Financial Frictions, Financial Shocks and Unemployment Volatility: Lessons from the Great Recession

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Premise: New Macro Interest in Labor and Finance

- Financial recessions are deeper and last longer than ordinary recessions. (IMF, 2010; Carmen and Rogoff, 2008; Boeri et al. 2013; Boissay et al. 2013)
- Financial recessions, or banking crises during recessions, are rare events. Boissay et al. (2013): once every 40 years.
- Not only job destruction: the 2007-2009 recession features an un-precedented decline in vacancies and firm entry (Siemer 2014)

Premise 1: Cross/Country Historical Evidence

Table: Unemployment and GDP during financial recessions

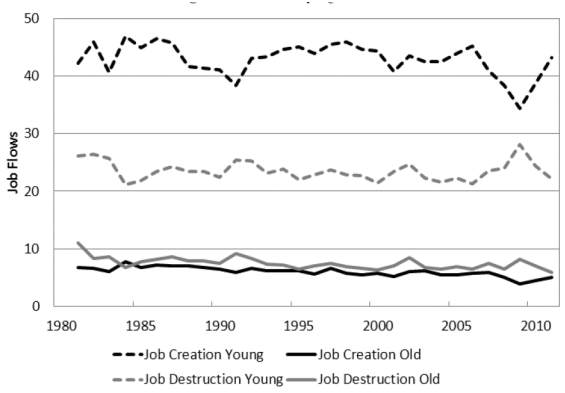
Country	Type of recession	du	du/u	dy/y	ϵ^a
US	Financial rec	2.65	50%	-3.0%	16.66
	Other rec	1.93	33%	-2.6%	12.69
	Difference	*0.72*	*17%*	*-0.4%*	*3.97*
UK	Financial rec	2.10	36%	-3.2%	11.25
	Other rec	0.50	7%	-3.1%	2.25
	Difference	*1.60*	*28%*	*0.0%*	*9.00*

[a] Apparent elasticity of unemployment with respect to GDP.

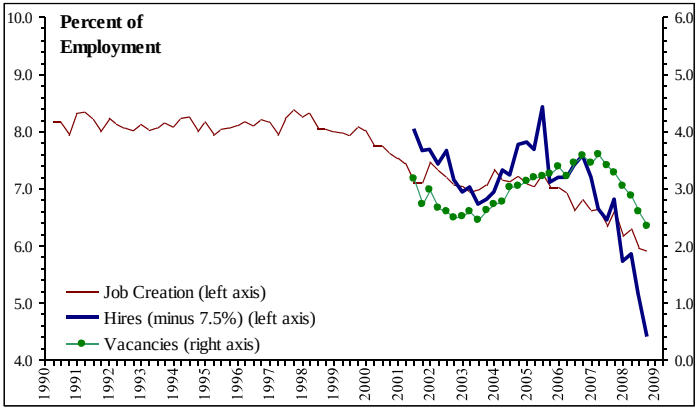
Notes: Episodes of recessions with financial crises: UK 1975, 1990, 2008; US 1990, 2008.

Sources: OECD, US Bureau of Labor Statistics.

JC and JD in young and old US firms during GR



JC and vacancies in the US during the GR



Labor and Finance over the Business Cycle

- Two interlinks between labor and finance:
  1. Financial frictions may propagate and *amplify* standard (productivity) fluctuations.
     - Negative productivity shocks may increase financial frictions and exacerbate their adverse effects on unemployment
  2. *Pure financial shocks* may influence aggregate labor market conditions.
- This paper addresses both channels in a tractable DSGEM with frictions in *both* labor and finance.

This Paper (I): A model of labor and finance

- Firms operate in a Diamond-Mortensen-Pissarides (DMP) labor market
  - Simple matching model (Pissarides 1985) with competitive search (Moen, 1997)
- Firms obtain funding in an imperfect financial market
  - Firms borrow to finance investments in capital and search
  - Limited pledgeability of future income flows: investors need to share part of firm's income with insiders. Holmstrom and Tirole (2011)

This Paper (II): Two quantitative exercises

1. *Amplification* effects of pure productivity shocks induced by limited pledgeability
   - Amplification effects do exist
   - Only the effects of productivity shocks on financial frictions are quantitatively important (*pleadgeability effect*).
   - Financial frictions by themselves have small amplification effects (*collateral effect)*
2. *Real effects* of financial shocks
   - A very adverse (and unlikely) financial shock can have a strong *adverse impact* on the aggregate labor market.

Macro labor and finance: A Vibrant Research Area

1. Early literature
   - (i) risk adjustment effect: Greenwald and Stiglitz, 1993;
   - ii) financing of quasi-fixed costs (Oi, 1962; Farmer, 1985);
   - iii) sticky bank/firm relationship (Sharpe, 1990; Homstrom and Tirole, 1987);
2. Post Great recession research:
   - Labor impact of shocks to consumers and firms' discount rate (Hall, 2014, Keho et al. 2014)
   - Real Effects of financial shocks as (borrowing spreads) (Christiano et al., 2015)
   - Search and asset price theory (Kuhen et al. 2014)
3. Search with financial imperfections
   - Double friction (Wasmer and Weil, 2005)
   - Wage setting with financial imperfections Quadrini and Trigari, 2013; Michelacci and Quadrini, 2009
   - Job Composition effect (Petroksy-Nadeu, 2013)
   - Liquidity as war chest, Boeri Garibaldi and Moen, 2014

Volatility and DMP framework

- Real effects of borrowing spreads. (Eckstein et al., 2014)
- Double search frictions (Wasmer and Perosky-Nadeu, 2013)
- Financing of vacancy costs (Petrosky-Nadeu, 2013)
- Shocks to collateral and Kiotaky and Moore (Garin, 2015; Iliopolus et al. 2014)

Our model

- **Basics**
  - Discrete time. Risk neutral firms and workers, discount rate β
  - Workers infinitely lived.
  - Firms die at rate λ, in which case the employees become unemployed and earn z.
  - Cobb-Douglas matching function. The probability of job filling in a period is $q(\theta) = M\theta^{-\alpha}$, where θ is vacancy/unemployment ratio.
- **Production technology: Leontief in Labor and Capital**
  - Entrepreneurs pay an entry cost K as *effort*. Then they invest A units in *physical capital*.
  - Price of capital is ϕ
  - A is measure of jobs.
- **Output** is $y_t A_t$. Productivity is stochastic $y_t = ye^{\epsilon_t}$,
  - $\epsilon_t = \rho_\epsilon \epsilon_{t-1} + u_t$. Discrete approximation to N states
  - stochastic matrix P: $p_{ij} = prob\left[y_t = i | y_{t-1} = j\right]$

Model

- **Matching**.
  - Firms post vacancies with wages attached to them (rents over unemployment) at cost c.
  - Firms pay c/q in search cost per worker hired, and get workers immediately
- **Funding and Borrowing Constraint**
  - Upfront investments in machines and search have to be financed
  - Set-up cost K is an effort cost, and is not financed.
  - Two sources of income
    - External liquidity: exogenous income flow originated outside the corporate sector $y_o(y_t)$ -*fully pledgeable*.
    - Internal liquidity: income from production - limited pledgeability á la Holmostrom and Tirole

Asset Values and Profits

Joint Income $M(y)$:

$$M(y) = yA + \beta\left\{(1-\lambda)M(y'|y) + \lambda AU(y'|y)\right\}$$

Joint surplus : $S(y) = M(y) - AU$

$$S(y) = (y - \rho U)A + \beta(1-\lambda)S(y'|y)$$

$$\rho(y) = \frac{U(y) - \beta U(y|y')}{U(y)}$$

Profits V:

$$V(U(y), y) = \left[S(y) - \phi - C(U(y))\right] A$$

where $C(U)$ are all labor related costs

Search and Worker's Rent (I)

- Competitive Search: Firms choose wages (rents R) to speed up hiring
- Firms trade-off optimal wage and search costs.
- Minimize total labor related costs

$$C = \min \left[c\theta(U)^{\alpha} + R \right] \qquad \text{S.T.} \qquad \rho(y)U = z + p(\theta)R$$

- Total Labor Cost per Worker:

$$C = \frac{c\theta^{\alpha}}{1-\alpha}; \quad C(U) = \kappa \left[\rho(y)U - z \right]^{\alpha}$$

κ is a constant

Finance (I): The financial structure

- Start-up cost K is effort and needs not be financed.
- External liquidity
  - External liquidity: flow $y_t y_o$ fully pledgeable
  - External liquidity depends on output - the *collateral effect* of productivity
- Internal liquidity
  - Internal liquidity: net revenues from the investment can be borrowed upon
  - Not fully pledgeable (Holmstrom and Tirole 2011)
  - Part of total income $x(y)A$ is not pledgeable
  - $x'(y) \leq 0$, the *pledgeability effect* of productivity
  - Idea: Geneakoplos, the Leverage Cycle, 2010.
- No savings of non-pledgeable income

The NPV of pledgeable income:

$$\begin{aligned} \tilde{P}(y) &= y_0 y + (y - w)A_t - x(y)A + (1 - \lambda)\beta P(y'|y) \\ &= Y_0(y) + A(S(y) - R - X(y)) \end{aligned} \tag{1}$$

where

$$\begin{aligned} X(y) &= x(y) + (1 - \lambda)\beta X(y'|y) \\ Y_0(y) &= y y_0 + \beta Y_0(y'|y) \end{aligned} \tag{2}$$

Borrowing constraint: financing machines and search costs

$$\tilde{P} = A(\phi + c/q)$$

Firm Size:

$$A(y) = \frac{Y_0(y)}{\phi + C + X(y) - S}; \quad A(y) = k(y)\,Y_0(y) \tag{3}$$

$k(y)$ is the financial multiplier (units of worker-machine the firm can invest in per unit of external liquidity).

General Equilibrium

General equilibrium is a set of value functions $U(y), C(U), V(U, y)$, a firm size $A(y, U)$ such that

1. $C(U)$ minimizes total labor costs
2. $A(y, U)$ satisfies the borrowing constraint without slack
3. $V(U(y), y) = K$ for all y.

Equilibrium unemployment

$$u_{t+1} = \lambda(1 - u_t) - \theta(U)^{1-\alpha} u_t \tag{4}$$

Deterministic Equilibrium (I)

$y'|y$ is degenerate, so that $y'|y = y$ with probability 1.

- **Free Entry**

$$K = \left[\frac{y - (1-\beta)U}{1-\beta(1-\lambda)} - \phi - C(U)\right] A$$

- **Optimal Size**

$$A = \frac{\frac{y_0 y}{1-\beta(1-\lambda)}}{\phi + C(U) - \frac{y - x(y) - (1-\beta)U}{1-\beta(1-\lambda)}}$$

- **Search Capital**

$$C(U) = \kappa \left[\rho(y)U - z\right]^{\alpha}$$

Deterministic Equilibrium (II): Results

Result

The following holds:

- *If the economy is sufficiently productive, the equilibrium exists and it is unique.*
- *Financial frictions reduce the value of unemployment and increase the unemployment rate.*
- *An increase in productivity increases firm size A (and reduces profit per worker)*

Deterministic Equilibrium (II): unemployment volatility and financial frictions

We compare our model with a benchmark model with constant firm size $A = \bar{A}$

Result

- *Compared with the fixed-size case, our model exhibits excess volatility*
- *The excess volatility of financial frictions is the sum of two effects, the pledgeability effect and the collateral effect*

Intuition: An increase in y increases firm size in our model. Financial frictions become less important. Hence unemployment responds more.

Calibration: 10 steady.s parameters+ productivity shocks

- **Basic Values** β, y, z, α Set from literature
  - unemployed income $z = 0.5$ (Shimer versus Hagedorn Manovski)
  - matching elasticity $\alpha = 0.5$
- **Key Labor Market Moments matched** m, c, λ
  - i) job finding probability; ii) market tightness; iii) average unemployment
- **Leverage** $K/yo, x, \phi$
  - $lev = \frac{\text{Total Asset}}{\text{equity}} = \frac{(C(U)+\phi)A+K}{K}$
  - Kalemili-Ozcan (2013), leverage in non-listed non-financial firms in 2006

Productivity, Pleadgeability and Collateral Effects

- Pure productivity ye^{ϵ_t}: Standard BC literature ρ, σ^2
- Pledgeability effect $x(y_t) = xye^{-\gamma\epsilon_t}$
  - γ is the elasticity of x wrt y, $\eta(y)$.
- How large is the change in pledgeability?
  - Relative pledgeable income $\nu(y = 1) = \frac{y - x(y)}{y} = .9$ in s.s.
  - $\nu(y = 0.96, \gamma = 6) = \frac{0.96 - 0.13}{0.96} = 0.87$
- Collateral effect $\frac{yoye^{\epsilon_t}}{1-\beta} = ye^{\epsilon_t}$
  - Pure productivity effect on collateral

Table: Matching the Calibration Target

	Target	Source	Value	
			Data	Model
1.	Average Job Finding Rate,	Shimer (2005)	0.8336	0.8366
2.	Average Market tightness, θ	Hagedorn Manovski (2008)	0.634	0.6634
3.	Firm Leverage , *lev*	Kalemli-Ozcan et al. (2011)	2.4	2.3990

Based on Shimer (2005) monthly probability of not finding a job set at 0.55

Source: Authors' calculation

Parameter	Notation	Value
Pure Discount Rate	β	0.990
Baseline productivity	y	1.000
Unemployed income	z	0.500
Exit rate	λ	0.053
Matching function elasticity	α	0.500
Matching function parameter	m	1.027
Search cost parameter	c	0.457
Own income flow	y_o	0.010
Financial friction	x	0.100
Entry cost	k	4.878
Price of capital	ϕ	1.137
Productivity Values		
Persistence of productivity process	ρ	0.970
Variance of innovation in productivity process	σ	0.007
Number of states	n	3.000
Withd of the state space	b	1.200
Maximum pledgeability effect	$\gamma(max)$	6.000
Equilibrium Values		
Value of unemployment	U	80.000
Firm size	A	3.695
Labor market frictions	$C(U)$	0.724
Job finding probability	$p(\theta(U))$	0.837
Vacancy unemployment ratio	$\theta(U)$	0.663
Unemployment rate	u	0.060
Leverage	lev	2.410

The Analytics of the Amplification

Table: Amplification with Endogenous Leverage

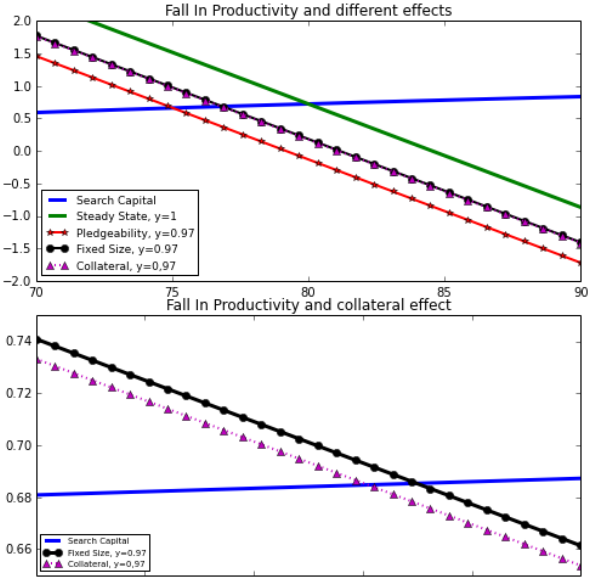
	Model	Effect	$\Psi_{U,y}$ Welfare vs Productivity	$\Psi_{u,y}$ Unemployment Rate vs productivity
(1)	Fixed Size [a]	$\frac{1}{1-\beta}$	1.25	1.01
(2)	Endog. Lev [b]	$\frac{\tilde{K}}{(y+\tilde{K})^2} y^2 x$	0.001	0.002
(3)	Endog. Lev [c]	$\frac{\tilde{K}}{(y+\tilde{K})} \frac{\gamma x y}{1-\beta}$	0.62	0.50
	Total Effect		1.872	1.521

[a] Model with fixed and maximum capacity of new firms $A = \overline{A}$

[b] Model with endogenous leverage and and capacity of new firms $A = A(U)$ and fixed non pledgeable income x. Pure collateral effect

[b] Model with endogenous leverage and and capacity of new firms $A = A(U)$

Figure: Decomposition of Productivity Effects: Steady State



Financial Shocks and Unemployment

- Productivity is constant at its steady state value y.
- Financial shocks in the form of pledgeability shock.

$$x_t = xe^{z_t} \tag{5}$$

$$z_t = \rho_z z_t + \omega_t$$

- A discrete approximation of x_t ; $x_1, ..., x_n$ and a stochastic matrix P^x

$$p^x_{if} = prob[x_t = i | x_{t-1} = j]$$

- Financial shocks affect directly the financial multiplier and the firm size (and indirectly U and S).

Calibrating Financial Shocks

- ρ_z, the persistence of the liquidity shock
  - Most severe adverse financial conditions take place at very low frequencies. Systemic financial crises take place every 45 years.
- σ^2_ω, the variance of the innovation of the financial shock.
  - A firm (and the economy) is in financial distress when internal funding completely dries up.
  - There exist a distress level of pledgeability x_d such that internal liquidity is zero

$$x_d : \frac{y - (1-\beta)U - x_d}{1 - \beta(1-\lambda)} \approx 0 \tag{6}$$

Table: Steady States with average liquidity and with Financial Distress

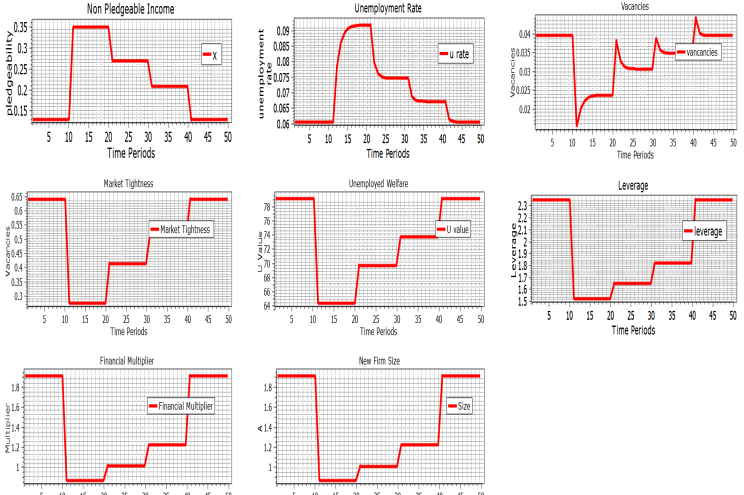
	Model	Plead. income	profits	Size	Welfare	Int Liq	Mkt Tightness
		$\nu(x)$	π	A	U		θ
(4)	Average liquidity [a]	0.90	1.320	3.69	80	0.10	0.66
(5)	Financial Distress [b]	0.57	5.62	0.86	55.51	0.01	0.12

[a] Model with endogenous leverage and pledgeable income calibrated as in the baseline model of Table **??**
[b] Model with endogenous leverage and a pledgeable income to distress level.
See main text for steady state equations

Sources: Author's calculation.

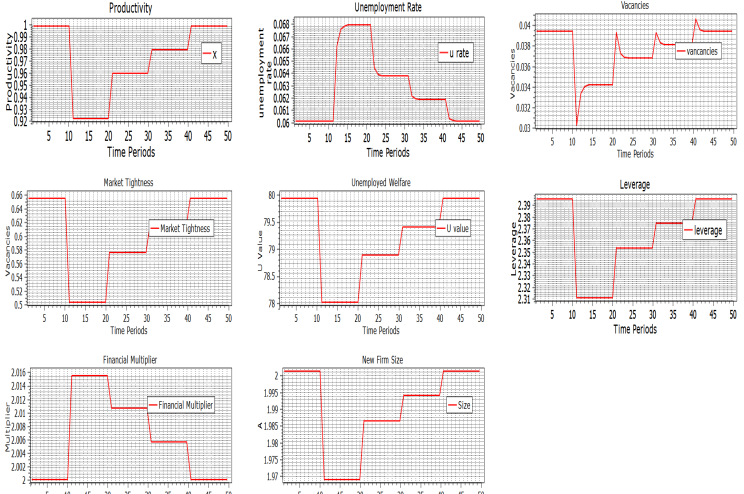
Impulse Response Function to an Extreme Financial Shock

Figure: One Time Financial Shock



One Time Productivity Shock

Figure: One Time Productivity Shock



Conclusion

- We introduced financial frictions a-lá Holmstrom and Tirole into a DMP model.
- Financial frictions increase unemployment volatility, through two channels
  - The collateral channel
  - The pledgeability channel
  - Only the second one is important quantitatively
- Financial frictions shocks increase unemployment drammatically
- Many issues to be explored
  - Calibration of financial shocks
  - Calibration to Europe

Model with Endogenous Size

Table: Simulation Statistics: Baseline Model

	y	U	C(.)	A	k	v	θ	u	$p(\theta)$	lev
y	1.00	1.00	1.00	0.86	-0.75	0.90	1.00	-0.71	1.00	0.99
U		1.00	1.00	0.85	-0.77	0.90	1.00	-0.71	1.00	0.99
C			1.00	0.85	-0.76	0.90	1.00	-0.71	1.00	0.99
A				1.00	-0.31	0.76	0.85	-0.61	0.85	0.92
k					1.00	-0.69	-0.76	0.55	-0.76	-0.66
v						1.00	0.90	-0.35	0.90	0.89
θ							1.00	-0.71	1.00	0.99
u								1.00	-0.71	-0.71
$p(\theta)$									1.00	0.99
Standard Deviations (%)										
	0.99	0.34	1.52	0.19	0.16	2.23	3.04	1.38	0.99	0.19

Source: Authors' calculation

The Model with Fixed Size

Table: Simulation Statistics: Baseline Model with Fixed Size

	y	U	C(.)	A	k	v	θ	u	$p(\theta)$	lev
y	1.00	1.00	1.00	-0.02	.	0.90	1.00	-0.71	1.00	1.00
U		1.00	1.00	-0.02	.	0.90	1.00	-0.71	1.00	1.00
C			1.00	-0.02	.	0.90	1.00	-0.71	1.00	1.00
A				1.00	.	-0.02	-0.02	0.01	-0.02	-0.02
k										
v						1.00	0.90	-0.34	0.90	0.90
θ							1.00	-0.71	1.00	1.00
u								1.00	-0.71	-0.71
$p(\theta)$									1.00	1.00
Standard Deviations (%)										
	0.99	0.33	1.51	0.00	.	2.24	3.02	1.38	0.99	0.00

Source: Authors' calculation

US economy between 2007 and 2009

- Job openings: fell from 3.2 percent in 2007(II) to 1.8 percent in 2009.
- Unemployment: rose from 5.2 in 2007(II) to 9% in 2009 and 10% in 2010.
- Productivity: did not fall;
- Financial crisis time line starts in 2007(I)
  - February 2007: Freddie Mac announced that was no longer buying sub-prime mortgages
  - April 2007 New Century Financial Corporation, a leading sub-prime lender, filed for Chapter 11.
  - June 2007 Bear Stearns suspended redemptions from one of its Structured Leveraged Funds.