# Good Booms, Bad Booms

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# Motivation

- Financial crises are not rare.
    - More than 150 systemic crises since 1970.
    - Both in developed and emerging economies.
- Credit booms are also not rare, and usually precede crises.
- Need macro models that relate credit booms and crises, where crises are not always the result of a "large shock".
- Some credit booms end in crisis (bad booms), and others do not (good booms). Why? What are credit booms financing?

# Peeking at the Results

- New stylized facts.
  - All booms start with TFP and LP growth, but this growth dies off very quickly in bad booms, not in good booms.

- We present a model consistent with this fact, where
  - Crises are not the result of a contemporaneous "shock".
  - The seeds of a crises are planted years beforehand.
  - Aggregate fluctuations are related to low frequency phenomena. The trend affects the cycle!

# Empirical Evidence: Data

- Sample of 34 countries (17 advanced and 17 emerging), 1960-2010.

- Credit (Domestic credit to the private sector/GDP): World Bank.
- TFP: Mendoza and Terrones (2012).
- LP and other variables: IMF
- Crises: Laeven and Valencia (2012).

# Empirical Evidence: Credit Booms

- Definition:
  - Start: 3 or more consecutive years averaging at least 5% growth.
  - End: 2 or more consecutive years of negative growth.
- Results are robust to changes in this definition.

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- Results are robust to changes in this definition.

- Why not detrend, as usual?
  - We do not way to impose a structure on the boom.
  - The trend affect the measured length.

    Less likely to capture booms that do not end in crises.

    More likely to shorten booms that end in crises.
- We will compare our results with those obtained from detrending

# Empirical Evidence: Credit Booms

- We find 87 credit booms in our sample.
- By our definition booms can be long....
  - Longest credit boom in Australia (28 years).
- ...and relatively frequent.
  - 55% of country/years in sample was spent on a credit boom.
  - Over 50 years, on average a country spends 27 years in a boom, 9 of which were spent in a boom ending in a crisis.

# First Finding

- Credit growth predicts crises, but mitigated by productivity growth.

| | 5Ychange | | | 5YchangeMA | | |
|---|---|---|---|---|---|---|
| | LOGIT | LPM | | LOGIT | LPM | |
| $\alpha$ | -2.93 | 0.05 | | -2.82 | 0.06 | |
| t-Statistic | -23.73 | 7.54 | | -22.36 | 7.52 | |
| $\beta$ | 0.52 | 0.04 | 0.05 | 0.59 | 0.05 | 0.07 |
| t-Statistic | 3.22 | 3.36 | 4.16 | 2.68 | 2.74 | 3.77 |
| Marginal | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.03 |
| $R^2$ | | 0.01 | 0.06 | | 0.02 | 0.07 |
| N | 1525 | 1525 | 1525 | 1389 | 1389 | 1389 |
| FE | No | No | Yes | No | No | Yes |

$$Logit(Crisis_{j,t}) = \Phi(\alpha + \beta \Delta Credit_{j,t-1})$$

# First Finding

- Credit growth predicts crises, but mitigated by productivity growth.

| | 5Ychange | | | 5YchangeMA | | |
|---|---|---|---|---|---|---|
| | LOGIT | LPM | | LOGIT | LPM | |
| $\alpha$ | -2.86 | 0.05 | | -2.75 | 0.06 | |
| t-Statistic | -23.07 | 7.91 | | -21.85 | 8.04 | |
| $\beta$ | 0.55 | 0.04 | 0.05 | 0.65 | 0.05 | 0.07 |
| t-Statistic | 3.41 | 3.57 | 4.27 | 3.00 | 3.08 | 3.92 |
| Marginal | 0.01 | 0.02 | 0.03 | 0.01 | 0.02 | 0.03 |
| $\gamma$ | -2.45 | -0.14 | -0.10 | -3.65 | -0.22 | -0.15 |
| t-Statistic | -2.25 | -2.35 | -1.74 | -2.78 | -2.88 | -1.87 |
| Marginal | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.01 |
| $R^2$ | | 0.01 | 0.07 | | 0.02 | 0.08 |
| N | 1525 | 1525 | 1525 | 1389 | 1389 | 1389 |
| FE | No | No | Yes | No | No | Yes |

$$Logit(Crisis_{j,t}) = \Phi(\alpha + \beta \Delta Credit_{j,t-1} + \gamma \Delta TFP_{j,t-1})$$

# First Finding

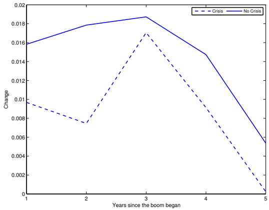
- Credit growth predicts crises, but mitigated by productivity growth.

| | 5Ychange | | | 5YchangeMA | | |
|---|---|---|---|---|---|---|
| | LOGIT | LPM | | LOGIT | LPM | |
| $\alpha$ | -2.77 | 0.06 | | -2.70 | 0.06 | |
| t-Statistic | -14.38 | 6.10 | | -13.08 | 5.72 | |
| $\beta$ | 0.47 | 0.03 | 0.04 | 0.60 | 0.04 | 0.06 |
| t-Statistic | 2.55 | 2.67 | 2.97 | 2.45 | 2.57 | 3.18 |
| Marginal | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 |
| $\gamma$ | -2.56 | -0.12 | -0.02 | -2.49 | -0.13 | 0.02 |
| t-Statistic | -2.24 | -2.36 | -0.40 | -1.99 | -2.14 | 0.22 |
| Marginal | -0.01 | -0.01 | -0.00 | -0.01 | -0.01 | 0.00 |
| $R^2$ | | 0.33 | 0.36 | | 0.34 | 0.38 |
| N | 1217 | 1217 | 1217 | 1097 | 1097 | 1097 |
| FE | No | No | Yes | No | No | Yes |

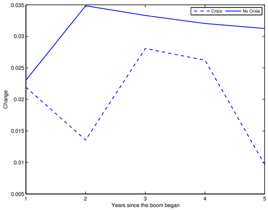
$$Logit(Crisis_{j,t}) = \Phi(\alpha + \beta \Delta Credit_{j,t-1} + \gamma \Delta LP_{j,t-1})$$

# Second Finding

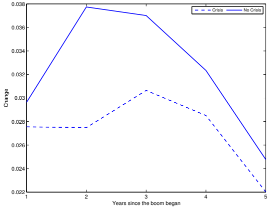
- Macro variables evolve differently in good booms and in bad booms.



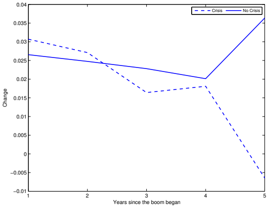

(a) Total Factor Productivity




(b) Labor Productivity




(c) Real GDP




(d) Capital Formation (Investment)

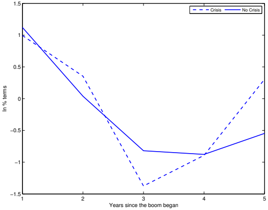
# Third Finding

- H-P filtering misses all this.

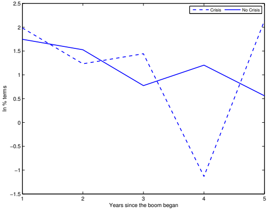
| | Number | As a ratio of HP booms |
|---|---|---|
| HP boom-years in GO | 161 | 0.80 |
| HP booms included in GO | 40 | 0.91 |
| HP booms | 44 | 1.00 |
| HP booms included in GO starting | | |
| - in the same year | 2 | 0.05 |
| - a year later | 6 | 0.15 |
| - two years later | 3 | 0.07 |
| - three years later | 4 | 0.10 |
| - more than three later | 25 | 0.63 |

# Third Finding

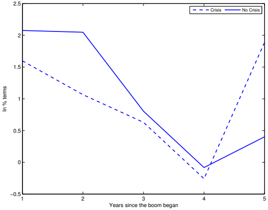
- H-P filtering misses all this.




(a) Total Factor Productivity




(b) Labor Productivity

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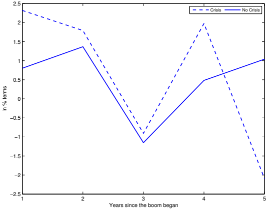



(d) Capital Formation (Investment)

# Setting

- Single Period. Mass 1 of risk-neutral firms and households.
- Technology:

$$K' = \begin{cases} A\min\{K, L^*\} & \texttt{with prob. } q \\ 0 & \texttt{with prob. } (1-q) \end{cases}$$

  - $q \in \{q_L, q_H\}$ where $q_H A > q_L A > 1 \implies$ Optimal scale is $K^* = L^*$
  - A fraction $\psi$ of projects has $q_H$.
  - The average $q$ depends on the mass of active producers $\eta$.

$$\widehat{q}(\eta) = \begin{cases} q_H & \texttt{if } \eta < \psi \\ \frac{\psi}{\eta} q_H + \left(1 - \frac{\psi}{\eta}\right) q_L & \texttt{if } \eta \geq \psi. \end{cases}$$

  - $K'$ and $q$ are privately known by the firm and non-verifiable.

# Setting

- Households: Endowment $\overline{K} > K^*$.

- Firms: Human capital $L^*$ (no disutility) and a unit of land.

$$\begin{cases} C > K^* & \texttt{with prob. } p \\ 0 & \texttt{with prob. } (1-p) \end{cases}$$

- Agents can privately learn the type of land
  - Cost for households is $\gamma_l$ in terms of numeraire.
  - Cost for firms is $\gamma_b$ in terms of human capital.

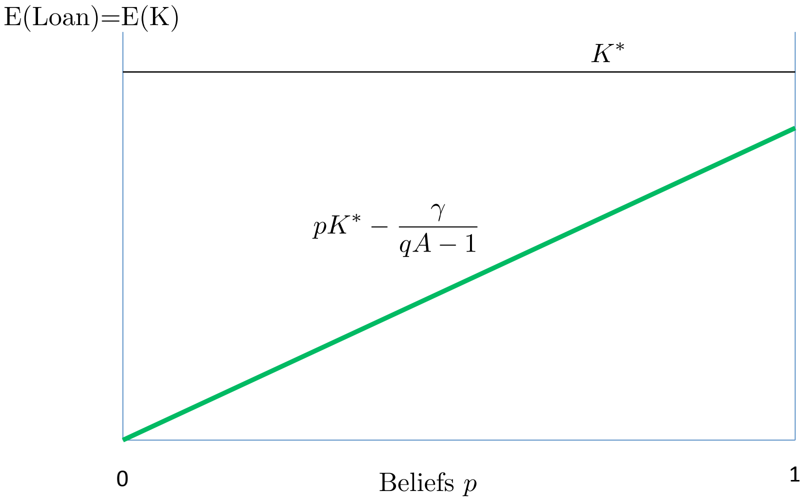
# Symmetric Information

- Lenders break even and debt is risk free

$$p(\widehat{q}(\eta)R_{IS} + (1-\widehat{q}(\eta))xC) = pK + \underbrace{\gamma_l}_{\texttt{Only if lenders pay for info}}$$

$$R_{IS} = xC$$

# Symmetric Information




$$\gamma = \min\{\underbrace{\gamma_l}_{\text{OC in terms of cons.}}, \underbrace{\gamma_b p(qA-1)}_{\text{OC in terms of prod.}}\}$$

# Symmetric Ignorance

- Lenders break even and debt is risk free

$$\widehat{q}(\eta)R_{II} + (1 - \widehat{q}(\eta))pxC = K$$

$$R_{II} = pxC$$

- Subject to loans not triggering information acquisition.

# Symmetric Ignorance

- Lenders do not acquire information if

$$p(1-\widehat{q}(\eta))\left[\frac{K}{p}-K\right]+(1-p)0 \leq \gamma_l$$

- Borrowers do not acquire information if

$$p(K^*-K)(qA-1)+(1-p)0 \leq \gamma_b p(qA-1)$$

# Symmetric Ignorance

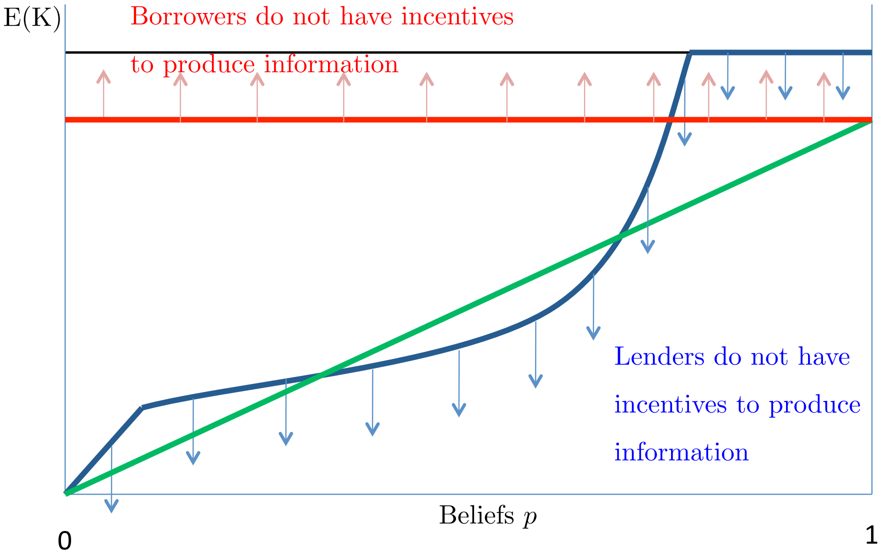
- Lenders do not acquire information if

$$K \leq \frac{\gamma_l}{(1-p)(1-\widehat{q}(\eta))}$$

- Borrowers do not acquire information if

$$K \geq K^* - \gamma_b$$

# Informational Regimes



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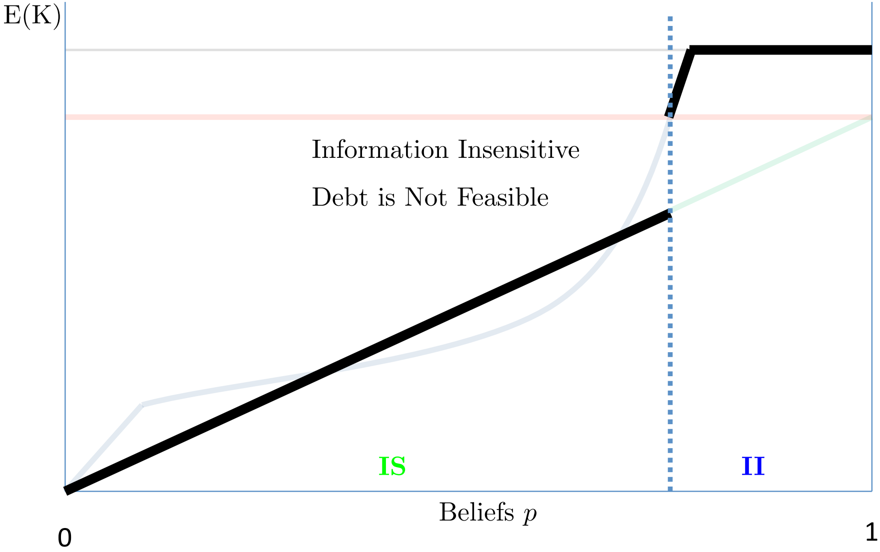
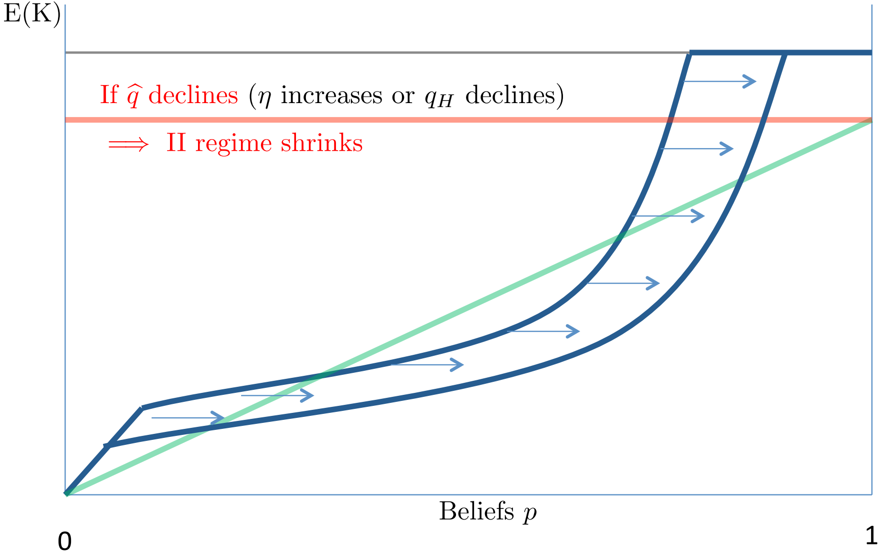


# Informational Regimes



# Setting Dynamics

- OG: "young" households, "old" firms.

- Land is storable, $K$ is not.
- Land is transferable across generations.

- We assume away bubbles and multiplicity.
- There are no fire sales.
- Price is $pC$ (i.e., single match and buyers' negotiation power).

# Timing

- A fraction $\eta$ of firms w/ collateral p>0 and project q
- Each borrows K w/ II or IS debt (conditions R and x)
- Lenders or borrowers can privately observe the type of collateral.

**Market for loans**

- Project realization
- Debts are paid off and any info is revealed (p')
- Firms sell land at p'C to households.

**Market for land**

# Timing

**Idiosyncratic and Aggregate Shocks**

- A fraction $\eta$ of firms w/ collateral p>0 and project q

- Each borrows K w/ II or IS debt (conditions R and x)

- Lenders or borrowers can privately observe the type of collateral.

**Market for loans**

- Project realization

- Debts are paid off and any info is revealed (p')

- Firms sell land at p'C to households.

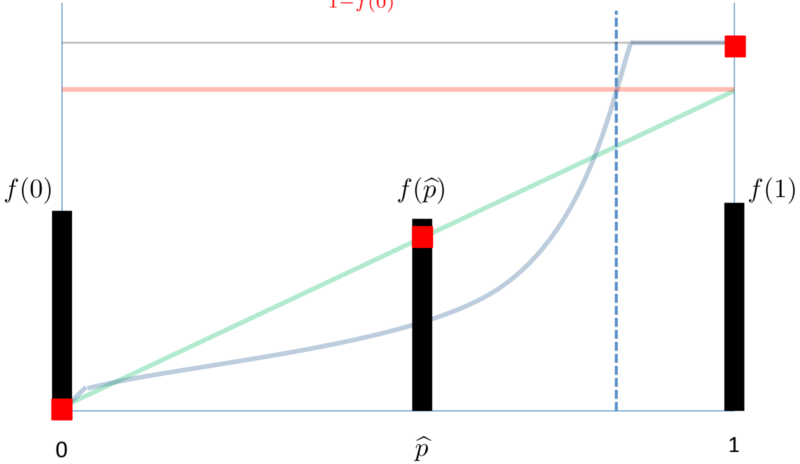
**Market for land**

# Evolution of Collateral Types

- Important assumption: Mean reversion of collateral.
- Simplifying assumptions
  - $\widehat{p}$: Fraction of good land.
  - Idiosyncratic shocks
    - Occur with probability $(1 - \lambda)$
    - Land becomes good with probability $\widehat{p}$.
    - The shock is observable, the realization is not.

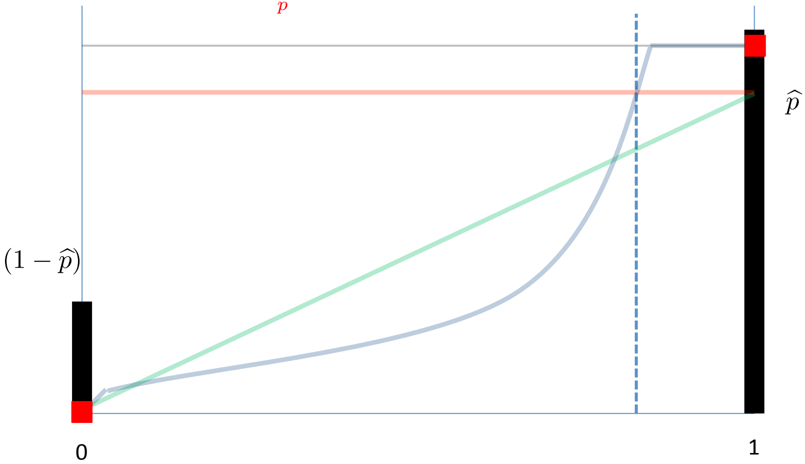
# Simpler Aggregation

$$W_t = [0 f(0) + K(\widehat{p}) f(\widehat{p}) + K^* f(1)](\widehat{q}(\underbrace{\eta_t}_{1-f(0)})A - 1) \;<\; \mathbf{W}^* = \mathbf{K}^*(\widehat{\mathbf{q}}(\mathbf{1})\mathbf{A} - \mathbf{1})$$



# Information Sensitive Dynamics

$$W_0^{IS} = \widehat{p} K^* (\widehat{q}(\underbrace{\eta_0}_{\widehat{p}}) A - 1)$$



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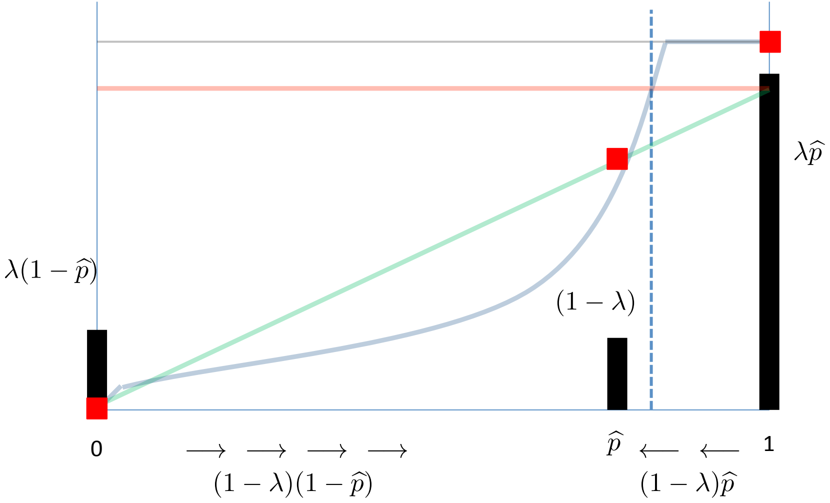
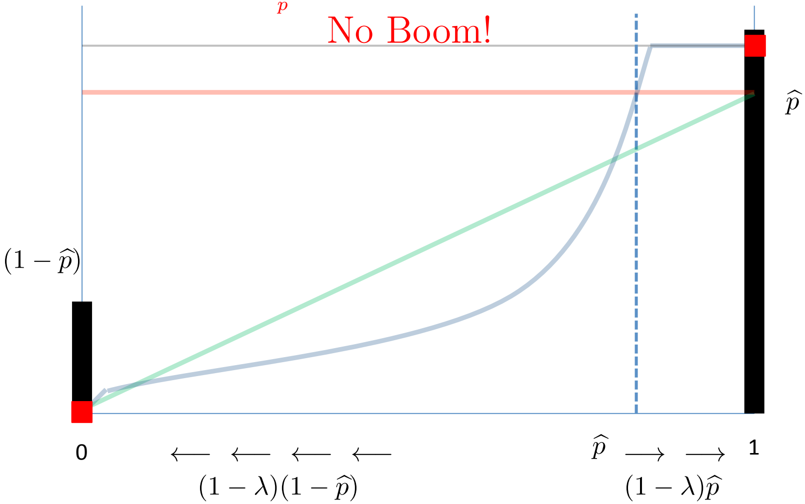


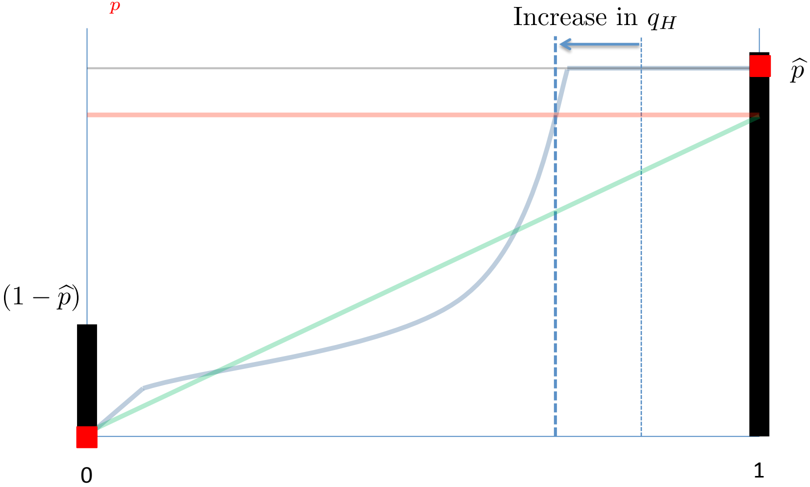
# Information Sensitive Dynamics

$$W_t^{IS} = \widehat{p}K^*(\widehat{q}(\underbrace{\eta_t}_{\widehat{p}})A-1)-(1-\lambda)\gamma \quad < \quad \mathbf{W}^*$$



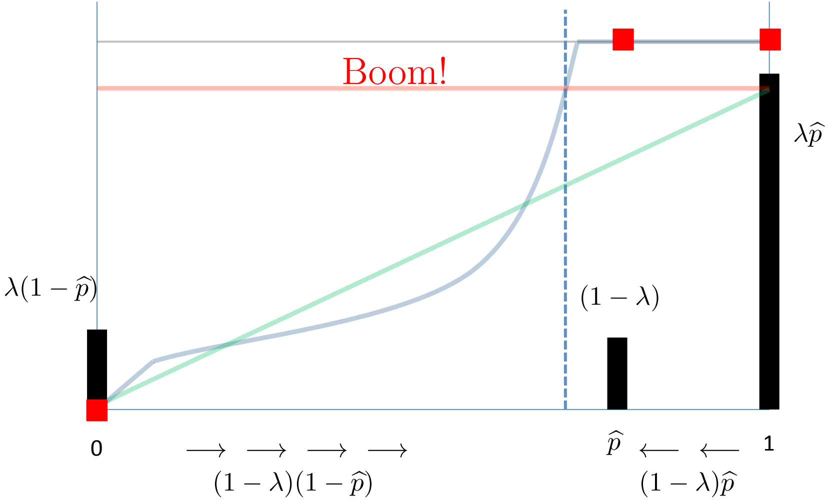
# Bad Booms

$$W_0^{II} = \widehat{p} K^*(\widehat{q}(\underbrace{\eta_0}_{\widehat{p}})A-1)$$



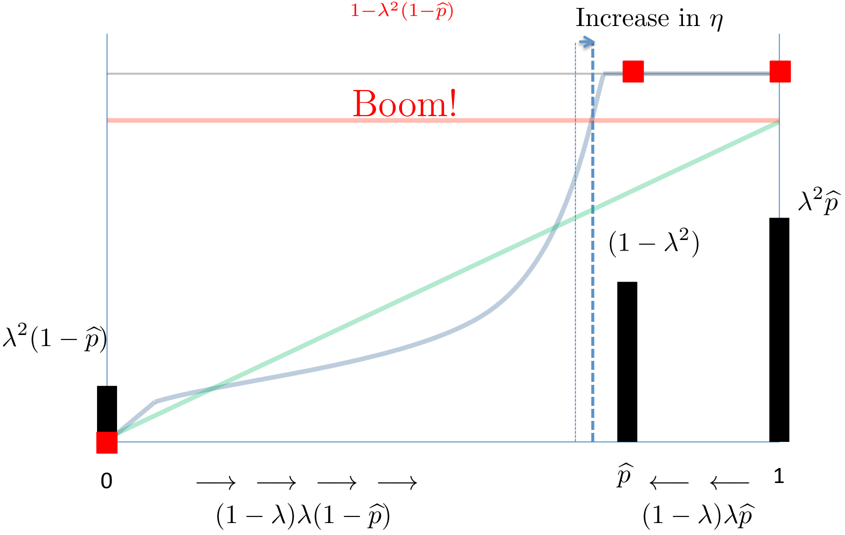
# Bad Booms

$$W_1^{II} = [(1-\lambda)K(\widehat{p}) + \lambda\widehat{p}K^*]\,(\widehat{q}(\underbrace{\quad\eta_1\quad}_{1-\lambda(1-\widehat{p})})A-1)$$



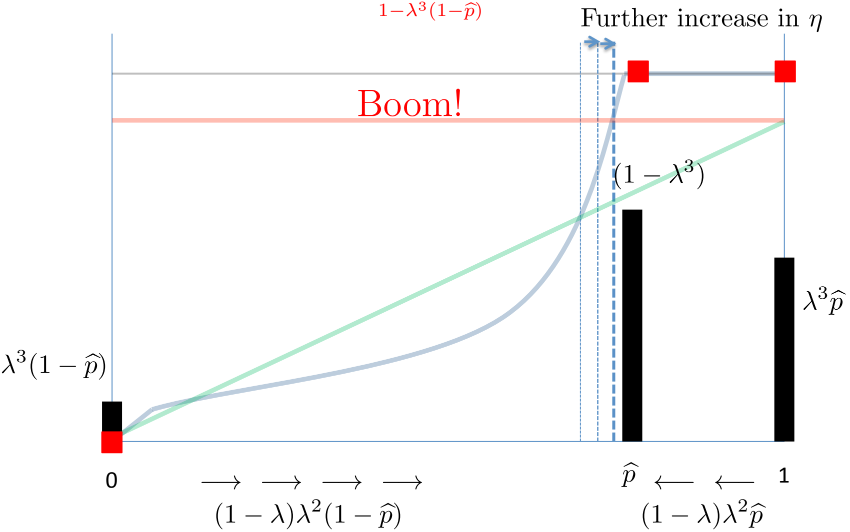
# Bad Booms

$$W_2^{II} = \left[(1-\lambda^2)K(\widehat{p}) + \lambda^2\widehat{p}K^*\right]\left(\widehat{q}(\underbrace{\eta_2}_{1-\lambda^2(1-\widehat{p})})A-1\right)$$



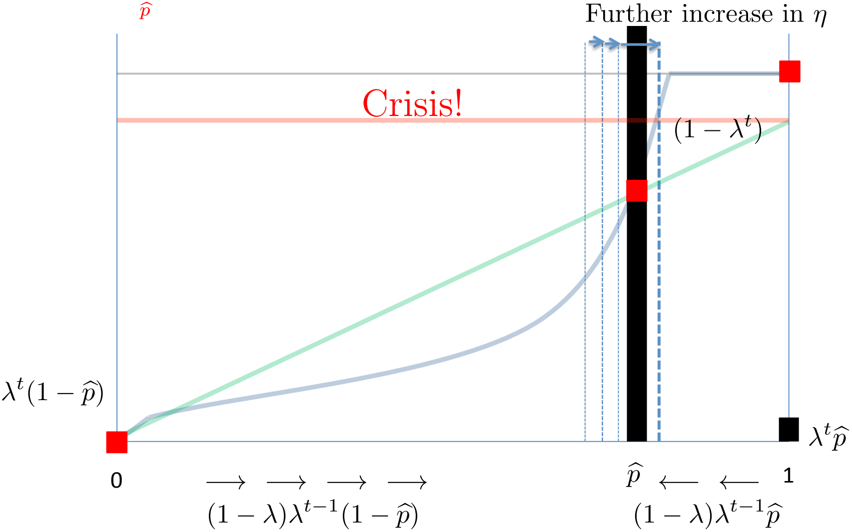
# Bad Booms

$$W_3^{II} = \left[(1-\lambda^3)K(\widehat{p}) + \lambda^3 \widehat{p} K^*\right] \left(q(\widehat{q}(\underbrace{\eta_3}_{1-\lambda^3(1-\widehat{p})})A-1\right)$$



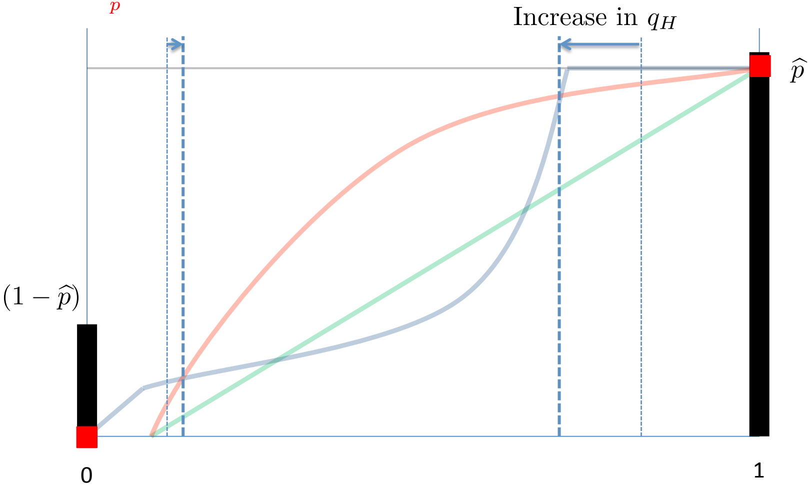
# Bad Booms

$$W_t^{II} = \widehat{p}K^*(\widehat{q}(\underbrace{\eta_t}_{\widehat{p}})A-1)-(1-\lambda^t)\gamma$$



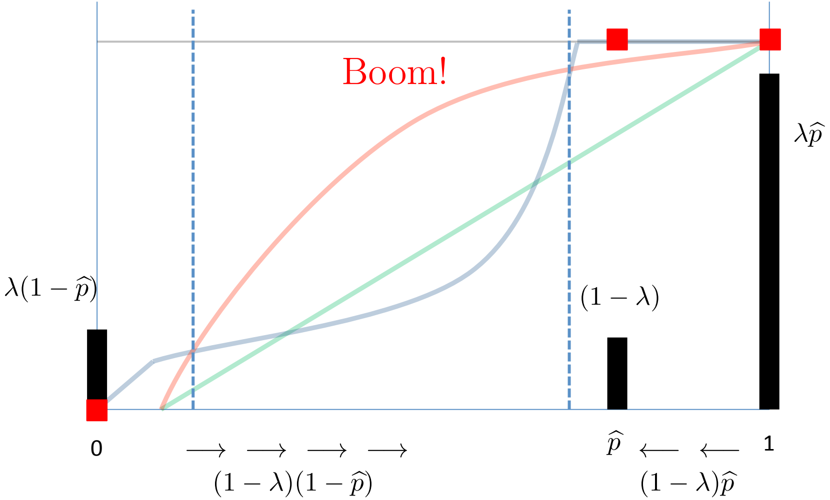
# Good Booms

$$W_0^{II} = \widehat{p} K^* (\widehat{q}(\underbrace{\eta_0}_{\widehat{p}}) A - 1)$$



# Good Booms

$$W_1^{II} = [(1-\lambda)K(\widehat{p}) + \lambda\widehat{p}K^*]\,(\widehat{q}(\underbrace{\eta_1}_{1-\lambda(1-\widehat{p})})A-1)$$

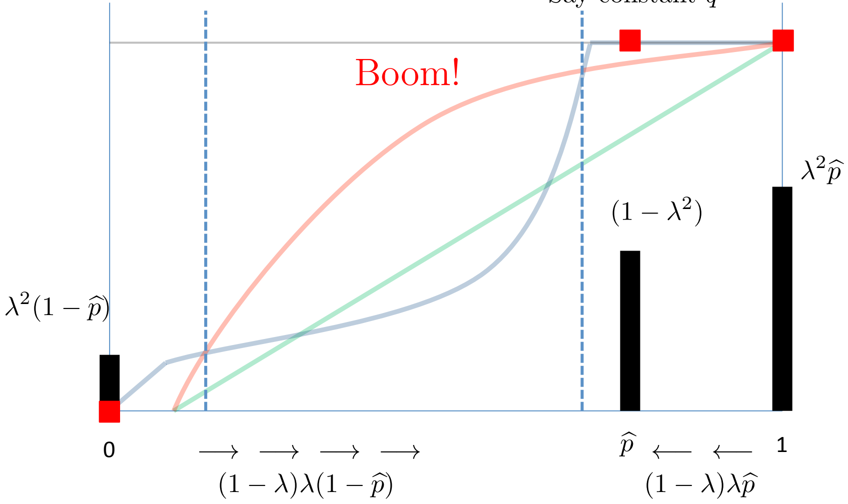


# Good Booms

$$W_2^{II} = \left[(1-\lambda^2)K(\widehat{p}) + \lambda^2\widehat{p}K^*\right]\left(\widehat{q}\left(\underbrace{\eta_2}_{1-\lambda^2(1-\widehat{p})}\right)A-1\right)$$

Increase in both $\eta$ and $q_H$

Say constant $\widehat{q}$

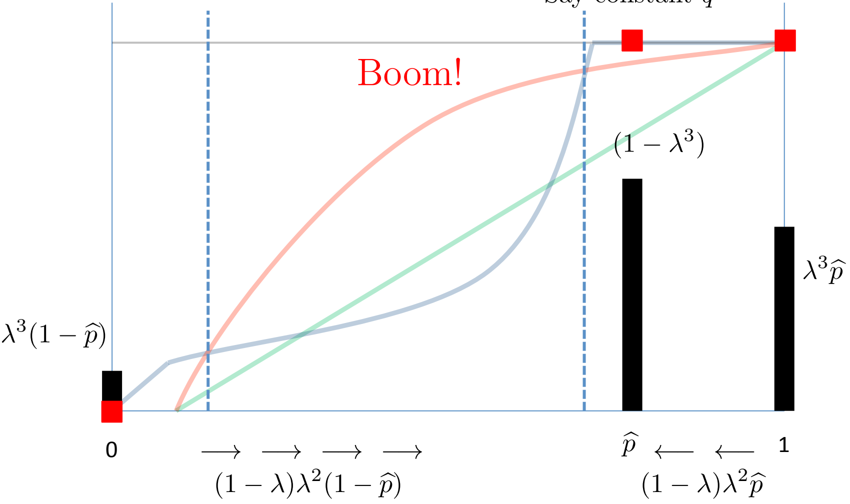


# Good Booms

$$W_3^{II} = \left[(1-\lambda^3)K(\widehat{p}) + \lambda^3\widehat{p}K^*\right]\left(\widehat{q}(\underbrace{\eta_3}_{1-\lambda^3(1-\widehat{p})})A-1\right)$$

Further increase in $\eta$ and $q_H$

Say constant $\widehat{q}$

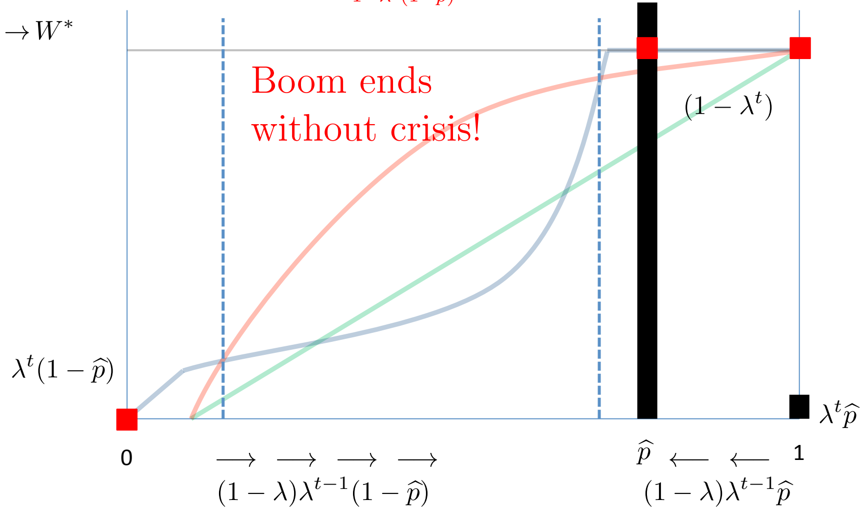


# Good Booms

$$W_t^{II} = \left[(1-\lambda^t)K(\widehat{p}) + \lambda^t \widehat{p} K^*\right] \left(\widehat{q}\Big( \underbrace{\eta_t}_{1-\lambda^t(1-\widehat{p})} \Big)A - 1\right)$$

Further increase in $\eta$ and $q_H$

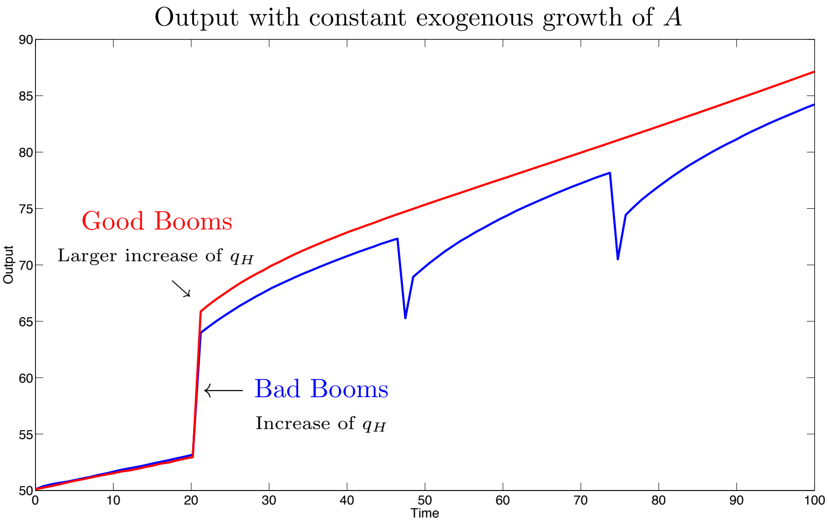
Say constant $\widehat{q}$



# A Summary

- A positive shock in productivity ($q$) triggers a credit boom.
- More firms operating reduces average productivity but
  - If the subsequent growth of $q$ is enough to compensate the productivity decline, the boom does not end in crisis (Good Boom).
  - If the subsequent growth of $q$ is NOT enough to compensate the decline, the boom ends in crisis (Bad Boom).
  - Bad Booms can become completely endogenous

# A Simulation - Shock Size



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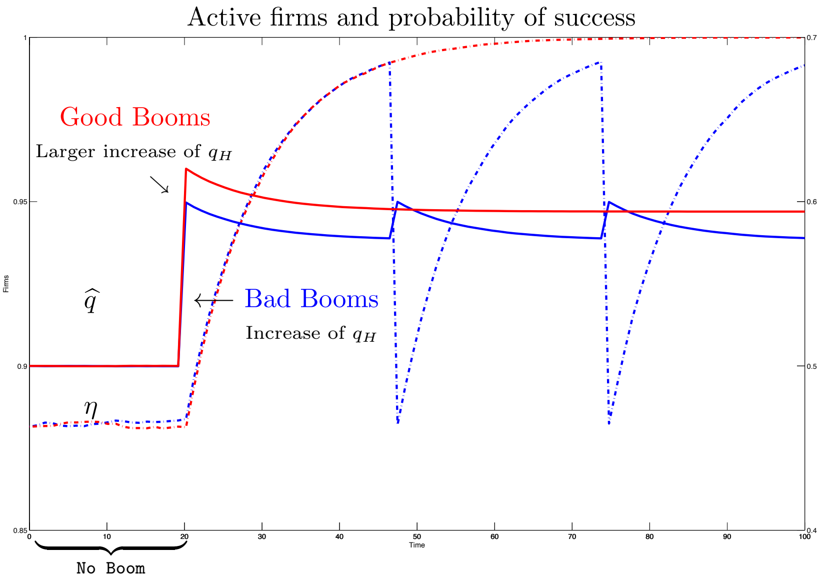
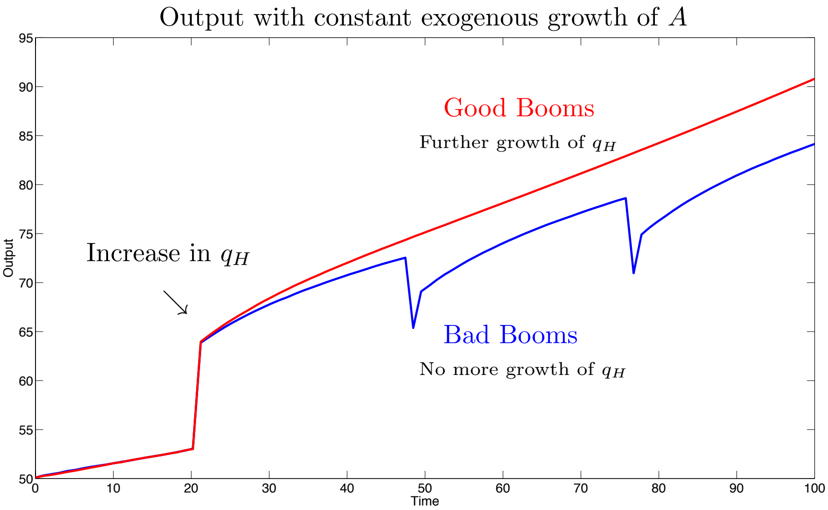


# A Simulation - Shock Persistency



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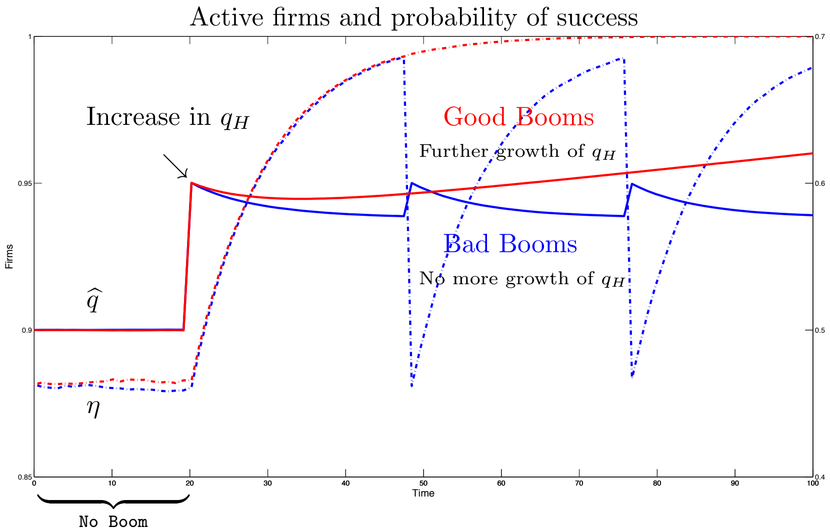

# First Testable Prediction

- Bursts of innovation predict booms.
  - We proxy bursts of innovation by new patents granted in a given country previous to the boom.

| | $(n=1)$ | | $(n=2)$ | | $(n=3)$ | | $(n=4)$ | |
|---|---|---|---|---|---|---|---|---|
| $\alpha$ | -1.65 | | -1.68 | | -1.71 | | | |
| t-Statistic | -29.31 | | -28.68 | | -28.23 | | -28.18 | |
| $\beta$ | -0.19 | -0.00 | -0.18 | -0.00 | -0.16 | -0.00 | -0.16 | -0.00 |
| t-Statistic | -0.99 | -0.60 | -1.13 | -0.60 | -1.07 | -0.51 | -1.12 | -0.53 |
| $\gamma$ | 0.40 | 0.03 | 0.35 | 0.03 | 0.27 | 0.01 | 0.25 | 0.02 |
| t-Statistic | 1.78 | 2.08 | 1.99 | 2.81 | 1.69 | 1.90 | 1.70 | 3.79 |
| | | | | | | | | |
| $R^2$ | 0.16 | 0.17 | 0.22 | 0.23 | 0.27 | 0.28 | 0.28 | 0.29 |
| N | 1459 | 1459 | 1423 | 1423 | 1392 | 1392 | 1358 | 1358 |
| FE | No | Yes | No | Yes | No | Yes | No | Yes |

$$\mathbb{I}(Start\ Boom)_{i,t} = \alpha + \beta\Delta(Pat)_{i,t-n-t} + \gamma\left[\Delta(Pat)_{i,t-n-t} \times \mathbb{I}(Boom)_{i,t}\right] + \epsilon_{i,t}$$

# Second Testable Prediction

- Firms' fragility is a component of the TFP measure.
  - Changes in TFP negatively correlated with changes in default prob.
  - We proxy default probabilities by $\frac{1}{vol}$, where $vol$ is the volatility of a firm's equity returns (as in Atkeson et al. (2013)).

| | $(n=0)$ | | $(n=1)$ | | $(n=2)$ | | $(n=3)$ | | $(n=4)$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | 0.01 | | 0.01 | | 0.02 | | 0.02 | | 0.03 | |
| t-Statistic | 4.67 | | 5.89 | | 7.46 | | 8.79 | | 9.59 | |
| $\beta$ | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| t-Statistic | 2.25 | 2.24 | 2.74 | 2.65 | 3.27 | 3.20 | 2.43 | 2.22 | 1.64 | 1.45 |
| $R^2$ | 0.90 | 0.48 | 0.88 | 0.52 | 0.88 | 0.56 | 0.87 | 0.58 | 0.87 | 0.60 |
| N | 1016 | 1016 | 980 | 980 | 945 | 945 | 910 | 910 | 875 | 875 |
| FE | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |

$$\Delta(TFP)_{i,t} = \alpha + \beta \Delta \frac{1}{vol_{i,t-n}} + \epsilon_{i,t}$$

# Third Testable Prediction

- Default probabilities predict crises.

| | 5Ychange | | | 5YchangeMA | | |
|---|---|---|---|---|---|---|
| | LOGIT | LPM | | LOGIT | LPM | |
| $\alpha$ | -3.21 | 0.04 | | -3.19 | 0.04 | |
| t-Statistic | -16.97 | 4.30 | | -14.42 | 4.67 | |
| $\beta$ | 0.63 | 0.05 | 0.06 | 0.05 | 0.00 | 0.02 |
| t-Statistic | 3.12 | 3.41 | 4.45 | 0.10 | 0.10 | 1.18 |
| Marginal | 0.01 | 0.02 | 0.03 | 0.00 | 0.00 | 0.01 |
| $\gamma$ | 0.11 | 0.01 | 0.00 | -0.07 | -0.00 | -0.01 |
| t-Statistic | 0.49 | 0.58 | 0.27 | -0.13 | -0.13 | -0.38 |
| Marginal | 0.00 | 0.00 | 0.00 | -0.00 | -0.00 | -0.00 |
| | | | | | | |
| $R^2$ | | 0.54 | 0.58 | | 0.68 | 0.71 |
| N | 844 | 844 | 844 | 702 | 702 | 702 |
| FE | No | No | Yes | No | No | Yes |

$$Logit\left(BadBooms_{j,t}\right) = \Phi\left(\alpha + \beta \Delta Cred_{j,t-1} + \gamma \frac{1}{vol_{j,t-1}}\right).$$

# Final Remarks

- Causal relation between productivity and credit?
- Most macro models rely heavily on exogenous contemporaneous "technology shocks"...but most times they cannot explain both credit booms and crises.
- We propose a unified model without those shocks. A crisis is not a big shock! A crisis is generated by previous dynamics!