
Output of tradables

●-●-●- Baseline economy

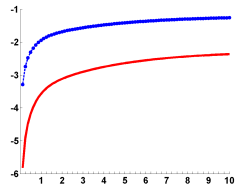
— Baseline without goods market friction



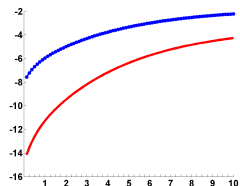
Number of varieties



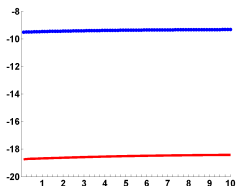
Price for nontradables



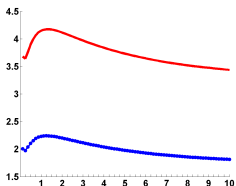
Wage



Investment



Wealth



Net export-output ratio

●-●-●- Baseline economy

— Baseline without goods market friction

## PROPERTIES OF SHOCKS TO WEALTH

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- A permanent output and consumption drop can be triggered by a loss of wealth.
- Mild permanent increase in employment
- There is a permanent deterioration of relative prices.
- Technology is unchanged, but measured Solow residual decreases.
  - It becomes more difficult for the nontradable firms to find a shopper.
- The extent of the recessions depend on the rigidity of prices and the flexibility of factor reallocation.

## WHAT SHORTCOMINGS?

- Large Recessions go together with large interval devaluations
  - They really do not happen
  - A need for some form of internal price rigidity. (Doable)
- Asset Price falls.
  - Need to model non reproducible assets.
- ●

## ANOTHER POSSIBLE INTERPRETATION TO THE SHOCKS

### ALTERNATIVE TO SHOCKS TO PATIENCE OR WEALTH:

- A shock to the financial system so people to want to save more.
- We also develop such a model within the Rep Ag structure.
- Financial Services are used to smooth consumption within the household (to those unemployed). Have to accommodate
  - Specialization of household members in different consumption markets (competitive search)
  - Costly transfers (cost  $\psi$  subject to shocks ) between members
- It ends up looking like a  $\beta$  shock in a two class world.
- The details of the goods search protocol do not matter much.

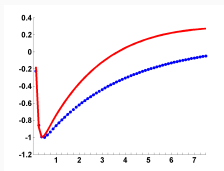


## RESULTS: EFFECTS OF FINANCIAL SHOCKS (WITH CONSTANT LABOR SHARE)

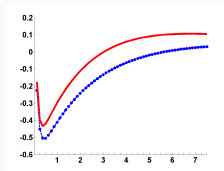
- Baseline
- FFI: Financial friction model: with Non-Segmented goods markets.
- FFI Financial friction model: Segmented goods markets.

Model economy	Implied $\hat{\beta}$	Empl.	TFP	Cons	Cost/Output
Baseline+constant labor share	0.69	-0.76	-0.51	-3.06	—
Non-segmented goods mrkts FFI	0.81	-0.82	-0.49	-2.75	1.23
Segmented goods mrkts FFII	0.83	-0.83	-0.47	-2.80	1.23

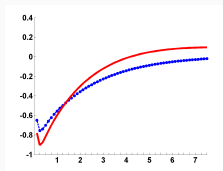
# FINANCIAL SHOCK: TWO CLASS WORLD



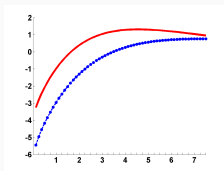
Real output



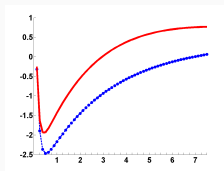
Solow residual



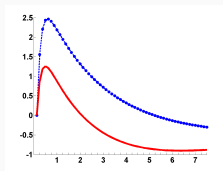
Employment



Investment



Output of nontradable

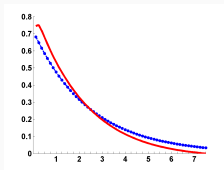


Output of tradable

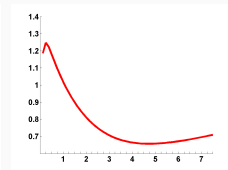
■ ■ ■ Baseline economy

■ ■ ■ Financial friction: II

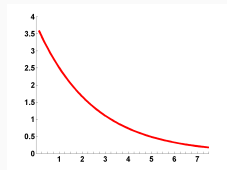
# FINANCIAL SHOCK: TWO CLASS WORLD



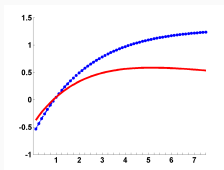
Discount factor



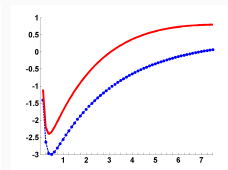
Financial cost/output ratio



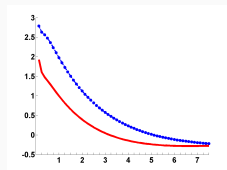
Ratio of  $C_e$  to  $C_u$



Wealth



Consumption



Net export/output ratio

■ ■ ■ Baseline economy    ■ ■ ■ Financial friction: II

1. Develop a theory of how a desire to save generates a recession and via the paradox of thrift, a temporal reduction of wealth.
2. Find that recessions can be the result of a desire to increase savings due to some financial mishap. Crucial ingredients:
  - Real Rigidities in the economy (sector reallocation).
  - The shopping structure amplifies the recession.
  - Other Rigidities further amplify (wage rigidities, rigidities price of non tradeable varieties)
3. All these are important departures from the standard model with productivity shocks (either new keynesian or neoclassical).

## WHERE TO GO WITH THIS LINE OF WORK?

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- Asset (houses) pricing exacerbate recessions
- Consistent with Wealth and Heterogeneity
- Wage and price rigidity
- Disentangle Exports and Imports
- Spatial differentiation to accommodate cross-sectional evidence

## WHERE TO GO WITH THIS PAPER?

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- Waiting to hear from the editors

## REFERENCES

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