Equilibrium Default and the Unemployment Accelerator

Julio Blanco
University of Michigan

Gaston Navarro
Federal Reserve Board

December 2015

Motivation

- **Macro-finance** models: financial frictions typically affect investment
  - ⇒ hard to obtain large contractions in output and employment

Motivation

- **Macro-finance** models: financial frictions typically affect investment

  $\Rightarrow$ hard to obtain large contractions in output and employment

- **Recent work:** link between financial conditions and labor costs

  (Jermann & Quadrini, 2012), (Monacelli, Quadrini & Trigari, 2014), (Petrosky-Nadeau, 2014)

  financial conditions $\Rightarrow$ labor market

Motivation

- **Macro-finance** models: financial frictions typically affect investment

  $\Rightarrow$ hard to obtain large contractions in output and employment

- **Recent work:** link between financial conditions and labor costs

  (Jermann & Quadrini, 2012), (Monacelli, Quadrini & Trigari, 2014), (Petrosky-Nadeau, 2014)

  financial conditions $\Rightarrow$ labor market

- **This paper**: *labor is an asset* for the firm

Motivation

- **Macro-finance** models: financial frictions typically affect investment

  $\Rightarrow$ hard to obtain large contractions in output and employment

- **Recent work:** link between financial conditions and labor costs

  (Jermann & Quadrini, 2012), (Monacelli, Quadrini & Trigari, 2014), (Petrosky-Nadeau, 2014)

  financial conditions $\Rightarrow$ labor market

- **This paper**: *labor is an asset* for the firm

  + link labor market and financial conditions
  + *value of a worker* affects financial conditions!

  labor market $\Leftrightarrow$ financial conditions

Motivation

- **Macro-finance** models: financial frictions typically affect investment

  $\Rightarrow$ hard to obtain large contractions in output and employment

- **Recent work:** link between financial conditions and labor costs

  (Jermann & Quadrini, 2012), (Monacelli, Quadrini & Trigari, 2014), (Petrosky-Nadeau, 2014)

  financial conditions $\Rightarrow$ labor market

- **This paper**: *labor is an asset* for the firm
  - + link labor market and financial conditions
  - + *value of a worker* affects financial conditions!

  labor market $\Leftrightarrow$ financial conditions

- *labor market* accounts for a large fraction of financial market fluctuations

Main idea: labor market affects financial market

- Firm with productivity x, wage w, n workers and debt $\bar{b}$.

Main idea: labor market affects financial market

- Firm with productivity x, wage w, n workers and debt $\bar{b}$.
- Search friction: $x > w$ (Pissarides, 1985)
- Value of a worker

$$S = \underbrace{(x - w)}_{>0} + \beta S' > 0$$

Main idea: labor market affects financial market

- Firm with productivity x, wage w, n workers and debt $\bar{b}$.
- Search friction: $x > w$ (Pissarides, 1985)
- Value of a worker

$$S = \underbrace{(x - w)}_{>0} + \beta S' > 0$$

- Option to default

$$\text{Default} \quad \Leftrightarrow \quad \underbrace{Sn - \bar{b}}_{\text{value of no defaulting}} < 0 \quad \Leftrightarrow \quad S < \frac{\bar{b}}{n}$$

Main idea: labor market affects financial market

- Firm with productivity x, wage w, n workers and debt $\bar{b}$.
- Search friction: $x > w$ (Pissarides, 1985)
- Value of a worker

$$S = \underbrace{(x - w)}_{>0} + \beta S' > 0$$

- Option to default

$$\text{Default} \quad \Leftrightarrow \quad \underbrace{Sn - \bar{b}}_{\text{value of no defaulting}} < 0 \quad \Leftrightarrow \quad S < \frac{\bar{b}}{n}$$

- Main mechanism

$$\Downarrow S \Rightarrow \Uparrow \text{Default} \Rightarrow \Uparrow \text{Borrowing costs} \Rightarrow \Downarrow S$$

Findings

Model:

- Fluctuations in the *labor market*
  - explain 68% of credit spreads volatility . . .
  - . . . and 80% of default rates volatility.

Evidence: (very preliminary!)

- A 10% decline in employment volatility
  - *associated* with a 4% decline in default rates volatility...

Model

Environment

- **Demography**: Family with measure one of workers, and firms.
- **Preferences**: $\mathbb{E}_0[\sum_{t=0}^{\infty} \beta^t C_t]$.
- **Technology**: $y_i = x a_i n_i$.
- **Shocks**: $a_i \sim H$ *i.i.d.* across firms and time;
  x follow a Markov process.
- **Labor Market**: search friction as in of Mortensen-Pissarides (1994).
- **Capital Market**: firms' debt, *subject to default risk*.
  - Upon **default**, a firm disappears.
  - **Long-term debt**: a fraction λ matures every period.

Timing of events

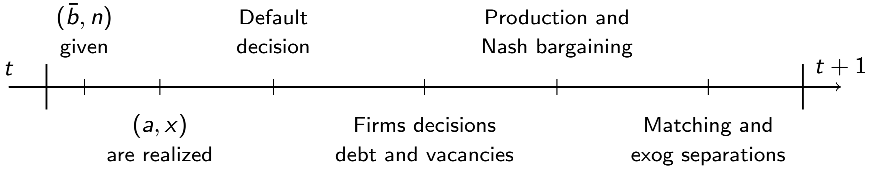


Figure: Timing of events in period t

Firm's problem

$$
\begin{aligned}
E(a,\bar{b},n,z) &= \max_{d,nd}\left\{0, \max_{\mu=\{d,\bar{v},\bar{b}'\}} \left\{d+\beta\mathbb{E}_{z',a'}\left[E(a',\bar{b}',n',z')|z\right]\right\}\right\} \\
\text{subject to} & \\
y &= axn - w(a,b,z,\mu)n - (1-\tau)\lambda\bar{b} \\
d+\kappa\bar{v} &\leq y + p(b',z)\overbrace{\left[\bar{b}'-(1-\lambda)\bar{b}\right]}^{\text{new debt}} \\
n' &= (1-s)n + \bar{v}q(z)
\end{aligned}
$$

with $b' = \bar{b}'/n'$

a = firm's productivity, $\bar{b}$ = debt, n = workers, z = aggregate state

$\bar{v}$ = vacancies, q = prob of filling a vacancy

Firms cont'd

Lemma

Firm's value function is linear: $E(a, \bar{b}, n, z) = e(a, b, z)n$.

Policies are linear in n and independent of y

$$\begin{aligned} \bar{v}(a, \bar{b}, n, z) &= \boldsymbol{v}(b, z)n \\ \bar{b}'(a, \bar{b}, n, z) &= \boldsymbol{b}'(b, z)n \end{aligned}$$

Default follows a productivity threshold decision $\underline{\boldsymbol{a}}(b, z)$:

$$\begin{cases} \text{default} & \text{if } a \leq \underline{\boldsymbol{a}}(b, z) \\ \text{no default} & \text{if } a \leq \underline{\boldsymbol{a}}(b, z) \end{cases}$$

Firms cont'd

Lemma

Firm's value function is linear: $E(a, \bar{b}, n, z) = e(a, b, z)n$.

Policies are linear in n and independent of y

$$\begin{aligned} \bar{v}(a, \bar{b}, n, z) &= \boldsymbol{v}(b, z)n \\ \bar{b}'(a, \bar{b}, n, z) &= \boldsymbol{b}'(b, z)n \end{aligned}$$

Default follows a productivity threshold decision $\underline{\boldsymbol{a}}(b, z)$:

$$\begin{cases} \text{default} & \text{if } a \leq \underline{\boldsymbol{a}}(b, z) \\ \text{no default} & \text{if } a \leq \underline{\boldsymbol{a}}(b, z) \end{cases}$$

Notation: Let b denote a firm's debt per worker and B the average debt per worker over firms.

Workers

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

Workers

Household

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

- Value of unemployment $\mathcal{U}(z)$

$$\mathcal{U}(z) = \bar{u} + \beta \mathbb{E}_{a',z'} \left[f(z)\mathcal{W}(a', B(z'), z') + (1 - f(z))\mathcal{U}(z') | z \right]$$

Workers

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

- Value of unemployment $\mathcal{U}(z)$

$$\mathcal{U}(z) = \bar{u} + \beta \mathbb{E}_{a',z'} \left[f(z)\mathcal{W}(a', B(z'), z') + (1 - f(z))\mathcal{U}(z')|z \right]$$

- If $a > \underline{\boldsymbol{a}}(b, z)$, value of being employed $\mathcal{W}(a, b, z)$

$$\mathcal{W}(a, b, z) = w(a, b, z) + \beta \mathbb{E}_{a',z'} \left[(1 - s)\mathcal{W}(a', \boldsymbol{b}'(b, z), z') + s\mathcal{U}(z')|z \right]$$

Workers

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

- Value of unemployment $\mathcal{U}(z)$

$$\mathcal{U}(z) = \bar{u} + \beta \mathbb{E}_{a',z'} \left[f(z)\mathcal{W}(a', B(z'), z') + (1 - f(z))\mathcal{U}(z') | z \right]$$

- If $a > \underline{\boldsymbol{a}}(b, z)$, value of being employed $\mathcal{W}(a, b, z)$

$$\mathcal{W}(a, b, z) = w(a, b, z) + \beta \mathbb{E}_{a',z'} \left[(1 - s)\mathcal{W}(a', \boldsymbol{b}'(b, z), z') + s\mathcal{U}(z') | z \right]$$

- If $a \leq \underline{\boldsymbol{a}}(b, z)$, $\mathcal{W}(a, b, z) = \mathcal{U}(z)$

Workers

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

- Value of unemployment $\mathcal{U}(z)$

$$\mathcal{U}(z) = \bar{u} + \beta \mathbb{E}_{a', z'} \left[f(z)\mathcal{W}(a', B(z'), z') + (1 - f(z))\mathcal{U}(z') | z \right]$$

- If $a > \underline{\boldsymbol{a}}(b, z)$, value of being employed $\mathcal{W}(a, b, z)$

$$\mathcal{W}(a, b, z) = w(a, b, z) + \beta \mathbb{E}_{a', z'} \left[(1 - s)\mathcal{W}(a', \boldsymbol{b}'(b, z), z') + s\mathcal{U}(z') | z \right]$$

- If $a \leq \underline{\boldsymbol{a}}(b, z)$, $\mathcal{W}(a, b, z) = \mathcal{U}(z)$
- Let $g(a, b, z) = \mathcal{W}(a, b, z) - \mathcal{U}(z)$ be the worker's surplus.

Workers

Household

Let $\mathcal{W}(a, b, z)$ and $\mathcal{U}(z)$ be the vale of being employed and unemployed.

- Value of unemployment $\mathcal{U}(z)$

$$\mathcal{U}(z) = \bar{u} + \beta \mathbb{E}_{a',z'} \left[f(z)\mathcal{W}(a', B(z'), z') + (1 - f(z))\mathcal{U}(z') | z \right]$$

- If $a > \underline{\boldsymbol{a}}(b, z)$, value of being employed $\mathcal{W}(a, b, z)$

$$\mathcal{W}(a, b, z) = w(a, b, z) + \beta \mathbb{E}_{a',z'} \left[(1 - s)\mathcal{W}(a', \boldsymbol{b}'(b, z), z') + s\mathcal{U}(z') | z \right]$$

- If $a \leq \underline{\boldsymbol{a}}(b, z)$, $\mathcal{W}(a, b, z) = \mathcal{U}(z)$
- Let $g(a, b, z) = \mathcal{W}(a, b, z) - \mathcal{U}(z)$ be the worker's surplus.

Wages

- Wages given by Nash bargaining. more
- γ firm's bargaining power.

Aggregates

- Matching function

$$f = \frac{m(V,U)}{U} \quad \text{and} \quad q = \frac{m(V,U)}{V}$$

- Unemployment

$$U(z) = (1 - N) + \underbrace{H(\underline{\boldsymbol{a}}(b,z))}_{\text{endogenous separation}} N$$

- Law of motion for labor

$$N' = (1 - s)\left[1 - H(\underline{\boldsymbol{a}}(b,z))\right] N + f(z)U(z)$$

- State of the economy $z = (x, B, N)$.

Equilibrium Definition

Model Characterization

Assumptions

Assumption

1. *One period debt* $\lambda = 1$*.*
2. *A Cobb-Douglas matching function:* $m(U, V) = U^{1-\nu} V^{\nu}$*.*

A "Fictional Planner"

more

- Let $S(a, b, z) = e(a, b, z) + g(a, b, z)$ be the surplus of a match

A "Fictional Planner"

more

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the surplus of a match

Proposition

For a given firm policies - b', v and $\underline{a}$- the surplus of a match is

$$
\begin{aligned}
= & \quad \Big\{0, \quad \Big\{ax - \bar{u} - \kappa v \\
- & \quad \underbrace{(1-\tau)b + p(b',z)b'\left[(1-s) + q(z)v\right]}_{\text{Debt outflow}} \\
+ & \quad (1-s)\beta \underbrace{\mathbb{E}_{a',z'}\left[S(a',b',z')|z\right]}_{\text{continuation value of a match}} \\
+ & \quad \beta\mathbb{E}_{a',z'}[\underbrace{q(z)v\gamma S(a',b',z')}_{\text{Firm's growth}} - \underbrace{f(z)(1-\gamma)S(a',B(z'),z')}_{\text{Workers outside value}}|z]\Big\}\Big\}
\end{aligned}
$$

A "Fictional Planner"

more

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the surplus of a match

Proposition

For a given firm policies - b', v and $\underline{a}$- the surplus of a match is

$$
\begin{aligned}
= \quad & \max_{d,nd}\left\{0, \max_{v,b'}\left\{ax - \bar{u} - \kappa v\right.\right. \\
- \quad & \underbrace{(1-\tau)b + p(b',z)b'\left[(1-s) + q(z)v\right]}_{\text{Debt outflow}} \\
+ \quad & (1-s)\beta \underbrace{\mathbb{E}_{a',z'}\left[S(a',b',z')|z\right]}_{\text{continuation value of a match}} \\
+ \quad & \left.\left.\beta\mathbb{E}_{a',z'}[\underbrace{q(z)v\gamma S(a',b',z')}_{\text{Firm's growth}} - \underbrace{f(z)(1-\gamma)S(a',B(z'),z')}_{\text{Workers outside value}}|z]\right\}\right\}
\end{aligned}
$$

A "Fictional Planner"

more

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the surplus of a match

Proposition

Firm's policies - $\mathbf{b}'(\cdot)$, $\mathbf{v}(\cdot)$ *and* $\underline{\mathbf{a}}(\cdot)$ *- maximize the the joint surplus, and solve*

$$\begin{aligned} S(a,b,z) &= \max_{d,nd}\Big\{0, \max_{v,b'}\Big\{ax - \bar{u} - \kappa v \\ &- \underbrace{(1-\tau)b + p(b',z)b'\left[(1-s) + q(z)v\right]}_{\text{Debt outflow}} \\ &+ (1-s)\beta \underbrace{\mathbb{E}_{a',z'}\left[S(a',b',z')|z\right]}_{\text{continuation value of a match}} \\ &+ \beta\mathbb{E}_{a',z'}[\underbrace{q(z)v\gamma S(a',b',z')}_{\text{Firm's growth}} - \underbrace{f(z)(1-\gamma)S(a',B(z'),z')}_{\text{Workers outside value}}|z]\Big\}\Big\} \end{aligned}$$

A "Fictional Planner"

more

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the surplus of a match

Proposition

Firm's policies - $\mathbf{b}'(\cdot)$, $\mathbf{v}(\cdot)$ and $\underline{\mathbf{a}}(\cdot)$ - maximize the the joint surplus, and solve

$$\begin{aligned} S(a,b,z) &= \max_{d,nd}\Big\{0, \max_{v,b'}\Big\{ax - \bar{u} - \kappa v \\ &- \underbrace{(1-\tau)b + p(b',z)b'\left[(1-s) + q(z)v\right]}_{\text{Debt outflow}} \\ &+ (1-s)\beta \underbrace{\mathbb{E}_{a',z'}\left[S(a',b',z')|z\right]}_{\text{continuation value of a match}} \\ &+ \beta\mathbb{E}_{a',z'}[\underbrace{q(z)v\gamma S(a',b',z')}_{\text{Firm's growth}} - \underbrace{f(z)(1-\gamma)S(a',B(z'),z')}_{\text{Workers outside value}}|z]\Big\}\Big\} \end{aligned}$$

+ Only equation to solve in the model!

Default responds to labor market conditions

Exercise

In equilibrium, default threshold is given as

$$\underline{\boldsymbol{a}}(b,z) = \frac{1}{x}\Big[\overbrace{(1-\tau)b - p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)(1-s)}^{\text{Debt outflow}} - \bar{u}\dots$$
$$- \quad (1-s-f(z)(1-\gamma))\,\beta\,\underbrace{\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}_{\text{Value of a match}}\Big]$$

+ Financial market component: Debt b and bond price $p(\boldsymbol{b}'(\cdot),z)$.
+ Labor market component: Joint surplus $S(a',\boldsymbol{b}'(\cdot),z')$

Default responds to labor market conditions

Exercise

In equilibrium, default threshold is given as

$$\underline{\boldsymbol{a}}(b,z) = \frac{1}{x}\Big[\overbrace{(1-\tau)b - p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)(1-s)}^{\text{Debt outflow}} - \bar{u}\ldots$$

$$- (1-s-f(z)(1-\gamma))\,\beta\,\underbrace{\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}_{\text{Value of a match}}\Big]$$

+ Financial market component: Debt b and bond price $p(\boldsymbol{b}'(\cdot),z)$.
+ Labor market component: Joint surplus $S(a',\boldsymbol{b}'(\cdot),z')$

Worsening in the **value of a match** $\Rightarrow$ Worsening in **financial conditions**

Financial value of a worker

- **Value of a match** if $a > \underline{\boldsymbol{a}}(b,z)$

$$S(a,b,z) = \overbrace{xa - \bar{u} + (1-s+f(z)(1-\gamma))\,\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}^{\text{Standard DMP}} \dots$$

$$- \underbrace{(1-\tau)b + p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)\left[(1-s)+q(z)\boldsymbol{v}(\cdot)\right]}_{\text{Debt outflow}}$$

Financial value of a worker

- **Value of a match** if $a > \underline{\boldsymbol{a}}(b,z)$

$$S(a,b,z) = \overbrace{xa - \bar{u} + (1 - s + f(z)(1-\gamma))\,\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}^{\text{Standard DMP}} \ldots$$

$$- \underbrace{(1-\tau)b + p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)\left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right]}_{\text{Debt outflow}}$$

- **Free entry condition**

$$\kappa \underbrace{f(z)^{\frac{1-\nu}{\nu}}}_{1/q(z)} = \underbrace{p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)}_{\text{Financial value}} + \underbrace{\gamma\beta\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}_{\text{Standard DMP}}$$

more

Financial value of a worker

- **Value of a match** if $a > \underline{\boldsymbol{a}}(b, z)$

$$S(a,b,z) = \overbrace{xa - \bar{u} + (1 - s + f(z)(1-\gamma))\,\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}^{\text{Standard DMP}} \ldots$$

$$- \underbrace{(1-\tau)b + p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)\left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right]}_{\text{Debt outflow}}$$

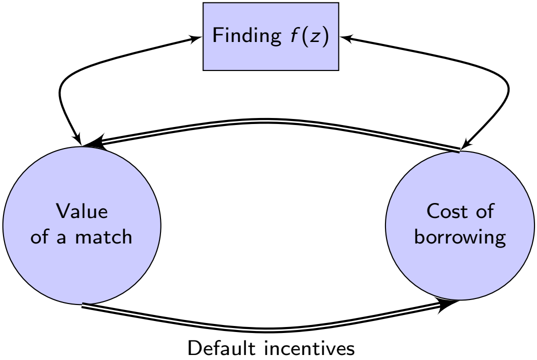
- **Free entry condition**

$$\kappa \underbrace{f(z)^{\frac{1-\nu}{\nu}}}_{1/q(z)} = \underbrace{p(\boldsymbol{b}'(\cdot),z)\boldsymbol{b}'(\cdot)}_{\text{Financial value}} + \underbrace{\gamma\beta\mathbb{E}_{a',z'}\left[S(a',\boldsymbol{b}'(\cdot),z')|z\right]}_{\text{Standard DMP}}$$

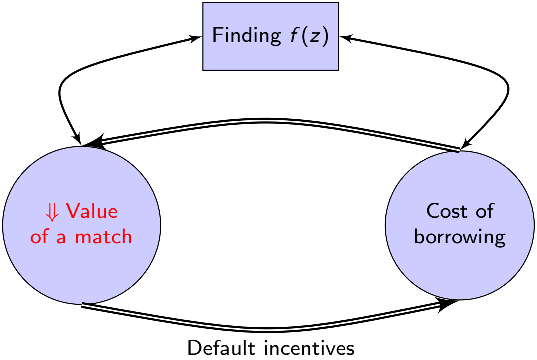
more

Worsening in **financial conditions** $\Rightarrow$ Worsening in the **value of a match**

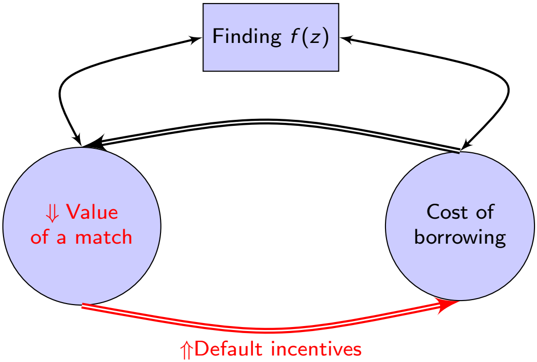
Unemployment Accelerator



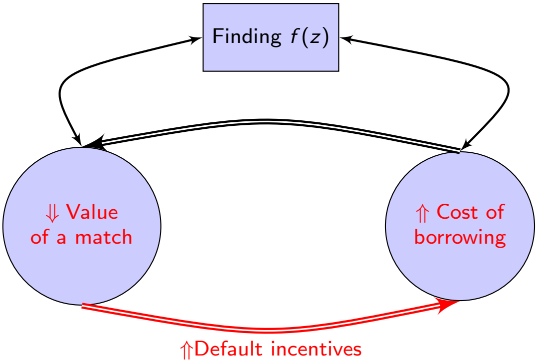
Unemployment Accelerator



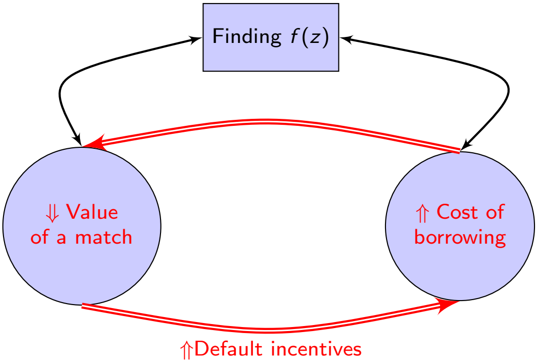
Unemployment Accelerator



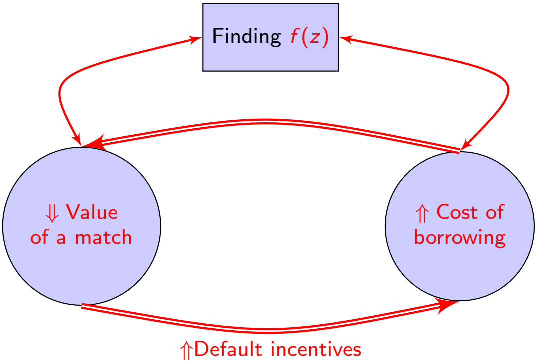
Unemployment Accelerator



Unemployment Accelerator



Unemployment Accelerator



Model Evaluation

Calibration

Full calibration

- Institutional parameters
  - Tax benefit $\tau = 13\%$ - U.S. Government Accountability Office (2013)
  - Maturity $\lambda = 1/24$ - average maturity of 2 years more

Calibration

Full calibration

- Institutional parameters
  - Tax benefit $\tau = 13\%$ - U.S. Government Accountability Office (2013)
  - Maturity $\lambda = 1/24$ - average maturity of 2 years more
- Technology
  - Porductivity $\ln a \sim N(-\frac{1}{2}\sigma_a^2, \sigma_a^2)$ with $\sigma_a = 0.2$, match annual default of 1%.
  - Aggregate productivity: $\ln x \sim AR(1)$ with $(\rho_x, \sigma_x) = (0.98, 0.005)$.

Calibration

Full calibration

- Institutional parameters
  - Tax benefit $\tau = 13\%$ - U.S. Government Accountability Office (2013)
  - Maturity $\lambda = 1/24$ - average maturity of 2 years more
- Technology
  - Porductivity $\ln a \sim N(-\frac{1}{2}\sigma_a^2, \sigma_a^2)$ with $\sigma_a = 0.2$, match annual default of 1%.
  - Aggregate productivity: $\ln x \sim AR(1)$ with $(\rho_x, \sigma_x) = (0.98, 0.005)$.
- Labor market:
  - Unemployment benefit $\bar{u} = 0.6$, Shimer (2005) and Hagedorn-Manovskii (2008)

Calibration

Full calibration

- Institutional parameters
  - Tax benefit $\tau = 13\%$ - U.S. Government Accountability Office (2013)
  - Maturity $\lambda = 1/24$ - average maturity of 2 years more
- Technology
  - Porductivity $\ln a \sim N(-\frac{1}{2}\sigma_a^2, \sigma_a^2)$ with $\sigma_a = 0.2$, match annual default of 1%.
  - Aggregate productivity: $\ln x \sim AR(1)$ with $(\rho_x, \sigma_x) = (0.98, 0.005)$.
- Labor market:
  - Unemployment benefit $\bar{u} = 0.6$, Shimer (2005) and Hagedorn-Manovskii (2008)
- Global solution - piecewise linear approximation.

Business Cycle Moments

	Std. dev		Corr w/ Output	
	Data	Model	Data	Model
Finding	0.13	0.08	0.87	0.63
Unemployment	0.19	0.11	-0.88	-0.63
Credit Spreads	0.62	0.41	-0.46	-0.54
Default Rate	0.20	1.67	-0.31	-0.48

Note: *Data is monthly for the period 1951-2012. Model correlations and standard deviations are computed as average over* $50,000$ *independently simulated economies, of 61 years of length. All variables are in log deviation from an HP trend with smoothing parameter of* 10^5.

Business Cycle Moments

	Std. dev		Corr w/ Output	
	Data	Model	Data	Model
Finding	0.13	0.08	0.87	0.63
Unemployment	0.19	0.11	-0.88	-0.63
Credit Spreads	0.62	0.41	-0.46	-0.54
Default Rate	0.20	1.67	-0.31	-0.48

Note: *Data is monthly for the period 1951-2012. Model correlations and standard deviations are computed as average over* $50,000$ *independently simulated economies, of 61 years of length. All variables are in log deviation from an HP trend with smoothing parameter of* 10^5*.*

Business Cycle Moments

	Std. dev		Corr w/ Output	
	Data	Model	Data	Model
Finding	0.13	0.08	0.87	0.63
Unemployment	0.19	0.11	-0.88	-0.63
Credit Spreads	0.62	0.41	-0.46	-0.54
Default Rate	0.20	1.67	-0.31	-0.48

Note: *Data is monthly for the period 1951-2012. Model correlations and standard deviations are computed as average over* $50,000$ *independently simulated economies, of 61 years of length. All variables are in log deviation from an HP trend with smoothing parameter of* 10^5.

Model Response to a productivity shock

Separation shock

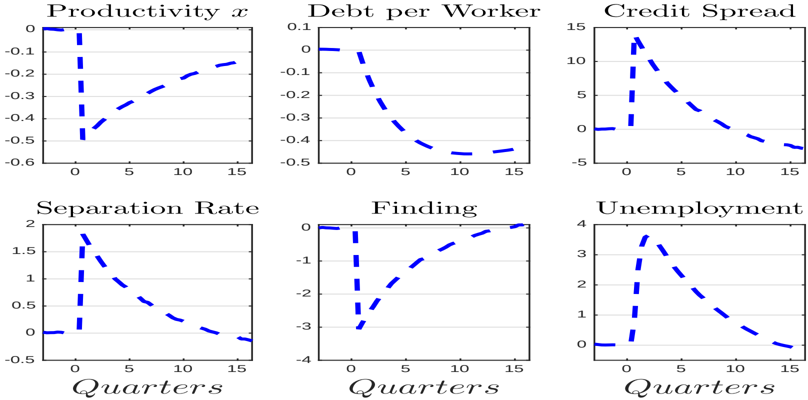


Figure: Model Response to a productivity shock

Note: *Impulse responses correspond to the average over* 50,000 *independently simulated economies, all with the same productivity innovation at* $t = 0$.

Evaluating the mechanism

What is the effect of movements *in the* **labor market** *on the* **financial market**?

Evaluating the mechanism

What is the effect of movements *in the* **labor market** *on the* **financial market**?

Exercise:

- Default threshold depends on $f(z)$ and $S(a, B, z)$. more

Evaluating the mechanism

What is the effect of movements *in the* **labor market** *on the* **financial market**?

Exercise:

- Default threshold depends on $f(z)$ and $S(a, B, z)$. more
- Endow the government with two instruments
  - A transfer to firms $T(z)$.
  - A vacancy posting subsidy $T^v(z)$.

Evaluating the mechanism

What is the effect of movements *in the* **labor market** *on the* **financial market**?

Exercise:

- Default threshold depends on $f(z)$ and $S(a, B, z)$. more
- Endow the government with two instruments
  - A transfer to firms $T(z)$.
  - A vacancy posting subsidy $T^v(z)$.
- Set $T(z)$ and $T^v(z)$ such that

$$f(z) = f^* \quad \text{and} \quad \mathbb{E}_a \left[S(a, B, z) \right] = S^*$$

Evaluating the mechanism

What is the effect of movements *in the* **labor market** *on the* **financial market**?

Exercise:

- Default threshold depends on $f(z)$ and $S(a, B, z)$. more
- Endow the government with two instruments
  - A transfer to firms $T(z)$.
  - A vacancy posting subsidy $T^v(z)$.
- Set $T(z)$ and $T^v(z)$ such that

$$f(z) = f^* \quad \text{and} \quad \mathbb{E}_a\left[S(a, B, z)\right] = S^*$$

- Compare business cycle statistics in both models.

Evaluating the mechanism

	Data	Full Model	Fix f and S
Finding	0.13	0.08	-
Unemployment	0.19	0.11	0.004
Credit Spreads	0.62	0.41	0.13
Default Rate	0.20	1.67	0.36

Note: *Model is mean and standard deviation over 50,000 bootstrap simulations with simulation length of 61 years. All variables are log as deviation from an HP trend with smoothing parameter* 10^5.

+ Labor market accounts for 68% and 80% of credit spreads and default fluctuations rate, respectively

Evidence

(very, very, very preliminary ...)

Evidence: Distance to Default

Want:

- Link between volatility of labor market and firms' default risk ...
- *ceteris paribus:* more volatile labor markets $\Rightarrow$ more volatile dfault risk

Evidence: Distance to Default

Want:

- Link between volatility of labor market and firms' default risk . . .
- *ceteris paribus:* more volatile labor markets ⇒ more volatile dfault risk

Idea:

- Compute a measure of firms' default risk
  - Distance to Default Merton's model DD Graph

    (Gilchrist & Zakrajsek, 2009), (Duffie, 2009)

Evidence: Distance to Default

Want:

- Link between volatility of labor market and firms' default risk ...
- *ceteris paribus:* more volatile labor markets ⇒ more volatile dfault risk

Idea:

- Compute a measure of firms' default risk
  - Distance to Default Merton's model DD Graph

    (Gilchrist & Zakrajsek, 2009), (Duffie, 2009)

- Control default risk by factors other than employment.

Evidence: Distance to Default

Want:

- Link between volatility of labor market and firms' default risk . . .
- *ceteris paribus:* more volatile labor markets ⇒ more volatile dfault risk

Idea:

- Compute a measure of firms' default risk
  - Distance to Default Merton's model DD Graph

    (Gilchrist & Zakrajsek, 2009), (Duffie, 2009)

- Control default risk by factors other than employment.
- Sectoral volatility of employment and default risk (residual).

Evidence: Volatility of default and employment

- Firm i, in sector s, at quarter t.
- Distance to default DD_{it}, and prob of default $\Phi_{it} = \Phi(-DD_{it})$

Evidence: Volatility of default and employment

- Firm i, in sector s, at quarter t.
- Distance to default DD_{it}, and prob of default $\Phi_{it} = \Phi(-DD_{it})$
- Control Φ_{it} (or DD_{it}) on many characteristics, but not employment

$$\Phi_{it} = \gamma_t^{\Phi} + \alpha_i^{\Phi} + X_{it}\beta + \epsilon_{it}^{\Phi}$$

X_{it}: assets, liabilities, investment, profits/assets, assets/market value

Evidence: Volatility of default and employment

- Firm i, in sector s, at quarter t.
- Distance to default DD_{it}, and prob of default $\Phi_{it} = \Phi(-DD_{it})$
- Control Φ_{it} (or DD_{it}) on many characteristics, but not employment

$$\Phi_{it} = \gamma_t^{\Phi} + \alpha_i^{\Phi} + X_{it}\beta + \epsilon_{it}^{\Phi}$$

X_{it}: assets, liabilities, investment, profits/assets, assets/market value

- Employment growth by sector ΔE_{st}

$$\Delta E_{st} = \gamma_t^{\Delta E} + \gamma_s^{\Delta E} + profits_{st}\beta + \epsilon_{st}^{\Delta E}$$

Evidence: Volatility of default and employment

- Firm i, in sector s, at quarter t.
- Distance to default DD_{it}, and prob of default $\Phi_{it} = \Phi(-DD_{it})$
- Control Φ_{it} (or DD_{it}) on many characteristics, but not employment

$$\Phi_{it} = \gamma_t^{\Phi} + \alpha_i^{\Phi} + X_{it}\beta + \epsilon_{it}^{\Phi}$$

X_{it}: assets, liabilities, investment, profits/assets, assets/market value

- Employment growth by sector ΔE_{st}

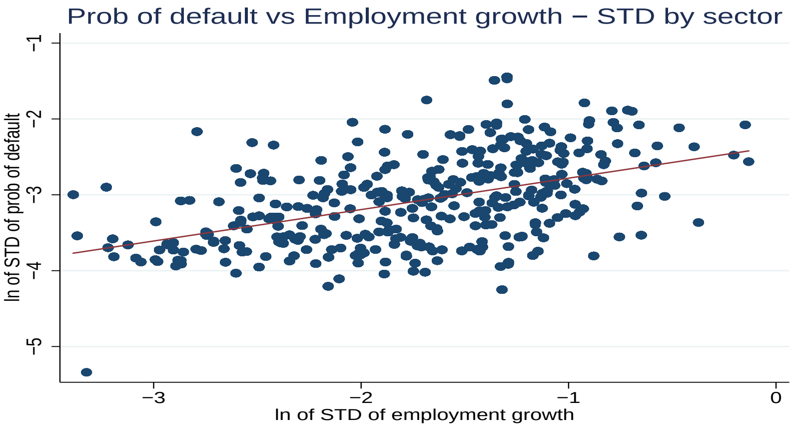
$$\Delta E_{st} = \gamma_t^{\Delta E} + \gamma_s^{\Delta E} + profits_{st}\beta + \epsilon_{st}^{\Delta E}$$

- Variances by sector:

$$\sigma_s^{2,\Phi} = \frac{1}{TN_s}\sum_{t,i\in s}\left(\epsilon_{it}^{\Phi} - \bar{\epsilon}_s^{\Phi}\right)^2 \quad \text{and} \quad \sigma_s^{2,\Delta E} = \frac{1}{TN_s}\sum_{t}\left(\epsilon_{st}^{\Delta E} - \bar{\epsilon}_s^{\Delta E}\right)^2$$

More volatile labor market, more volatile default risk

$$\ln \sigma_s^{\Phi} = 0.028 + \underset{[0.401\ 0.427]}{0.414} \ln \sigma_s^{\Delta E}, \qquad R^2 = 22\%$$



Note: *Non-financial corporate sector, period 1975q1 - 2014q4. STD on equation residuals. Data source CRSP-Compustat merged panel for 15,320 firms, 372 sectors.*

in levels | raw measures | DD measure

Next steps

Conclusions:

- Proposed an interaction between labor and financial markets ...
- ... "Unemployment accelerator" loop.
- Important amplification of financial conditions.

Next steps

Conclusions:

- Proposed an interaction between labor and financial markets . . .
- . . . "Unemployment accelerator" loop.
- Important amplification of financial conditions.

Next Steps:

- Evaluate the mechanism in a larger DSGE model
- Evidence: need more work ...

Next steps

Conclusions:

- Proposed an interaction between labor and financial markets . . .
- . . . "Unemployment accelerator" loop.
- Important amplification of financial conditions.

Next Steps:

- Evaluate the mechanism in a larger DSGE model
- Evidence: need more work ...

Thank you!!!

Appendix

Household

Return

$$
\begin{aligned}
V(\omega, z) &= \max_{\{C, b'_h(b'), \omega'\}} \left\{ U(C) + \beta \mathbb{E}_{z'}[V(\omega', z')|z] \right\} \\
\text{subject to} & \\
C &+ \int p(b', z) b'_h(b') db' + \mathbb{T}(z) \leq \omega + d(z) + \bar{u} U(z) \\
&+ \mathbb{E}_a \left[\mathbb{I}\{a \geq \underline{\boldsymbol{a}}(B(z), z)\} w(a, B(z), z) \right] \bar{N} \\
\omega' &= \int \left[1 - H(\underline{\boldsymbol{a}}(b', z')) \right] \left[\lambda + (1-\lambda) p(\boldsymbol{b}'(b', z'), z') \right] b'_h(b') db' \\
z' &= \Gamma(z)
\end{aligned}
$$

where $d(z)$ are firms' dividend payments

Nash bargaining

Return

Wages are given by

$$w(a,b,z,v,b') = \arg\max_{\vec{w}} \left\{ \tilde{e}(a,b,z,v,b')_w^{\gamma} \tilde{g}(a,b,z,v,b')_w^{1-\gamma} \right\}$$

where

$$\begin{aligned} \tilde{e}(a,b,z,v,b')_w &= ax - w - \kappa v - (1-\tau)\lambda b \\ &+ p(b',z)\left[b'[(1-s)+vq(z)] - (1-\lambda)b\right] \\ &+ [(1-s)+vq(z)]\beta\mathbb{E}_{a',z'}\left[e(a',b',z')|z\right] \end{aligned}$$

$$\begin{aligned} \tilde{g}(a,b,z,b')_w &= w - \bar{u} + \\ &+ \beta\mathbb{E}_{a',z'}\left[(1-s)g(a',b',z') - f(z)g(a',B(z'),z')|z\right] \end{aligned}$$

and $\vec{w} = \{w(a,b,z,b')\}$

Equilibrium definition

Return

Definition

A recursive equilibrium is given by **value functions**: $\{E, \mathcal{W}, \mathcal{U}, V\}$; **policies** for the firm $\{\bar{b}', \bar{v}, d\}$, the household $\{C, b_h'\}$; probabilities $\{f, q\}$; and prices $\{p(b'), w\}$ such that

- Agents optimize and achieve values E, $\mathcal{W}$, $\mathcal{U}$, and V.
- Wages w solve the Nash bargaining problem.
- (Walrasian) markets clear:
  - Bonds market: $\int b'(a, \bar{b}, n, z) = b_h(b', z)$
  - Goods market: $Y(z) = C(z) + \int \bar{v}(a, \bar{b}, n, z)$

A "Fictional Planner"

Return

- Let $S(a, b, z) = e(a, b, z) + g(a, b, z)$ be the joint surplus of a match.

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- \underbrace{(1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot)\left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right]}_{\text{Debt outflow}} \\
&+ \left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right] \underbrace{\beta \mathbb{E}_{z',a'}\left[e(a', \boldsymbol{b}'(\cdot), z')|z\right]}_{\text{Firm's continuation value}} \\
&+ \underbrace{\beta \mathbb{E}_{z',a'}\left[(1-s)g(a', \boldsymbol{b}'(\cdot), z') - f(z)g(a', B(z'), z')|z\right]}_{\text{Worker's continuation value}} \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot) \left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right] \\
&+ \left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right] \beta \mathbb{E}_{z',a'} \left[e(a', \boldsymbol{b}'(\cdot), z') | z \right] \\
&+ \beta \mathbb{E}_{z',a'} \left[(1-s) g(a', \boldsymbol{b}'(\cdot), z') - f(z) g(a', B(z'), z') | z \right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) \quad &= \quad \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{\boldsymbol{u}} - \kappa \boldsymbol{v}(\cdot) \\
&- \quad (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot) \left[(1-s) + q(z)\boldsymbol{v}(\cdot) \right] \\
&+ \quad (1-s)\beta \mathbb{E}_{a',z'} \left[S(a', \boldsymbol{b}'(\cdot), z') | z \right] \\
&+ \quad \beta \mathbb{E}_{a',z'} \left[q(z)\boldsymbol{v}(\cdot) e(a', \boldsymbol{b}'(\cdot), z') - f(z) g(a', B(z'), z') | z \right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a, b, z) = e(a, b, z) + g(a, b, z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a, b, z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot) \left[(1-s) + q(z)\boldsymbol{v}(\cdot) \right] \\
&+ (1-s)\beta \mathbb{E}_{a', z'} \left[S(a', \boldsymbol{b}'(\cdot), z') | z \right] \\
&+ \beta \mathbb{E}_{a', z'} \left[q(z)\boldsymbol{v}(\cdot) e(a', \boldsymbol{b}'(\cdot), z') - f(z) g(a', B(z'), z') | z \right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot) \left[(1-s) + q(z)\boldsymbol{v}(\cdot) \right] \\
&+ (1-s)\beta \mathbb{E}_{a',z'} \left[S(a', \boldsymbol{b}'(\cdot), z') | z \right] \\
&+ \beta \mathbb{E}_{a',z'} \left[q(z)\boldsymbol{v}(\cdot) \underbrace{e(a', \boldsymbol{b}'(\cdot), z')}_{\gamma S(a', \boldsymbol{b}'(\cdot), z')} - f(z) \underbrace{g(a', B(z'), z')}_{(1-\gamma) S(a', B(z'), z')} | z \right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot)\left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right] \\
&+ (1-s)\beta \mathbb{E}_{a',z'}\left[S(a', \boldsymbol{b}'(\cdot), z') | z\right] \\
&+ \beta \mathbb{E}_{a',z'}\left[q(z)\boldsymbol{v}(\cdot)\gamma S(a', \boldsymbol{b}'(\cdot), z') - f(z)(1-\gamma)S(a', B(z'), z') | z\right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \mathbb{I}_{\{a \leq \underline{\boldsymbol{a}}(\cdot)\}} 0 + \mathbb{I}_{\{a > \underline{\boldsymbol{a}}(\cdot)\}} \Big\{ ax - \bar{u} - \kappa \boldsymbol{v}(\cdot) \\
&- (1-\tau)b + p(\boldsymbol{b}'(\cdot), z)\boldsymbol{b}'(\cdot)\left[(1-s) + q(z)\boldsymbol{v}(\cdot)\right] \\
&+ (1-s)\beta \mathbb{E}_{a',z'}\left[S(a', \boldsymbol{b}'(\cdot), z') | z\right] \\
&+ \beta \mathbb{E}_{a',z'}\left[q(z)\boldsymbol{v}(\cdot)\gamma S(a', \boldsymbol{b}'(\cdot), z') - f(z)(1-\gamma)S(a', B(z'), z') | z\right] \Big\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) \quad = \quad & \max_{d,nd} \left\{ 0, \max_{v,b'} \Big\{ ax - \bar{u} - \kappa v \right. \\
- \quad & (1-\tau)b + p(b',z)b' \left[(1-s) + q(z)v \right] \\
+ \quad & (1-s)\beta \mathbb{E}_{a',z'} \left[S(a',b',z') | z \right] \\
+ \quad & \left. \beta \mathbb{E}_{a',z'} \left[q(z)v\gamma S(a',b',z') - f(z)(1-\gamma)S(a',B(z'),z') | z \right] \Big\} \right\}
\end{aligned}
$$

A "Fictional Planner"

Return

- Let $S(a,b,z) = e(a,b,z) + g(a,b,z)$ be the joint surplus of a match.

$$
\begin{aligned}
S(a,b,z) &= \max_{d,nd}\left\{0, \max_{v,b'}\left\{ax - \bar{u} - \kappa v\right.\right. \\
&- (1-\tau)b + p(b',z)b'\left[(1-s) + q(z)v\right] \\
&+ (1-s)\beta\mathbb{E}_{a',z'}\left[S(a',b',z')|z\right] \\
&+ \left.\left.\beta\mathbb{E}_{a',z'}\left[q(z)v\gamma S(a',b',z') - f(z)(1-\gamma)S(a',B(z'),z')|z\right]\right\}\right\}
\end{aligned}
$$

Proposition

Firm's policies - $\mathbf{b}'(b,z)$, $\mathbf{v}(b,z)$ and $\underline{\mathbf{a}}(b,z)$ - maximize the value of a match $S(a,b,z)$.

Financial value of a worker

Return

- **Perturbation**: increase n' by ϕ, keeping debt per worker b' fixed.
- **Need:** vacancies $\Delta \bar{v} = \frac{\phi n'}{q(z)}$ and debt $\Delta \bar{b}' = \phi b'$.

Financial value of a worker

Return

- **Perturbation**: increase n' by ϕ, keeping debt per worker b' fixed.
- **Need:** vacancies $\Delta \bar{v} = \frac{\phi n'}{q(z)}$ and debt $\Delta \bar{b}' = \phi b'$.
- **Cost:** $\Delta \bar{v} = \frac{\kappa \phi n'}{q(z)}$

Financial value of a worker

Return

- **Perturbation**: increase n' by ϕ, keeping debt per worker b' fixed.
- **Need:** vacancies $\Delta\bar{v} = \frac{\phi n'}{q(z)}$ and debt $\Delta\bar{b}' = \phi b'$.
- **Cost:** $\Delta\bar{v} = \frac{\kappa\phi n'}{q(z)}$
- **Benefits:**
  - Surplus: $\phi n' \gamma\beta\mathbb{E}\left[S(a', \boldsymbol{b}'(\cdot), z')|z\right]$
  - New debt: $p(\boldsymbol{b}'(\cdot), z)\phi\bar{b}'$

Financial value of a worker

Return

- **Perturbation**: increase n' by ϕ, keeping debt per worker b' fixed.
- **Need:** vacancies $\Delta\bar{v} = \frac{\phi n'}{q(z)}$ and debt $\Delta\bar{b}' = \phi b'$.
- **Cost:** $\Delta\bar{v} = \frac{\kappa\phi n'}{q(z)}$
- **Benefits:**
  - Surplus: $\phi n' \gamma\beta\mathbb{E}\left[S(a', \boldsymbol{b}'(\cdot), z')|z\right]$
  - New debt: $p(\boldsymbol{b}'(\cdot), z)\phi\bar{b}'$
- Optimally

$$\kappa\frac{\phi n'}{q(z)} = p(\boldsymbol{b}'(\cdot), z)\phi\bar{b}' + \phi n' \gamma\beta\mathbb{E}\left[S(a', \boldsymbol{b}'(\cdot), z')|z\right]$$

Financial value of a worker

Return

- **Perturbation**: increase n' by ϕ, keeping debt per worker b' fixed.
- **Need:** vacancies $\Delta\bar{v} = \frac{\phi n'}{q(z)}$ and debt $\Delta\bar{b}' = \phi b'$.
- **Cost:** $\Delta\bar{v} = \frac{\kappa\phi n'}{q(z)}$
- **Benefits:**
  - Surplus: $\phi n' \gamma\beta\mathbb{E}\left[S(a', \boldsymbol{b}'(\cdot), z')|z\right]$
  - New debt: $p(\boldsymbol{b}'(\cdot), z)\phi\bar{b}'$
- Optimally

$$\kappa\frac{1}{q(z)} = p(\boldsymbol{b}'(\cdot), z)b' + \gamma\beta\mathbb{E}\left[S(a', \boldsymbol{b}'(\cdot), z')|z\right]$$

Long term debt induces persistence in b

Return

- From firm's optimal conditions

$$\boldsymbol{b}'(b,z) = \tau\lambda \frac{\mathbb{E}_{z'}\left[1 - H\left(\underline{\boldsymbol{a}}(\boldsymbol{b}'(b,z), z')\right)\right]}{-\partial p(\boldsymbol{b}'(b,z), z)/\partial b'} + \frac{1-\lambda}{1-s} b$$

  - Low λ (long maturity), adds persistence to debt!
  - Need $s < \lambda$ for a stationary model ...

Calibration cont'd

Return

Parameter	Value	Target/Source
β	$0.96^{1}2$	Annual risk-free rate 1%
ν	0.5	Standard
γ	0.5	Standard
κ	17	Finding $\approx$ 45%
s	0.033	3.5% monthly separation rate
$\bar{u}$	0.6	Shimer (2005) - Hagedorn and Manovskii (2008)
τ	13%	U.S. Government Accountability Office
λ	1/24	2 year debt maturity
σ_a	0.2	Annual default rate 1%
(ρ_x, σ_x)	$(0.98, 0.005)$	Standard

Table: Parameter values

Labor as an asset

Return

Question: How important is labor as an asset to the firm?

- A separation shock
  - Employment decreases 3%.
  - One period sock.
  - Unexpected shock!
- Compute model response

Labor as an asset

Return

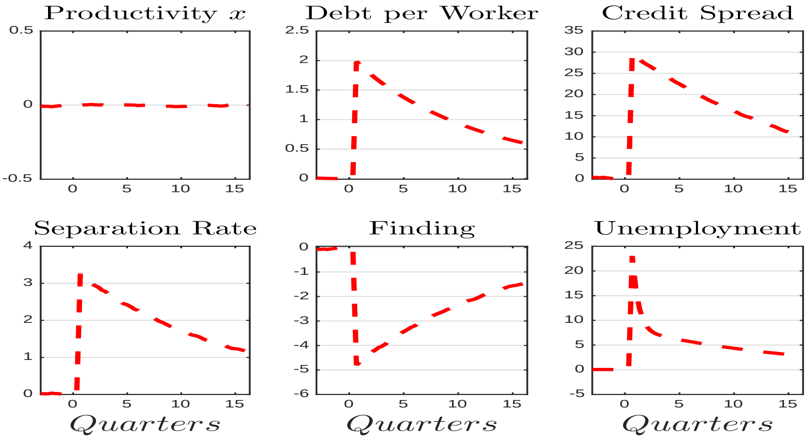


Figure: Model Response to a separation shock

Note: *Impulse responses correspond to the average over* 50, 000 *independently simulated economies, all which experienced the same productivity innovation at* $t = 0$.

Distance to Default (DD)Computation

Return

Theory(-ish)

+ Firms total value evolve as: $dA_t = \mu_A dt + \sigma_A dW_t$
+ "Default point" L_t, in T periods.
+ Value of equity (Merton ,1970)

$$S_t = A_t \Phi(d_1) - L_t e^{-r_t} \Phi(d_2)$$

$$d_1 = \frac{1}{\sigma_A}\left(\ln\left(\frac{A_t}{L_t}\right) + \left(r_t + \frac{1}{2}\sigma_A^2\right)\right), \qquad d_2 = d_1 - \sigma_A$$

+ DD: size of shock that induces default (in units of σ_A)

$$DD_t = \frac{\ln\left(\frac{A_t}{L_t}\right) + \left(\mu_A - \frac{1}{2}\sigma_A^2\right) T}{\sigma_A \sqrt{T}}$$

+ Probability of default = $\Phi(-DD_t)$

Distance to Default (DD)Computation

Return

Theory(-ish)

- Firms total value evolve as: $dA_t = \mu_A dt + \sigma_A dW_t$
- "Default point" L_t, in T periods.
- Value of equity (Merton ,1970)

$$S_t = A_t \Phi(d_1) - L_t e^{-r_t} \Phi(d_2)$$

$$d_1 = \frac{1}{\sigma_A}\left(\ln\left(\frac{A_t}{L_t}\right) + \left(r_t + \frac{1}{2}\sigma_A^2\right)\right), \qquad d_2 = d_1 - \sigma_A$$

- DD: size of shock that induces default (in units of σ_A)

$$DD_t = \frac{\ln\left(\frac{A_t}{L_t}\right) + \left(\mu_A - \frac{1}{2}\sigma_A^2\right) T}{\sigma_A \sqrt{T}}$$

- Probability of default $= \Phi(-DD_t)$

Implementation:

- Data: S_t = stock market value, L_t = short-term debt + $\frac{1}{2}$ long-term debt.
- Solve for A_t as a fixed point problem.
- Compute δ_t.
- Daily data, averaged to quarterly frequency.

Distance to Default (DD) Computation

Return

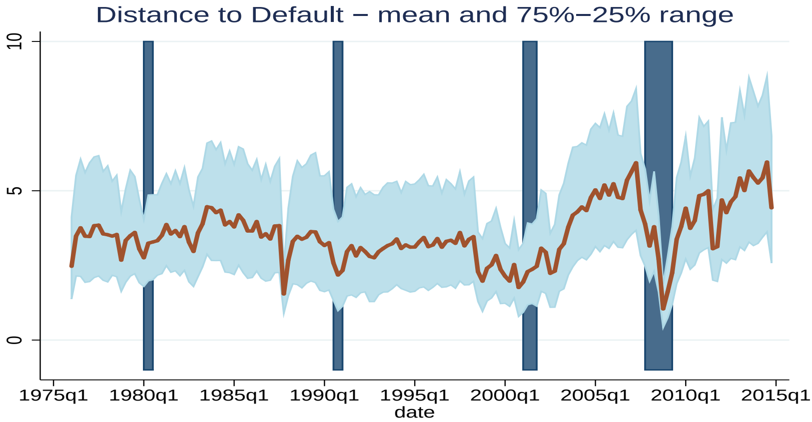
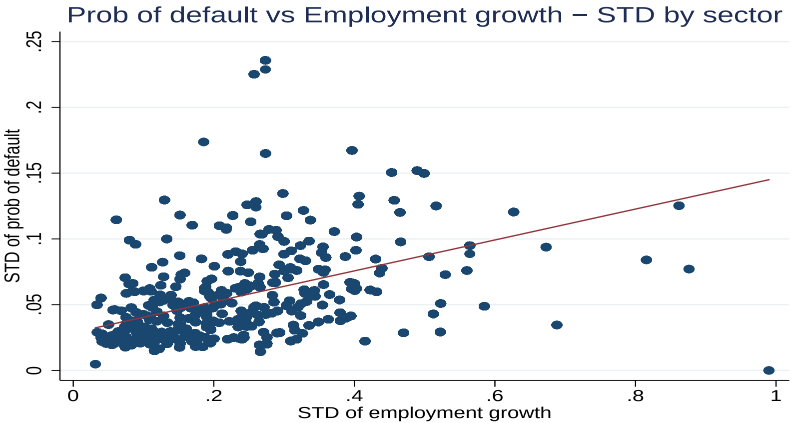


Figure: Distance to Default

Note: *Distance to Default for non-financial corporate sector, sample period 1975q1 - 2014q4. Computed using CRSP-Compustat merged panel for 15,320 firms.*

More volatile labor market, more volatile default risk Return

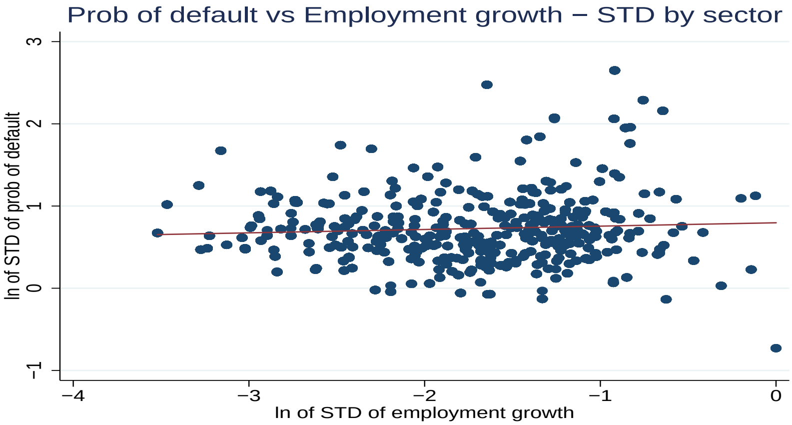
$$\sigma_s^{\Phi} = 0.028 + \underset{[0.1134\ 0.121]}{\color{red}{0.117}} \sigma_s^{\Delta E} \qquad R^2 = 19\%$$



Note: *Non-financial corporate sector, period 1975q1 - 2014q4. STD on equation residuals. Data source CRSP-Compustat merged panel for 15,320 firms.*

More volatile labor market, more volatile default risk Return

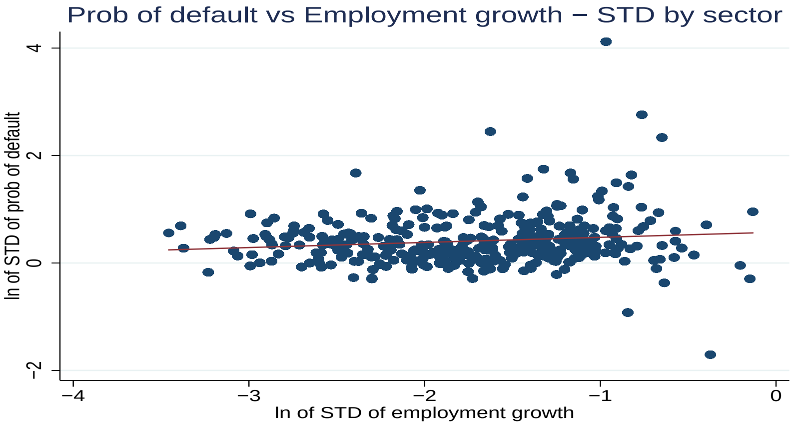
$$\ln \mathbb{V}(\Phi_s) = 0.79 + \underset{[0.03\ 0.05]}{\color{red}{0.04}} \ln \mathbb{V}(\Delta E_s) \qquad R^2 = 0.4\%$$



Note: *Non-financial corporate sector, period 1975q1 - 2014q4. STD on original variables. Data source CRSP-Compustat merged panel for 15,320 firms.*

More volatile labor market, more volatile default risk Return

$$\ln \sigma_s^{DD} = 0.57 + \underset{[0.083\ 0.107]}{0.095} \ln \sigma_s^{\Delta E} \qquad R^2 = 1.7\%$$



Note: *Non-financial corporate sector, period 1975q1 - 2014q4. STD on equation residuals. Data source CRSP-Compustat merged panel for 15,320 firms.*