Industrial Evolution in Crisis-Prone Economies

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Crises-prone economies

- Since the early 1980s, currency crashes and banking crises have tended to occur together (Kaminsky and Reinhart, 1999).

- Possible reasons:
  - External shocks coupled with a fixed exchange rate can trigger loss of reserves, credit crunch, and bankruptcies.

  - Financial sector problems can trigger a bail-out, excessive money creation, and a currency crash.

  - Exchange rate-based stabilization plans can induce rapid capital inflows, squeeze tradeables producers and eventually inspire speculative attacks.

Firm-level consequences

- Crisis-prone macro environments create:
  - Big swings in intensity of import competition and export earnings.
  - Big swings in credit costs and availability.
- Consequences
  - Patterns of firm survival and growth depends upon collateral.
  - With risk-averse households, size of initial wealth also affects desire to own firms.
  - Industrial growth and productivity-based selection processes are affected.
- Our Objective: Quantify these forces

The exercise

- Fit VAR switching model to time series on exchange rates (e) and interest rates (r).

- Fit establishment-level profit functions to panel data on textiles producers.
  - Links profits to capital stocks, productivity, exchange rates and interest rates
  - Characterizes producer-specific productivity shocks

- Use a model of optimizing behavior to estimate entry costs, fixed costs, and the degree of credit market imperfections.

- Simulate industrial evolution patterns under alternative macro scenarios.

The model: overview

- Basic features of our model:
  - Partial equilibrium; macro variables exogenous.
  - No secondary equity markets.
  - Risk-averse, forward-looking households allocate their wealth between proprietorships and bank deposits.
  - Households are heterogeneous in terms of their management opportunities and wealth.
  - Those that do operate businesses can borrow to expand their businesses, subject to collateral constraints.

The model: primitives

- Given current wealth (a_{it}), each household chooses whether to operate a proprietorship.
- At the beginning of period *t*, household *i* decides how to allocate its wealth (a_{it}) between
  - investments in its firm (k_{it}) and
  - bank deposits (a_{it}- k_{it}), which earn at rate r_t- μ

- Negative bank deposits amount to bank loans, which cost r_t and are used to finance business investments.

The model: primitives

- Operating profits before interest:

$$\pi(k_{it}, e_t, v_{it}) = \begin{cases} \exp(\eta_0 + \eta_1 e_t + v_{it}) \cdot R(k_{it}) - f - \delta k_{it} & if \ k_{it} > 0 \\ 0 & if \ k_{it} = 0 \end{cases}$$

- Exogenous transition densities

$$\phi(v_{it+1} \mid v_{it})$$

$$\psi(e_{t+1}, r_{t+1} \mid e_t, r_t)$$

The model: primitives

- Utility:

$$U(c_{it}) = \frac{(c_{it})^{1-\sigma}}{1 - \sigma}$$

- Consumption:

$$c_{it} = y_{i0} + \pi(k_{it}, z_{it}) + (r_t - \mu D_{it}) \cdot (a_{it} - k_{it}) - (a_{it+1} - a_{it})$$

The model: optimization

- Households choose current savings and capital stock to maximize:

$$E_t \sum_{\tau=t}^{\infty} U(c_{i\tau}) \beta^{\tau-t}$$

subject to a borrowing constraint, and recognizing that threshold costs are associated with the creation of a new firm.

The model: optimization

- The borrowing constraint (Banerjee and Newman, 1993):

  – Firms' productivity levels are public knowledge, so lenders know how much they can earn *if* the household invests its loan in the firm.

  – But households can sell their firms and abscond with $\theta \cdot k_{it}$, $0 < \theta < 1$.

  – Banks do not make loans sufficiently large that this is the borrower's best option.

The model: optimization

- If household *i* owns a firm, and it shuts this firm down in period *t*, its expected present value of utility is:

$$V^E(a_{it}, y_{i0}, s_t) =$$

$$\max_{a' \geq 0} \left[U\big(y_{i0} + (r_t - \mu)a_{it} - (a' - a_{it})\big) + \beta \sum_{s'} \psi(s' \mid s_t) V^E(a', y_{i0}, s') \right]$$

where $s_t = (e_t, r_t)$.

The model: optimization

- The unconditional expected utility for owner-households is thus

$$V(a_{it}, y_{i0}, s_t, v_{it}) = \max \left[V^I(a_{it}, y_{i0}, s_t, v_{it}), V^E(a_{it}, y_{i0}, s_t,) \right],$$

- Where $V^I(\cdot)$ is the value of continuing to operate:

$$V^I(a_{it}, y_{i0}, s_t, v_{it}) =$$

$$\max_{a' \geq 0, k_{it} > 0} \left[U\big(y_{i0} + \pi(k_{it}, e_t, v_{it}) + (r_t - \mu D_{it})(a_{it} - k_{it}) - (a' - a_{it})\big) + \right.$$

$$\left. \beta \sum_{v'} \sum_{s'} V(a', y_{i0}, s', v') \cdot \psi(s', \mid s_t) \cdot \phi(v' \mid v_{it}) \right].$$

subject to (5)

The model: optimization

- The max problem for the continuation value is subject to the no-default constraint:

$$V^I(a_{it}, y_{i0}, s_t, v_{it}) \geq V^E(\theta k_{it}, y_{i0}, s_t)$$

The model: optimization

- Households that do not own firms create them if:

$$V^N(a_{it}, y_{i0}, s_t) =$$

$$\sum_v \max_{a' \geq 0, k_{it} > 0} \left[U(y_{i0} - F + \pi(k_{it}, e_t, v) + (r_t - \mu D_{it}) \cdot (a_{it} - k_{it}) - (a' - a_{it})) + \right.$$

$$\left. \beta \cdot \sum_{v'} \sum_{s'} V(a', y_{i0}, s', v') \cdot \psi(s'|s_t) \phi(v'|v) \right] q_0(v)$$

$$>$$

$$V^O(a_{it}, y_{i0}, s_t) =$$

$$\max_{a' \geq 0} \left[U(y_{i0} + (r_t - \mu) \cdot a_{it} - (a' - a_{it})) + \right.$$

$$\left. \beta \sum_{e'} \sum_{s'} \max\left[V^N(a', y_{i0}, s'), V^O(a', y_{i0}, s') \right] \psi(s'|s_t) \right].$$

where F is the sunk cost of establishing a new firm.

Estimating the profit function

- Production technology:

$$Q_{it} = \exp(u_{it}) \cdot k_{it}{}^{\alpha} l_{it}{}^{\gamma}$$

Revenue function:

$$G_{it}^* = \gamma^{-1} \exp\!\left(u_{it}(1-\gamma)^{-1}\right) w_{it} \left(\frac{\gamma P_{it}}{w_{it}}\right)^{(1-\gamma)^{-1}} \left(k_{it}{}^{\alpha}\right)^{(1-\gamma)^{-1}}$$

Variable cost function:

$$C_{it}^* = \exp\!\left(u_{it}(1-\gamma)^{-1}\right) w_{it} \left(\frac{\gamma P_{it}}{w_{it}}\right)^{(1-\gamma)^{-1}} \left(k_{it}{}^{\alpha}\right)^{(1-\gamma)^{-1}}$$

Estimating the profit function

- Let $w_{it}(P_{it}/w_{it})^{1/(1-\gamma)}$ be a Cobb-Douglas function of a time trend, the real exchange rate, and firm-specific shocks.

- Assume that revenues and variable costs are measured with serially-correlated noise.

$$\ln(G_{it}) = \eta_0^G + \eta_1 e_t + \eta_2 t + \eta_3 \ln K_{it} + \varepsilon_{it}^E + \varepsilon_{it}^G$$

$$\ln(C_{it}) = \eta_0^C + \eta_1 e_t + \eta_2 t + \eta_3 \ln K_{it} + \varepsilon_{it}^E + \varepsilon_{it}^C$$

Profit function parameters

Variable	Coefficient	Std. Error	Z-ratio
	Level-form estimator		
Exchange rate	-0.329	0.038	-8.722
Capital stock	0.201	0.007	29.400
Trend term	0.007	0.003	2.038
Initial year dummy	-0.015	0.013	-1.196
Intercept, revenue equation	8.570	0.207	41.428
Intercept, cost equation	8.319	0.207	40.221
Variance of innovations in ε^E process	0.130	0.004	31.287
Root of ε^E process	0.937	0.007	143.980
Variance of innovations in ε^C process	0.027	0.003	8.072
Root of ε^C process	0.260	0.022	11.987
Variance of innovations in ε^R process	0.026	0.004	6.002
Root of ε^R process	0.728	0.022	32.858
Number of observations	2,640		

Estimating the VAR

- Define $s_t = \begin{pmatrix} e_t \\ r_t \end{pmatrix}$

- The VAR: $s_t = \beta_0^m + \beta_1^m s_{t-1} + \upsilon_t^m$

  where $E\left(\upsilon_t^m \upsilon_t^{m'} \right) = \Sigma^m$ and switches between regimes are governed by the transition matrix $p = \{p_{mn}\}$.

- Restricted version: only the covariance matrix varies between regimes.

Switching VAR, macro processes

Parameters	e	r
Intercepts ($\boldsymbol{\beta_0}$)	0.012 (0.03)	0.031 (0.01)
AR coefficients ($\boldsymbol{\beta_1}$)	0.996 (0.006)	0.028 (0.02)
	-0.006 (0.002)	0.953 (0.011)
Non-crisis covariance matrix ($\boldsymbol{\Sigma^2}$)	3.94 e-4	-1.34 e-5
	-1.33 e-5	7.01 e-5
Crisis covariance matrix ($\boldsymbol{\Sigma^1}$)	9.25 e-3	-2.82 e-4
	-2.82 e-4	2.69 e-3
Switching probabilities ($\boldsymbol{P}$)	0.965	0.035
	0.598	0.410
Log likelihood	1472.83	
H_0: same as simple VAR model	$\chi^2(12) = 363.59$	
H_0: MSH and MIASH are same	$\chi^2(4) = 18.80$	

Estimating θ, F, and f

- Embed our behavioral model in a method of moments estimator.

- Choose the (F, f, θ) combination that minimizes
$$\left(\overline{m} - m(F, f, \theta)\right)' W \left(\overline{m} - m(F, f, \theta)\right)$$

  - $m(F,f,\theta)$: simulated moments based on model (entry rate, exit rate, investment rate, etc.)

  - $\overline{m}$: moments based on industry data from DANE

Estimates of (θ, F, f)

Parameter	Estimated value (1,000s of 1977 pesos)
Sunk entry costs (F)	71.306 ($US 3,960)
Fixed costs (f)	1997.2 ($US 111,300)
Credit market imperfection index (θ)	0.994

Moments: simulated and sample-based

|	Simulated Moment	Sample-based Moment
Expected value of log capital stock	6.119	6.198
Variance of log capital stock	1.079	2.070
Expected value of log operating profits	7.907	6.757
Variance of log operating profits	0.884	2.064
Expected value of log debt (given debt is positive)	-1.617	-0.973
Variance of log debt (given debt is positive)	0.327	1.946
Expected growth in capital stock (net of deprec.)	-0.105	-0.062
Variance of growth in capital stock (net of deprec.)	0.245	0.215
Expected entry rate (expressed as a percentage)	15.813	17.390
Expected exit rate (expressed as a percentage)	16.192	15.170
Variance of entry rate	0.005	0.004
Variance of exit rate	0.005	0.001
Covariance of log capital and log operating profits	0.921	1.093
Covariance of log capital and lagged log capital	0.378	1.931
Covariance of log debt and log capital	0.000	-0.159
Covariance of log debt and log profits	0.000	0.379
Covariance of capital growth rate and log profits	0.201	0.007
Covariance of capital growth rate and log capital	0.261	0.200

Simulations

- Compare two macro environments

  – Estimated:
  $$P = \begin{bmatrix} 0.965 & 0.035 \\ 0.598 & 0.410 \end{bmatrix}$$

  – More crisis-prone:
  $$P = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \end{bmatrix}$$

- Simulate behavior over 300 periods, repeat 100 times and average


Simulated macro series
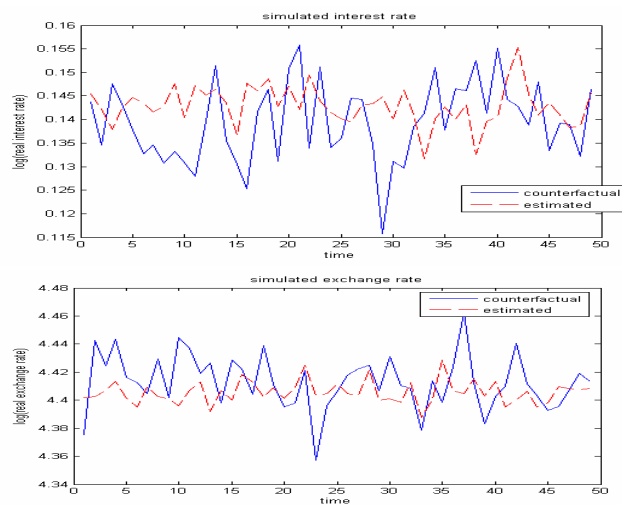
Simulations: Effect of Volatility

|	Base Case	High Volatility
Mean number of firms	65.708	65.303
Variance, number of firms	17.333	19.142
Mean log capital among active firms	5.881	7.165
Mean rate of investment	-0.110	-0.104
Mean $(\eta_0 + v_{it})$, active firms	0.860	0.854
Size-weighted mean $(\eta_0 + v_{it})$, active firms	0.985	0.975

Simulations: Effect of Volatility

	Base Case	High Volatility
Mean entry rate	0.124	0.125
Mean exit rate	0.124	0.125
Mean debt to capital ratio among borrowers	0.234	0.228
Percent of firms with positive debt	0.134	0.280
Mean log wealth of firm owners	8.974	9.033
Variance, log wealth of firm owners	0.621	0.654

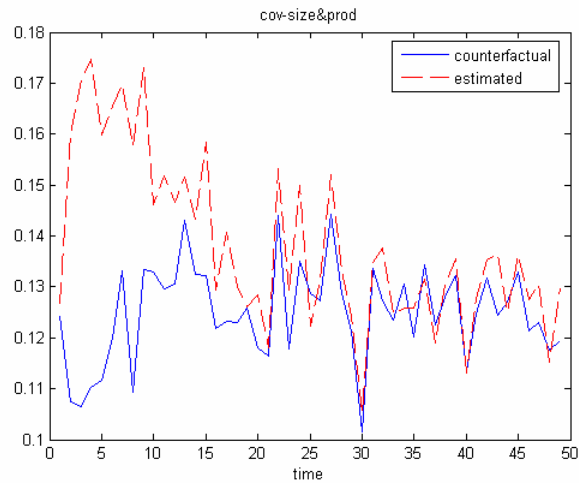# Simulated Transition to High Volatility
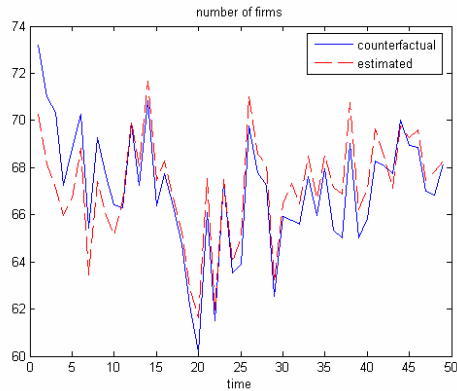
- Initially, volatility *increases* number of firms, relative to the base case
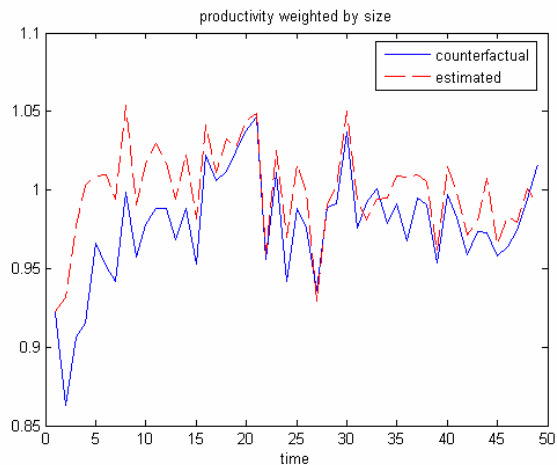
Simulated Transition to High Volatility
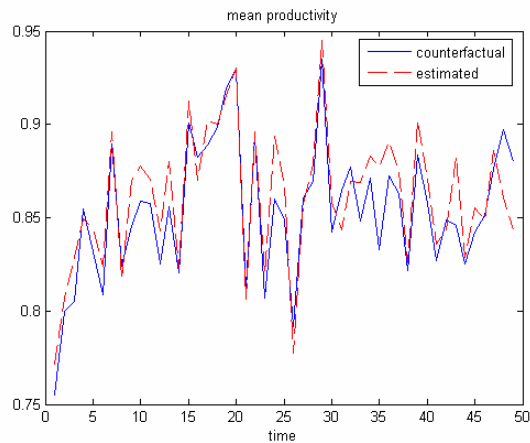
- Mean profitability levels generally fall—some small productive firms are induced to exit

Simulated Transition to High Volatility


cov-size&prod

- The association between size and profitability is initially weakened by volatility—big, poorly performing firms are induced to hang around

Simulated Transition to High Volatility

productivity weighted by size

- The poorly performing firms that hang on reduce size-weighted productivity significantly.

Simulated Transition to High Volatility

cross-household(among firm owners with capital <log(6.9)) distr of debt
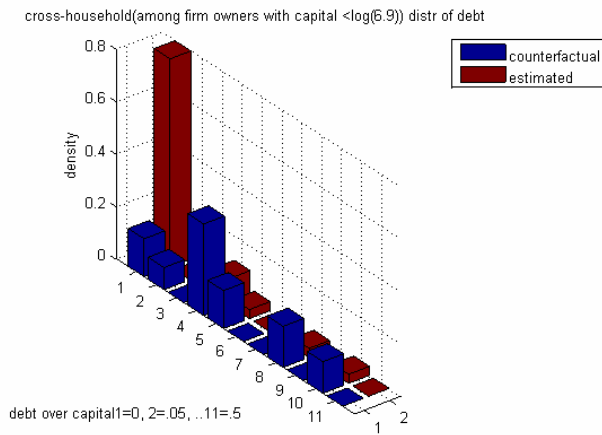
- Volatility induces some extra borrowing among small firms

Simulated Transition to High Volatility

cross-household(among firm ownerswith capital >log(6.9)) distr of debt
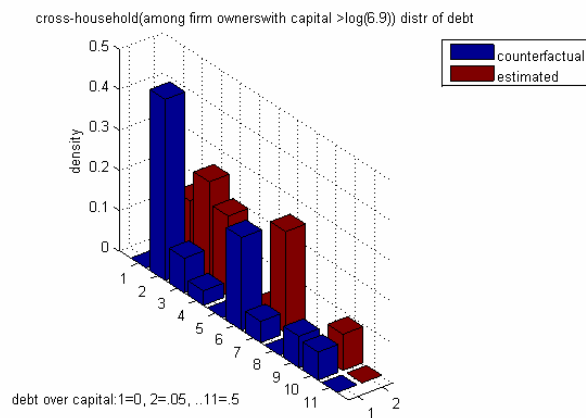
- . . . but not among the larger firms, which are owned by wealthier households

Simulations: Credit Market Imperfections

	Base Case (θ=.995)	Counterfactual (θ=0)
Mean number of firms	58.062	48.174
Variance, number of firms	3.995	3.129
Mean log wealth of firm owners	9.957	9.894
Variance, log wealth of firm owners	1.103	0.965
Mean entry, exit rate	0.129	0.151
Mean $(\eta_0 + v_{it})$, active firms	0.868	0.888
Size-weighted mean $(\eta_0 + v_{it})$, active firms	0.661	0.656
Percent of firms with positive debt	0.027	1.577

Concluding remarks

- Results are preliminary
  - They may be sensitive to our assumptions concerning household wealth, income and preferences.
  - The counter-factual crisis-prone environment may not be realistic.
- Nonetheless, the exercise establishes that the sizes and productivities of industrial sector firms are potentially sensitive to the macro environment, and
- The effects of crisis-prone environments depend upon:
  - Wealth distributions
  - Risk aversity
  - Credit market imperfections

Concluding remarks, continued

- Directions for further work
    - Add adjustment costs for changes in capital stocks.
    - Allow firms to borrow in dollars.
    - Do a better job of estimating characteristics of entrepreneurial households.
    - Move from single agent setting to monopolistic competition.