Banks, Credit Market Frictions, and Business Cycles

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Views expressed in this presentation are those of the author and do not necessary reflect those of the Bank of Canada.

Introduction

- The recent financial crisis demonstrates that a breakdown in the banking system can severely disrupt economic activity.
- Also, disturbances in the banking system can be a source of economic fluctuations.
- Financial conditions amplify and propagate the impact of real shocks to the economy.

Outline

- Motivation
- Modeling financial frictions
- Model
- Results
- Conclusion
- Future work

Motivation

- Models used by policymakers typically abstract from financial frictions (because of Modigliani-Miller theorem)

- In the literature, financial frictions introduced focusing only on the demand of credit:
  - Using BGG (1999) or Iacoviello (2005) [Christiano *et al*. 2009]
  - Banks only play a passive role

- Few recent studies introduce banks in DSGE models: de Walque *et al*. (2008), Gerali *et al*. (2009), Gertler and Karadi (2009), and others.

Motivation

- This paper proposes a fully micro-founded framework to incorporate an active banking sector into a DSGE model. We introduce:
  - demand- *and* supply-sides of credit markets
  - an interbank market (to examine how interactions between banks affect credit supply)
  - bank capital (to satisfy the bank capital requirements, Basel II, capital regulations)
  - structural financial shocks (originating in the banking sector) and unconventional monetary shocks

Modeling Financial Frictions

Modeling Financial Frictions

Financial frictions are introduced based on:

1. Corporate balance sheet channel---Financial accelerator à la BGG (1999)

   -This is to model the demand-side of credit markets

2. Bank' balance sheet channel: shrinking balance sheet restrains banks' ability to make loans and affects costs of producing loans (therefore, external financing costs)

   - This is to model the supply-side of credit markets

Corporate Balance Sheet Channel

- Entrepreneurs are subject to idiosyncratic shocks → may default on loans
- Information asymmetry and costly state verification imply an external finance premium, which depends on entrepreneurs' net worth
- Unlike BGG, in this paper:
  - nominal debt contracts (to capture debt deflation effects)
  - external financing costs depend on the prime lending rate set by banks (instead of policy rate)

Bank Balance Sheet Channel

- The banking sector consists of a continuum of profit-maximizing monopolistically competitive banks
- To introduce an interbank market, we assume two types of banks that interact in the interbank market:
  - "savings banks" → lenders in the interbank market
  - "lending banks" → borrowers in the interbank market

Bank Balance Sheet Channel

Banks affect credit supply conditions through:

- Monopoly power when setting deposit and loan rates → time-varying spreads in retail rates
  - Deposit rate set as a mark-down of the interbank rate
  - Loan rate set as a mark-up of marginal costs of producing loans
- Risk sharing with households and entrepreneurs
  - Banks help consumption smoothing and efficient allocation of savings to risky investment
- Endogenous (optimal) bank leverage ratio
  - potential excess of bank capital holdings (capital buffer)
  - lower ratio implies lower costs of raising bank capital

Bank Balance Sheet Channel

- Endogenous bank defaults (strategic or mandatory), subject to penalties (Goodhart *et al*. 2006)

- Optimal banks' portfolio composition: split deposits between loans and holdings of risk-free assets

Questions

- What is the role of active banks in the U.S. business cycles: as an amplification and propagation mechanism?
- What are real effects of shocks originating in the banking sector?
- What is the importance of unconventional monetary policies in reducing effects of financial shocks?

Main findings

The model shows that :

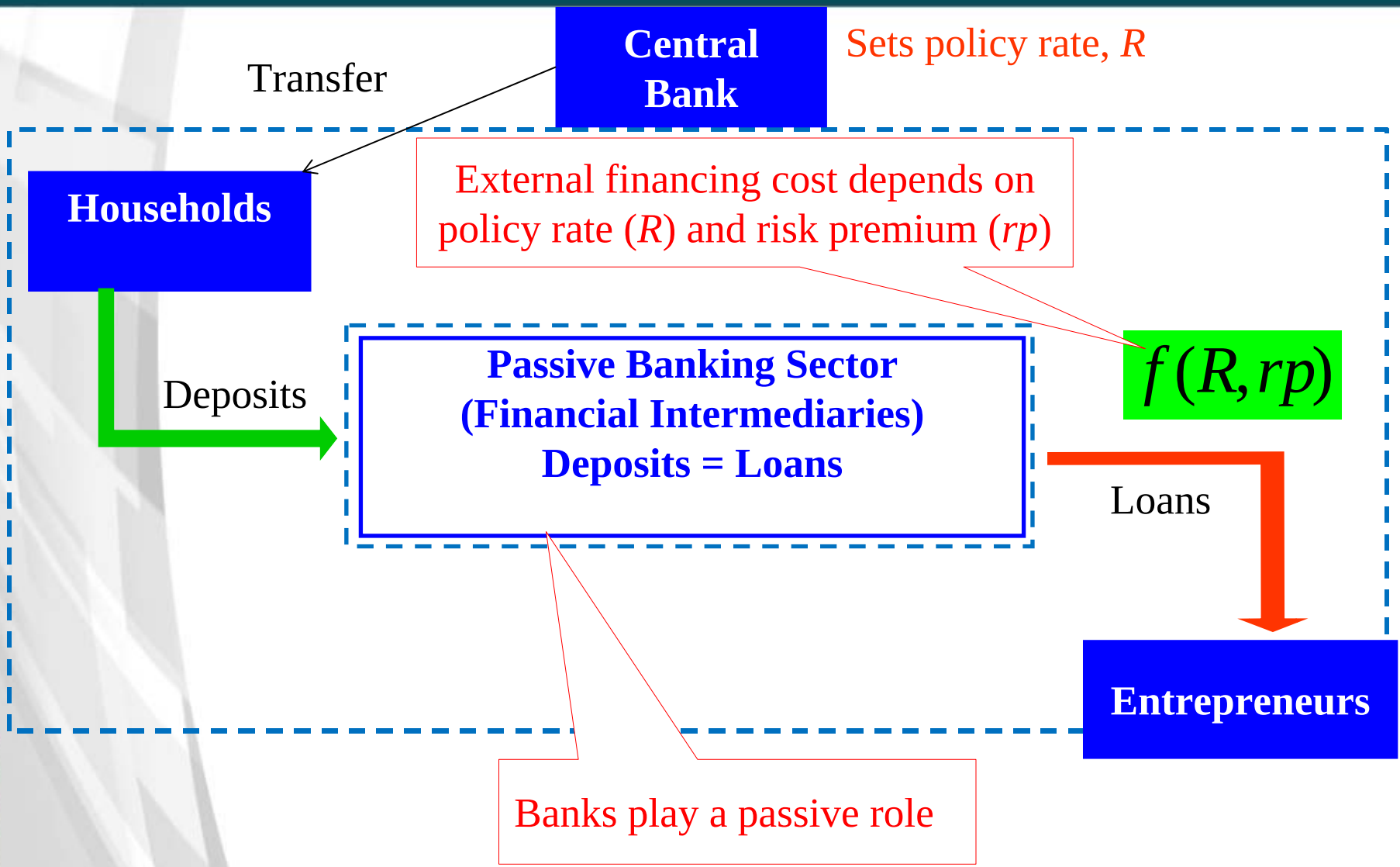
- An active banking sector amplifies and propagates impacts of real shocks to the economy
- Bank leverage is procyclical
- Shocks originating in the banking sector can generate recessions
- Unconventional monetary policy has modest effects on the real economy

The Model

The Model

- A New Keynesian model for a closed economy built on BGG (1999)
- Real rigidity:
  - Habit formation on consumption
  - Bank capital adjustment costs
  - Investment adjustment costs
- Nominal rigidity:
  - Sticky prices à la Calvo-Yun contracts
  - Adjustment costs of changing deposit and prime lending rates (as in Gerali *et al*. 2009)

Structure of the BGG model



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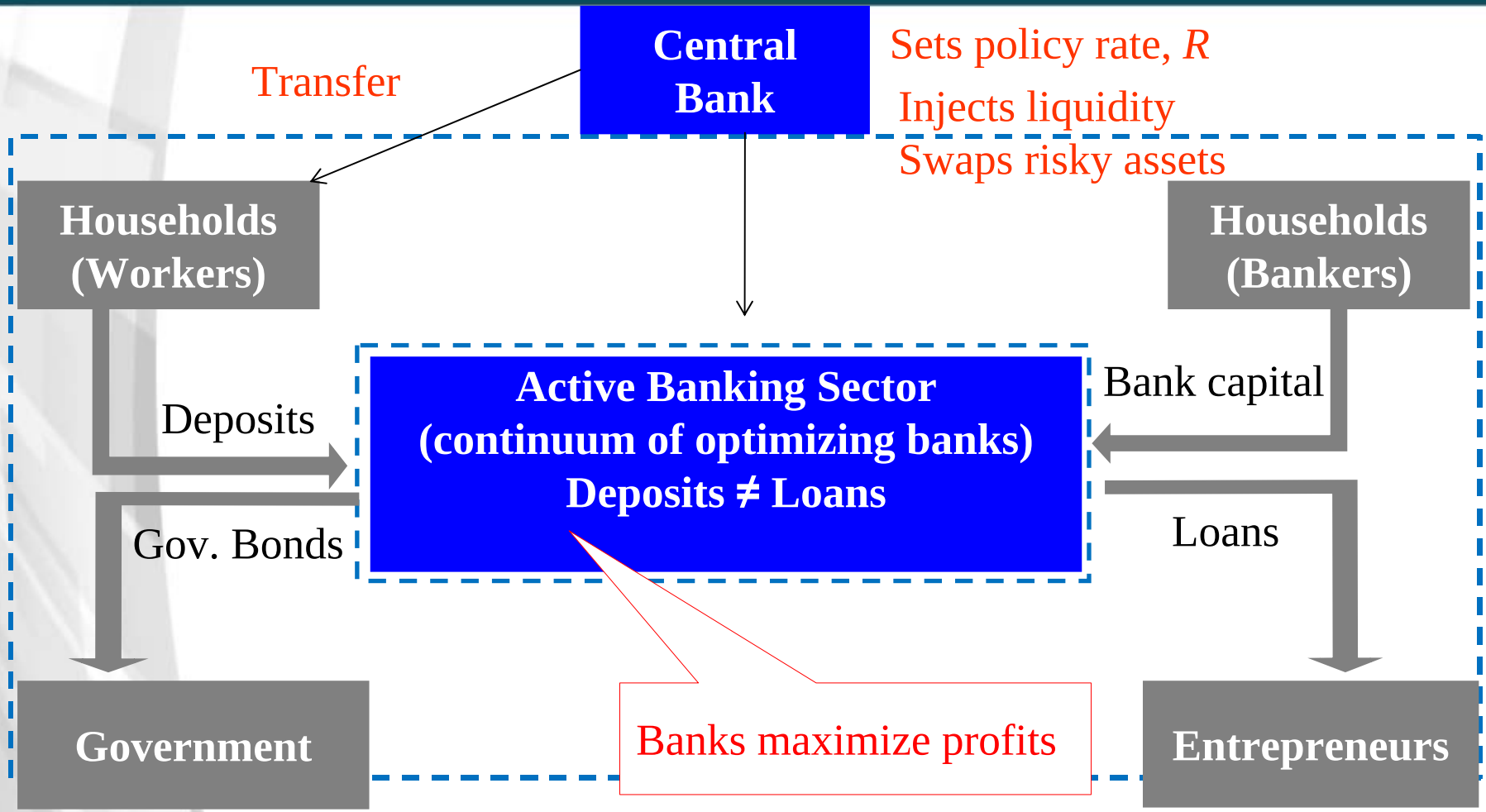

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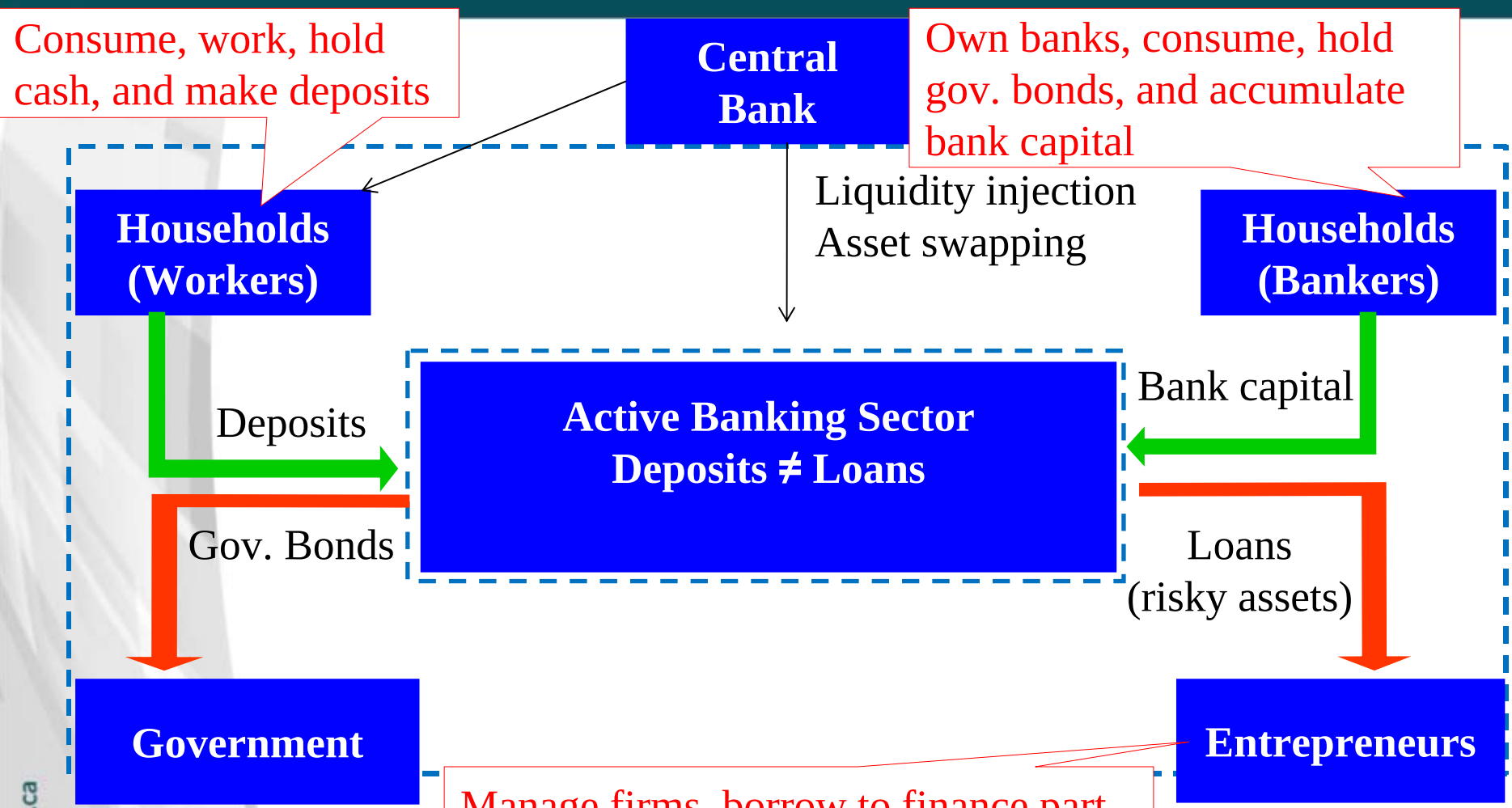

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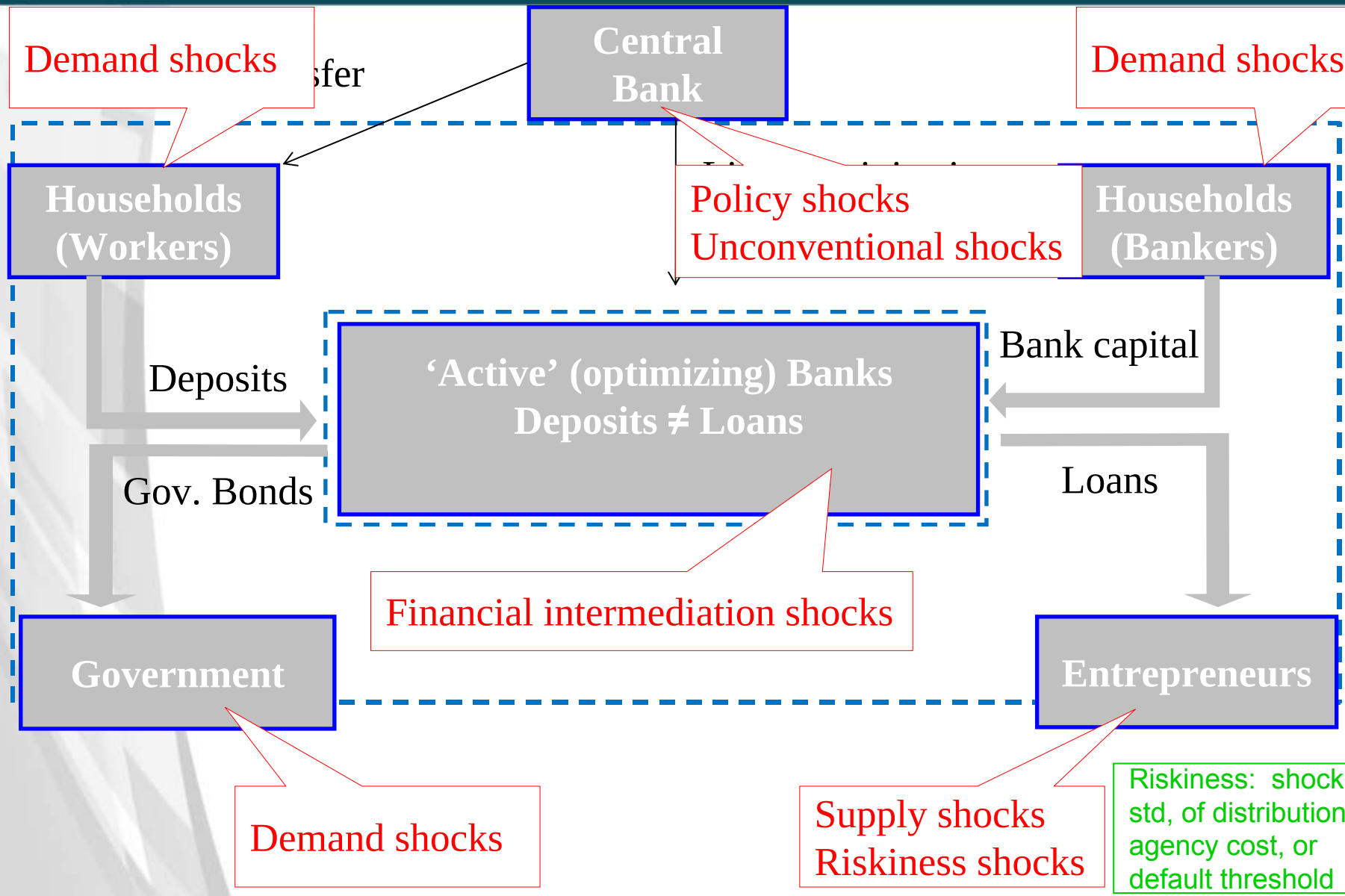

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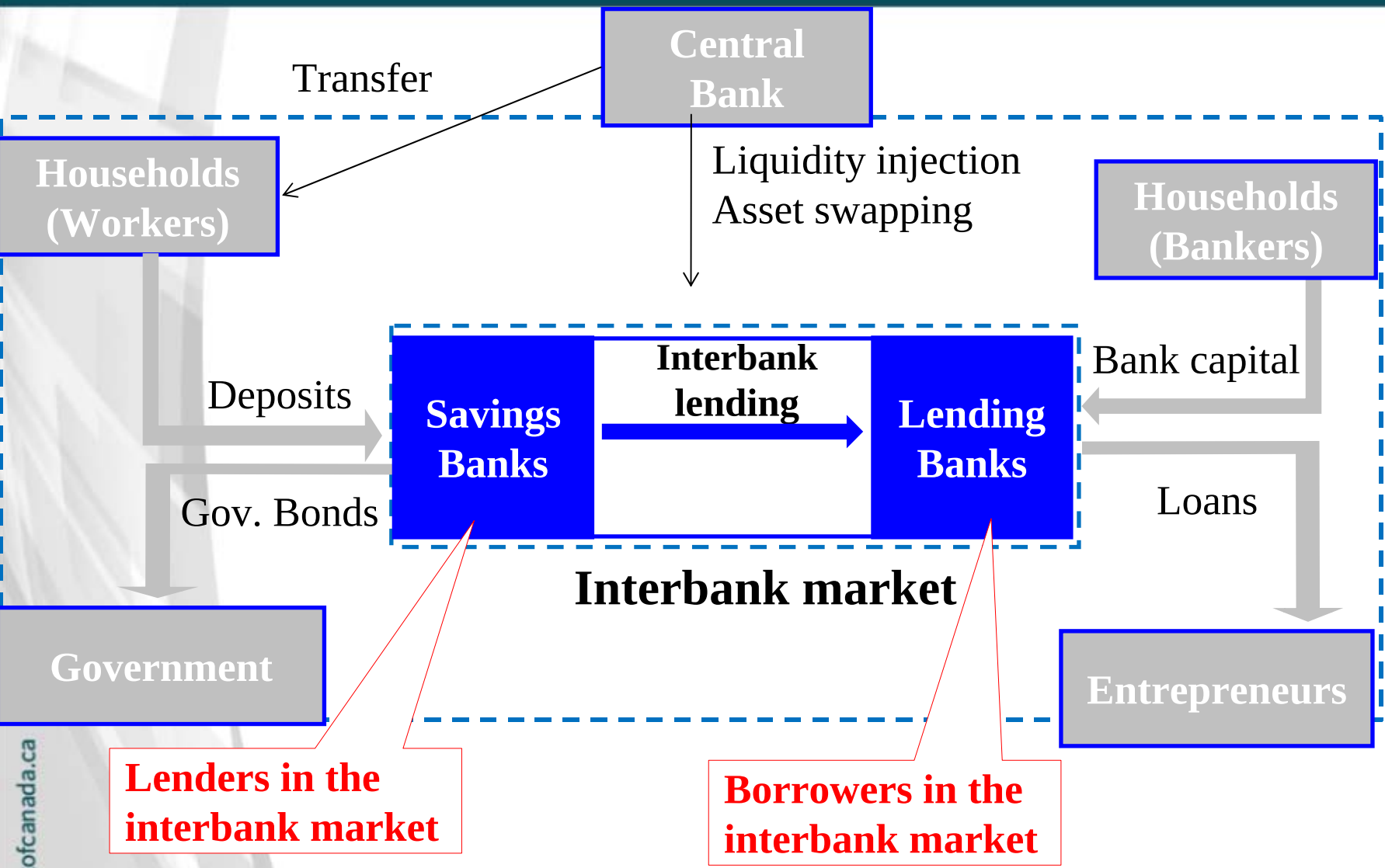

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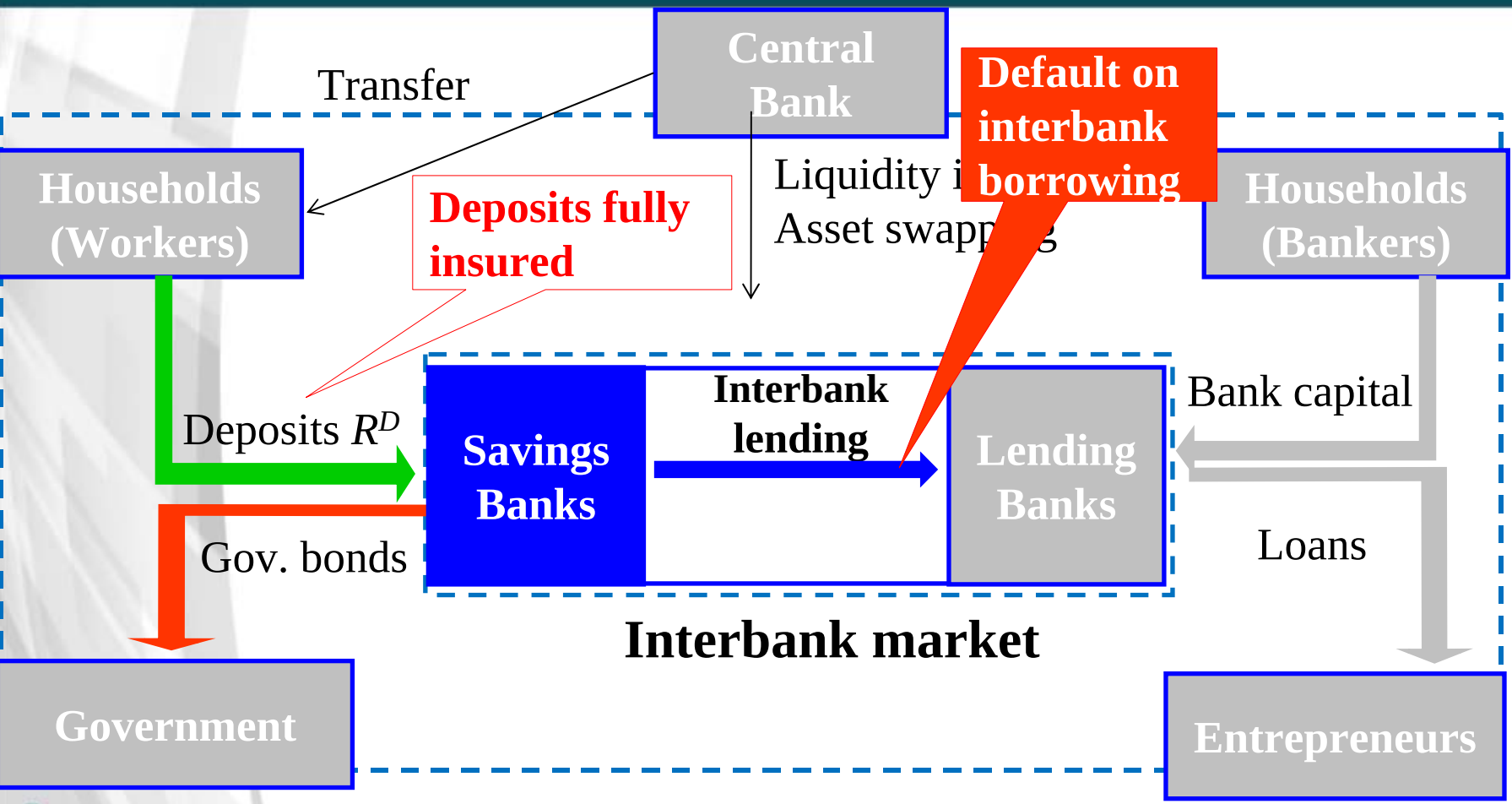

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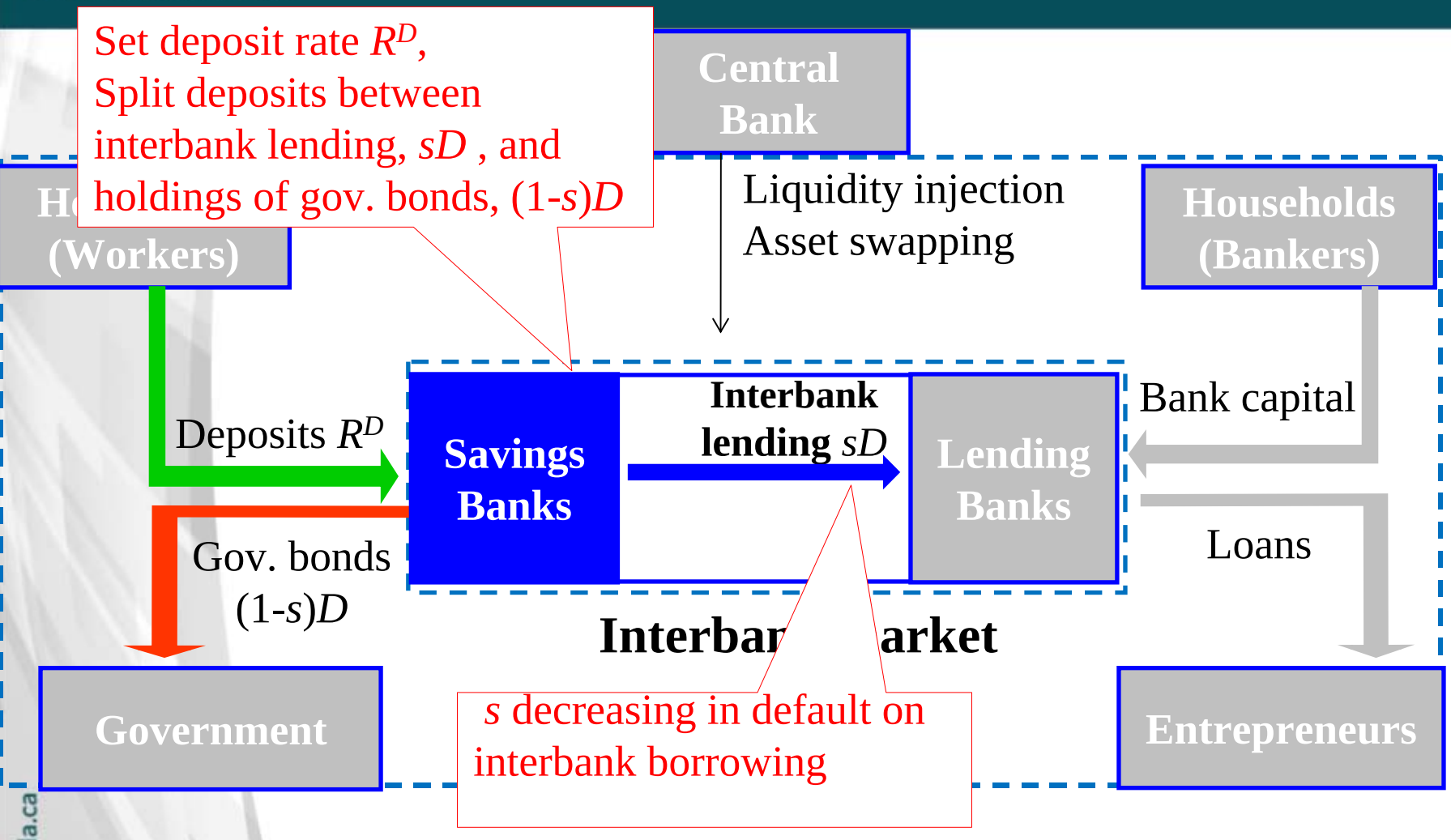

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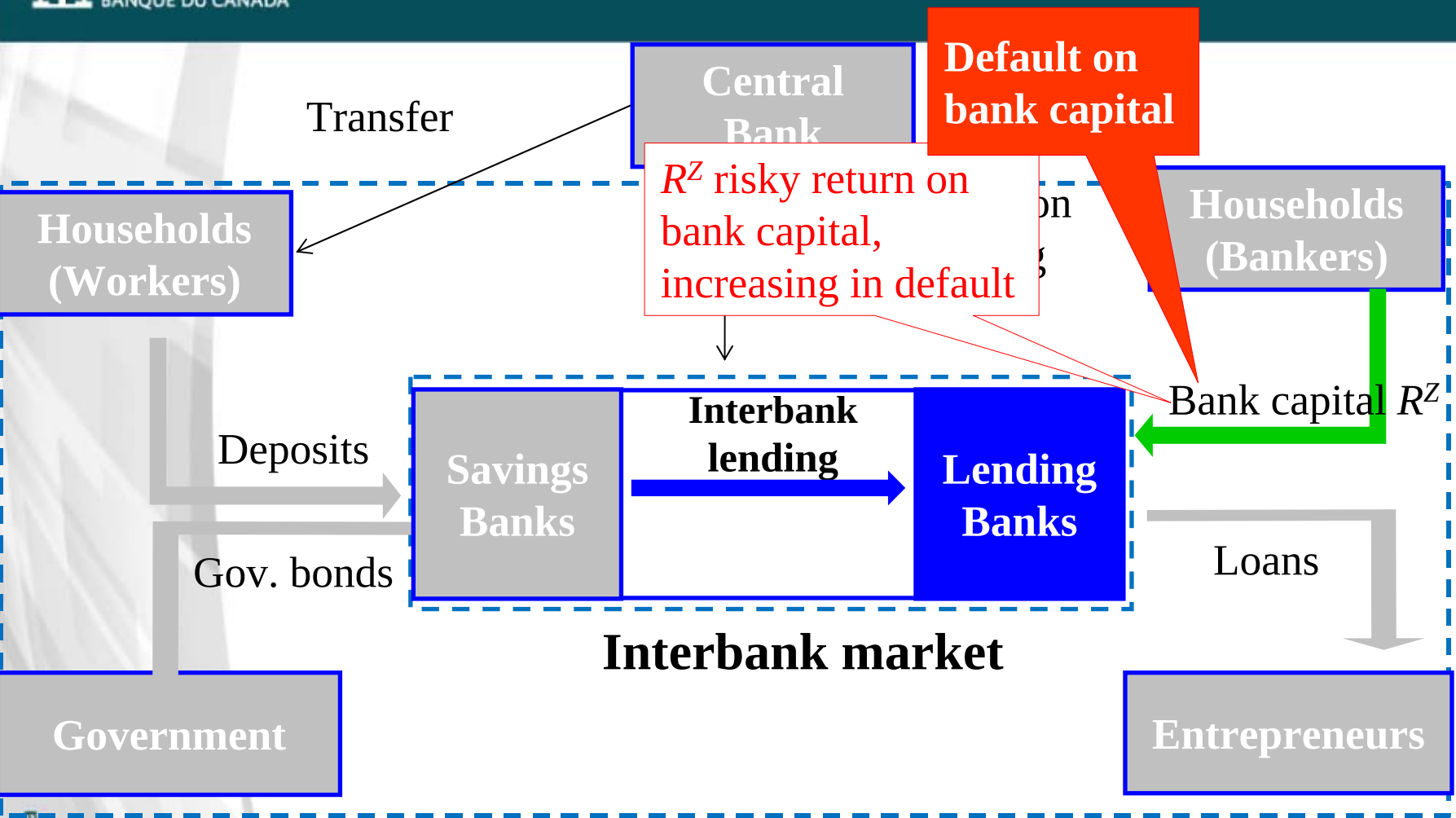

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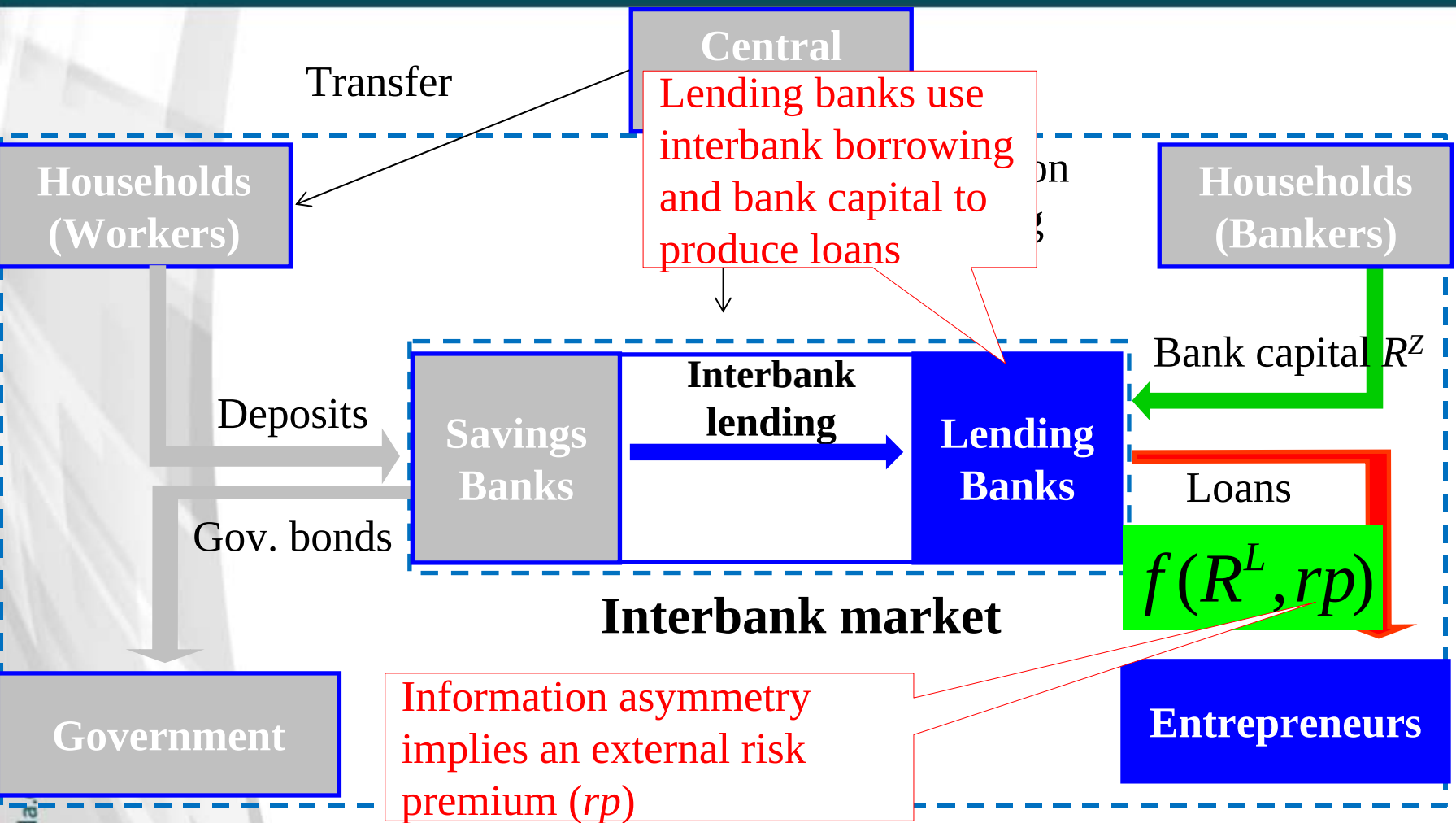

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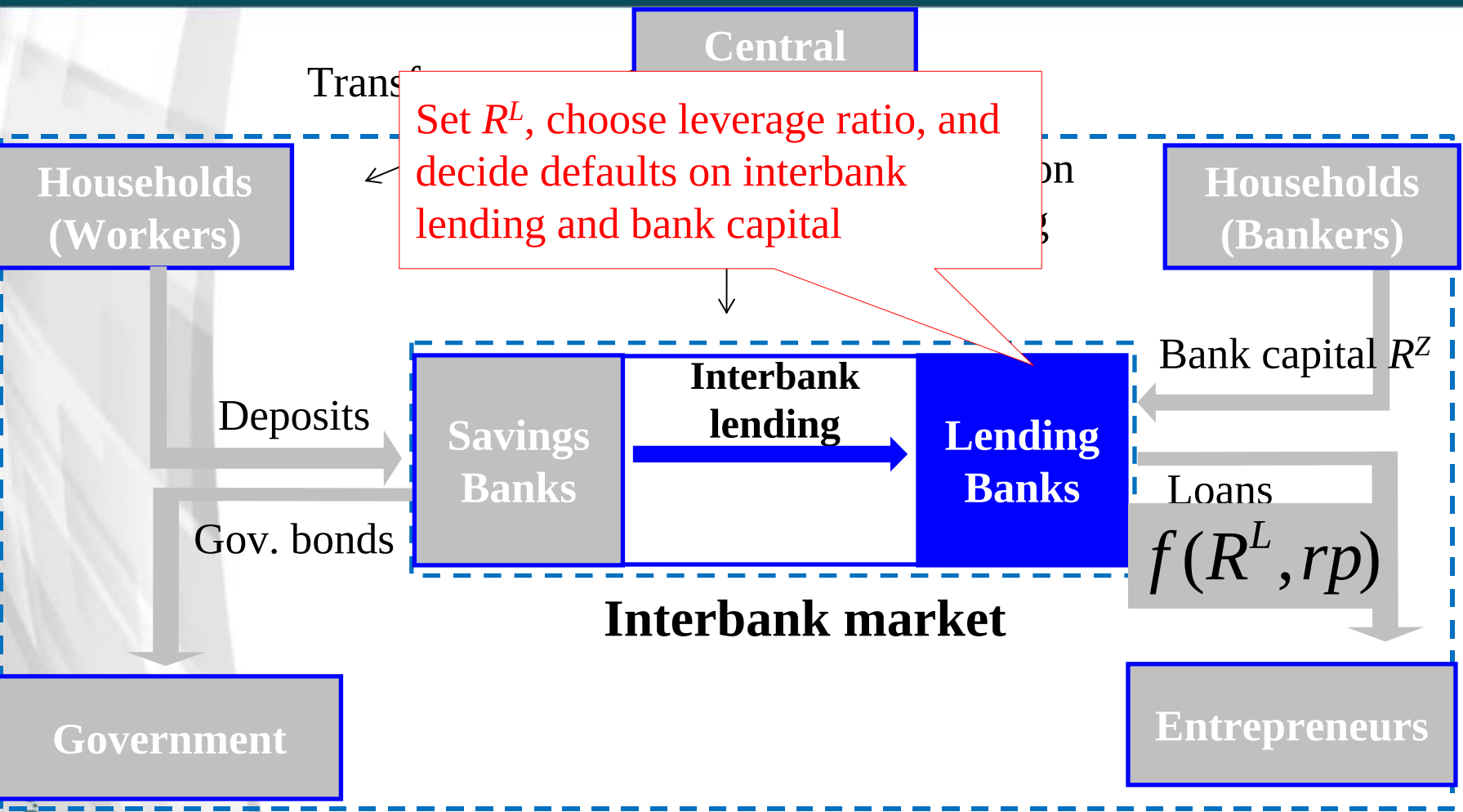

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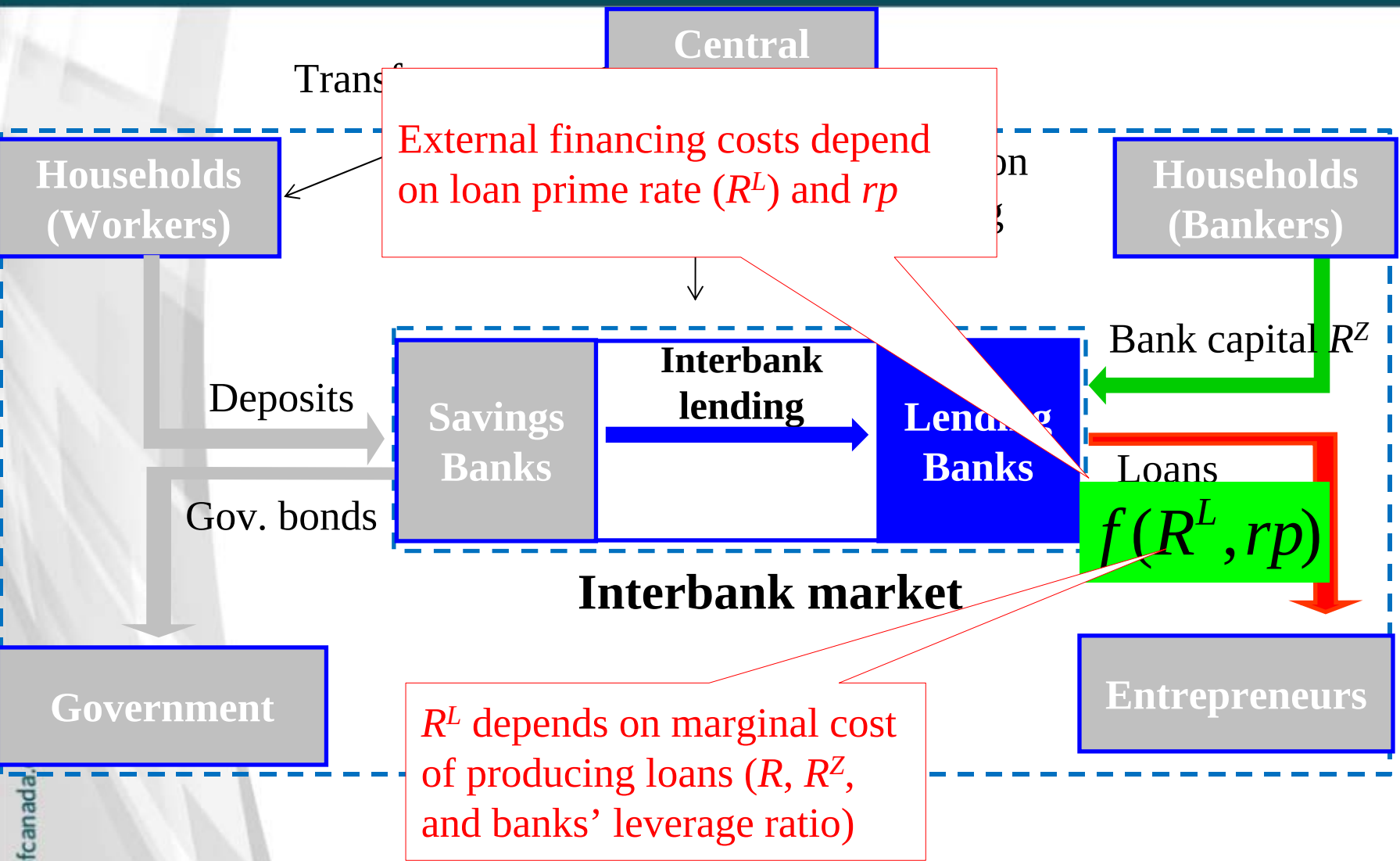

Banks

Savings banks

- Collect deposits from households (workers)
- Lend in the interbank market
- Set deposit rates as mark-down of the interbank rate
- Optimally choose the composition of their portfolio: interbank lending and holdings of risk-free assets
- Face default on their interbank lending

Savings banks

Savings banks' balance sheet

Assets	**Liabilities**
Gov. bonds: (1-*s*)*D* Interbank lending: *sD*	Deposits: *D*

Lending banks

- Receive bank capital from households (bankers)
- Borrow on the interbank market
- Optimally choose their leverage ratio
- Set prime lending rate as mark-up of the marginal cost of producing loans
  - Marginal cost depends on the interbank rate and the marginal cost of raising bank capital, which is increasing in the bank leverage ratio
- Optimally decide to default on interbank borrowing and/or bank capital

Lending banks

- Produce loans using interbank borrowing and bank capital according to:

$$L_t = \min\left\{s_t D_t + m_t, \kappa_t\left(Q_t^Z Z_t + x_t\right)\right\}\Gamma_t$$

Loans

Risky assets

Interbank borrowing

$0 \leq s \leq 1$
D = deposits

Bank capital value

Z=claims on bank capital
Q^Z = price of bank capital

Lending banks

- Produce loans using interbank borrowing and bank capital according to:

$$L_t = \min\left\{s_t D_t + m_t, \kappa_t\left(Q_t^Z Z_t + x_t\right)\right\}\Gamma_t$$

Maximum imposed leverage ratio

Leverage ratio subject to $\kappa_t \leq \bar{\kappa}$ and gains of holdings of bank capital in excess: $\frac{\chi}{2}\left(\frac{\bar{\kappa} - \kappa_t}{\bar{\kappa}} Q_t^Z Z_t\right)^2$

Lending banks

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Liquidity injections

Asset swapping

Financial intermediation shocks:
- -Risk perception
- -Fin. innovation
- -Banking tech.
- -Off-bal. sheet operations

Lending banks

- Prime lending rate:

$$R_t^L = \frac{\vartheta_L}{\vartheta_L - 1}\zeta_t - Adj_t' + \beta E_t[Adj_{t+1}']$$

- Marginal cost of producing loans

$$\zeta_t = \Gamma_t^{-1}\left[R_t + \kappa_t^{-1}Q_t^Z\left(R_{t+1}^Z - R_t - (R_t^L - 1)\left(\frac{\bar{\kappa} - \kappa_t}{\bar{\kappa}}\right)\right)\right]$$

Lending banks

- Prime lending rate:

$$R_t^L = \frac{\vartheta_L}{\vartheta_L - 1}\zeta_t - Adj'_t + \beta E_t[Adj'_{t+1}]$$

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Cost of interbank borrowing

Lending banks

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Cost of interbank borrowing

Cost of bank capital is increasing in leverage ratio

Lending banks

- Prime lending rate:

$$R_t^L = \frac{\vartheta_L}{\vartheta_L - 1}\zeta_t - Adj'_t + \beta E_t[Adj'_{t+1}]$$

- Marginal cost of producing loans

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Cost of interbank borrowing

Cost of bank capital is increasing in leverage ratio

Marginal gain of holding bank capital in excess is decreasing in leverage ratio

Lending banks

Lending banks' balance sheet

Assets	Liabilities
Gov. bonds: $Q^Z Z + x$ Loans: $L - x$ $(L = sD + m)$	Bank capital: $Q^Z Z$ Interbank borrowing: sD Liquidity injection: m Others: $(\Gamma - 1)(sD + m)$

- x = qualitative (credit) easing shock (swap a fraction of banks' risky assets for risk-free assets)
- m = quantitative easing shock (liquidity injections that expend balance sheets)

Simulation Results

Simulation results

- Two versions of the model have been simulated:
  - **Baseline model**: the model with the banking sector and the financial accelerator
  - **FA model**: the model with only the financial accelerator (without the banking sector)

Simulation results

Table 1: Volatilities (Data 80:1-08:4)

Variables	Data	Baseline	FA
A. Standard deviations in %			
Output	1.27	**1.48**	2.21
Investment	6.15	**7.20**	9.64
Consumption	1.06	**1.26**	1.61
Loans	4.21	**4.80**	4.24
Risk premium	0.38	**0.44**	0.51
B. Relative volatilities			
Output	1	1	1
Investment	4.84	4.86	4.36
Consumption	0.83	0.85	0.73
Loans	3.31	3.25	1.91
Risk premium	0.30	0.30	0.23

Lower volatilities compared to FA, except for loans

Calibrated to reproduce relative volatilities

Simulation results

Table 2: Correlations with output (Data 80:1-08:4)

Variables	Data	Baseline	FA
Output	1	1	1
Investment	0.87	0.79	0.87
Consumption	0.84	0.53	0.43
Loans	0.20	0.30	0.17
Risk premium	**-0.30**	**-0.28**	-0.55
Share of inter. lending	+	0.34	.
Bank leverage	+	0.51	.
Default on inter. lending	-	-0.35	.
Default on bank capital	-	-0.27	.

Counter-cyclical

procyclical interbank lending and bank leverage

countercyclical defaults

Impulse Responses

Impulse Response Functions

- Propagation of standard shocks
  - Technology shock
- Structural financial shocks
  - Riskiness shock
  - Financial intermediation shock
- Unconventional monetary policy shocks
  - Liquidity injection (quantitative monetary easing)

Technology shocks

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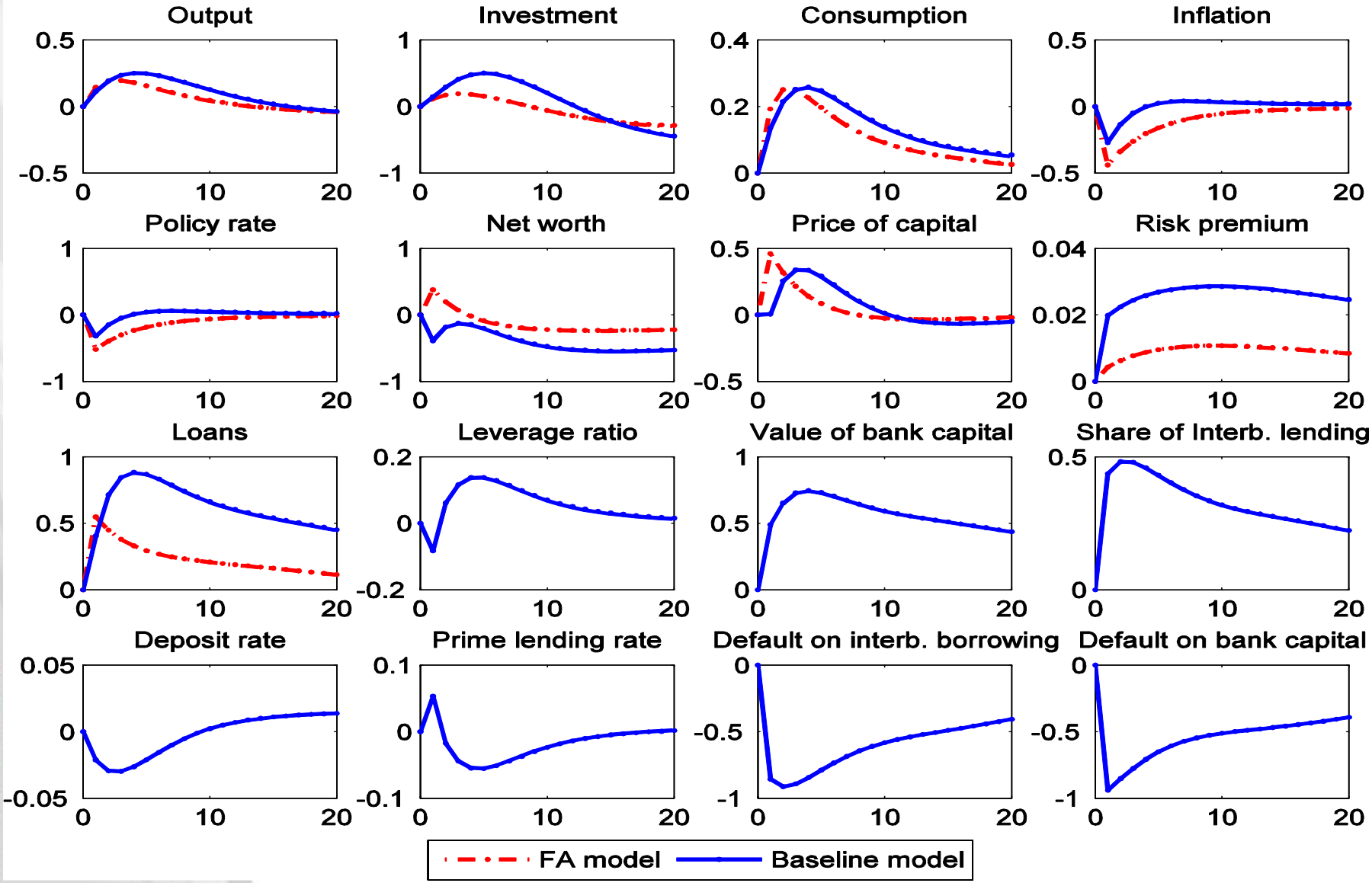
Figure 1: Responses to technology shocks



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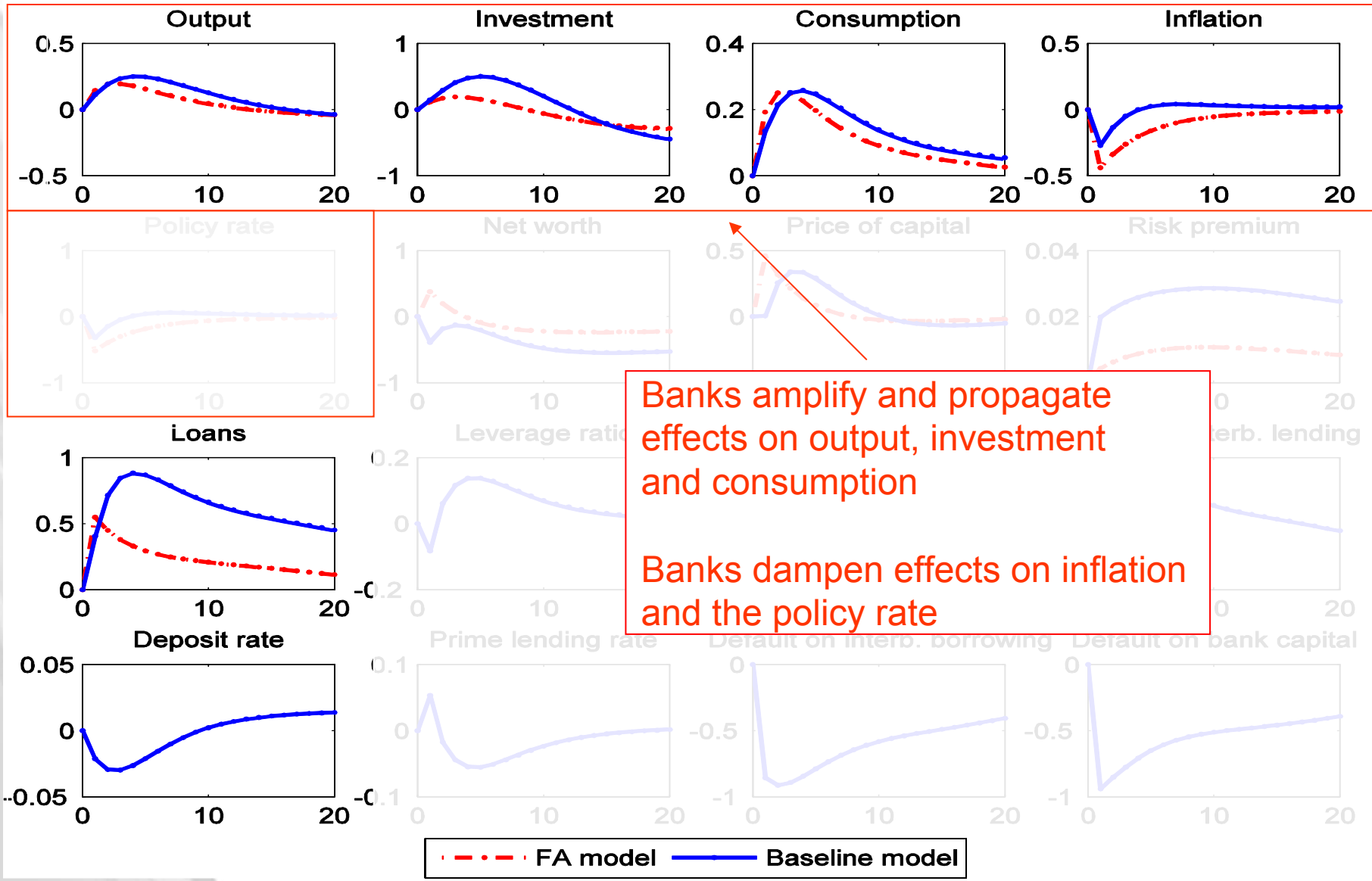

Banks amplify and propagate effects on output, investment and consumption

Banks dampen effects on inflation and the policy rate

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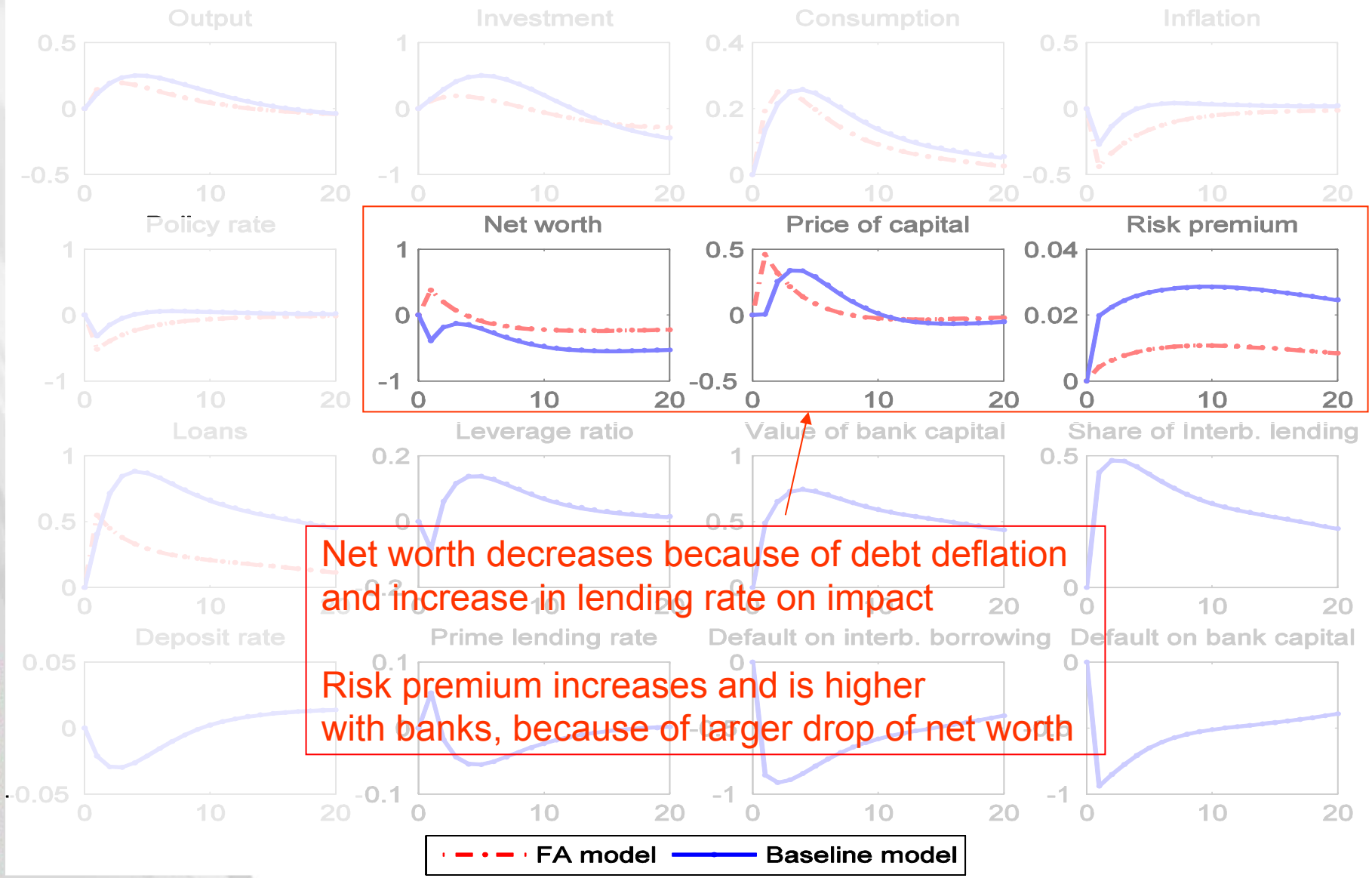
Figure 1: Responses to technology shocks



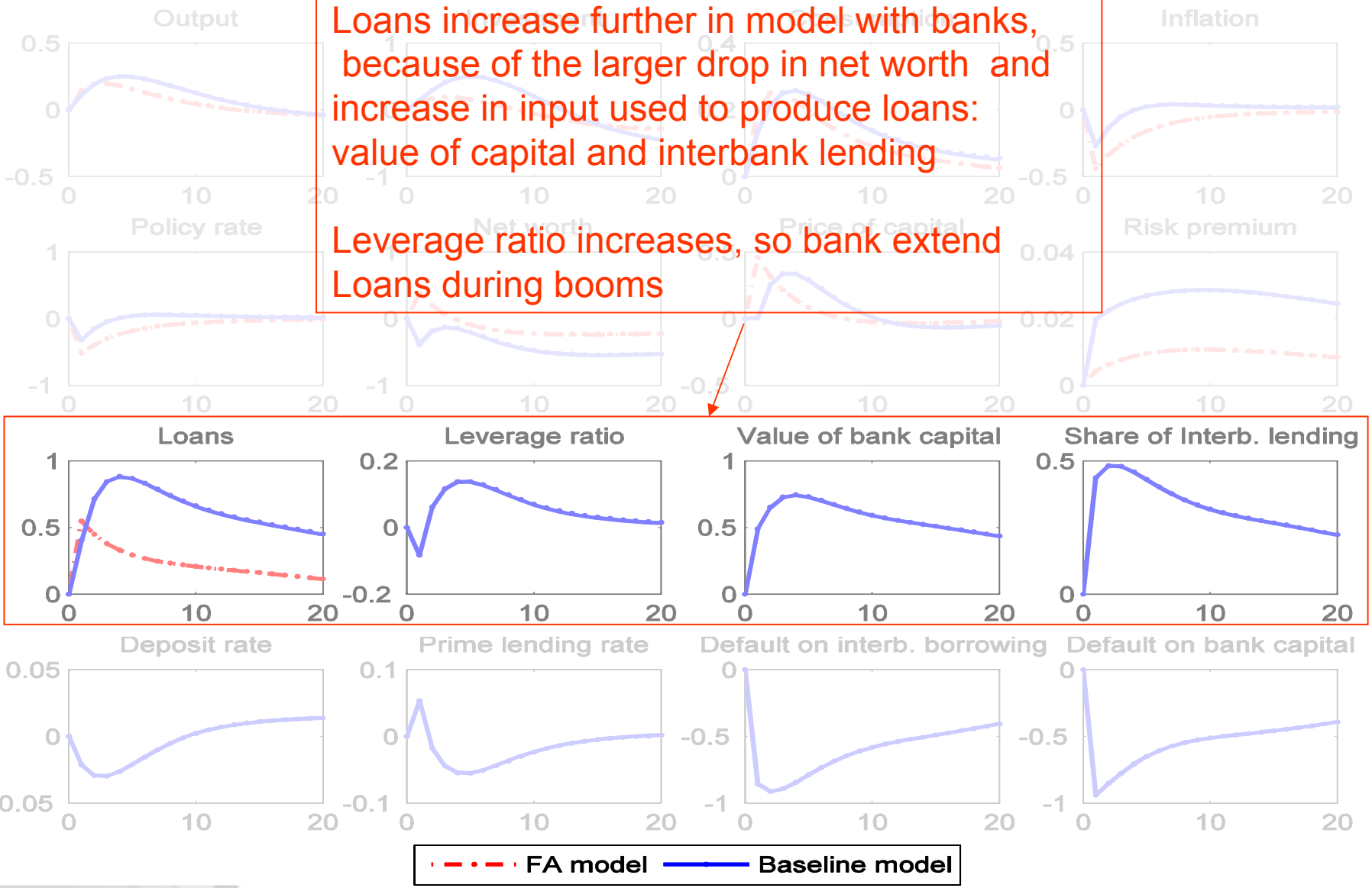
Net worth decreases because of debt deflation and increase in lending rate on impact

Risk premium increases and is higher with banks, because of larger drop of net worth

Figure 1: Responses to technology shocks

Loans increase further in model with banks, because of the larger drop in net worth and increase in input used to produce loans: value of capital and interbank lending

Leverage ratio increases, so bank extend Loans during booms



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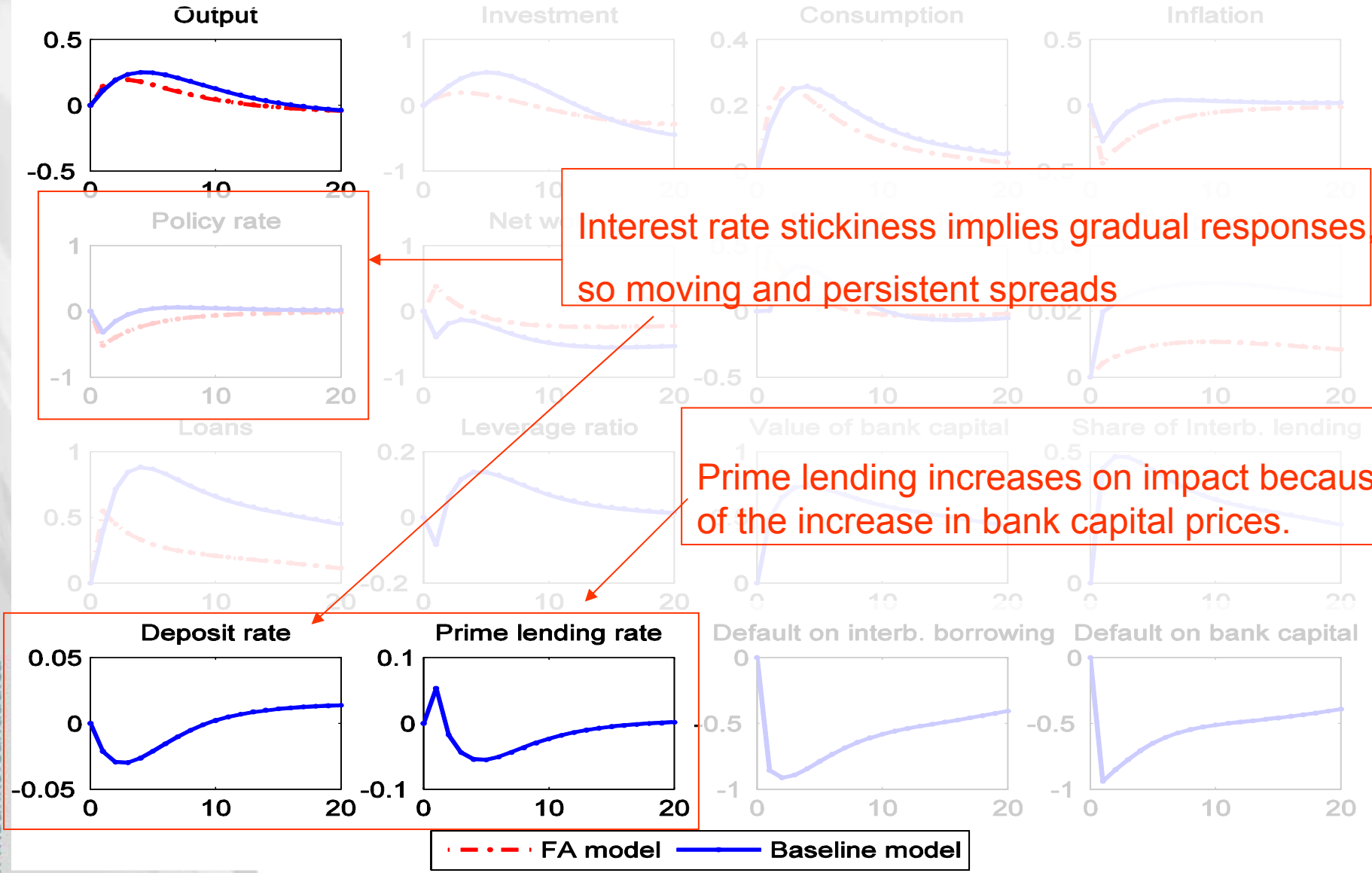
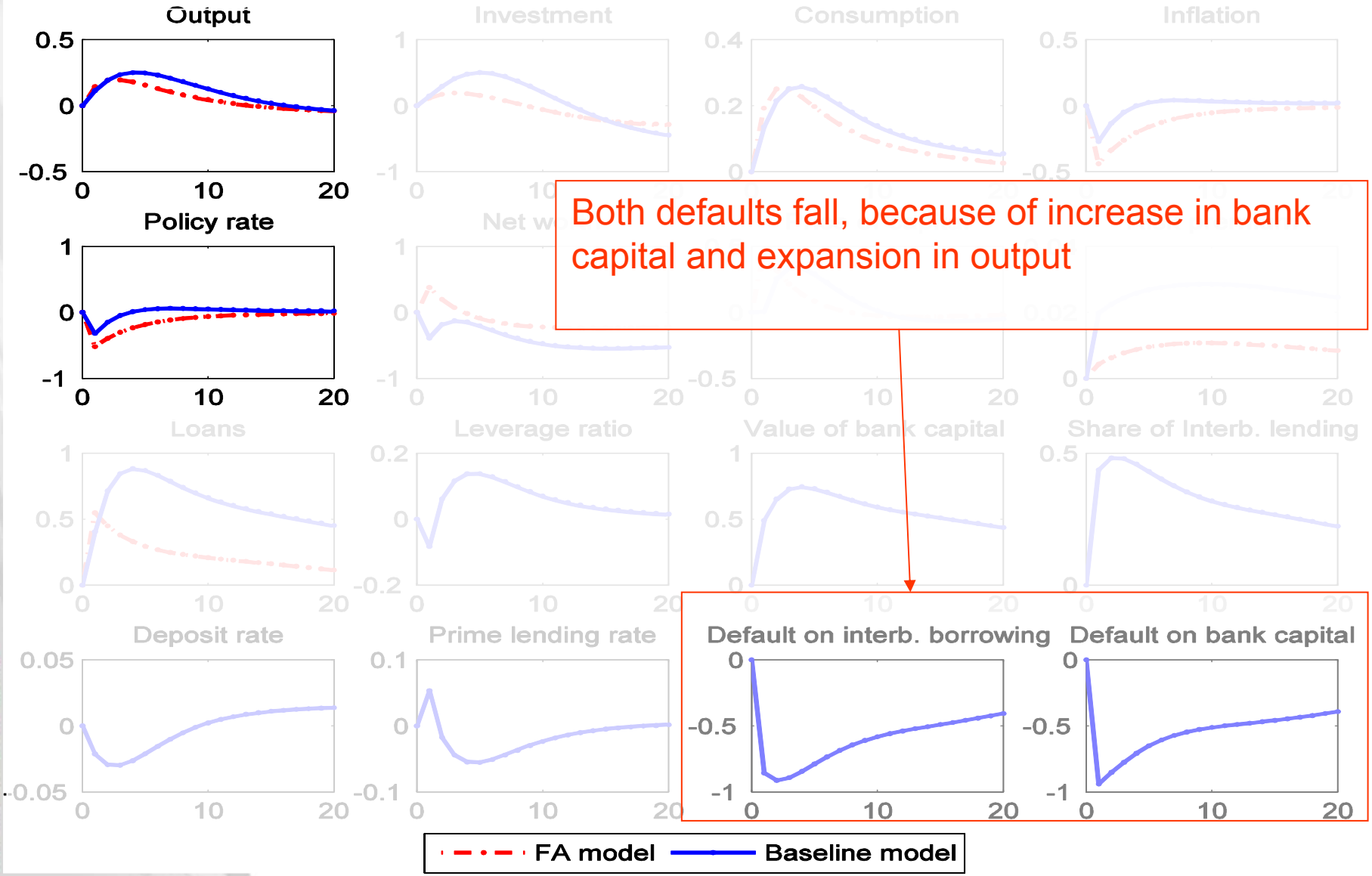


Interest rate stickiness implies gradual responses, so moving and persistent spreads

Prime lending increases on impact because of the increase in bank capital prices.

Figure 1: Responses to technology shocks



Financial shocks

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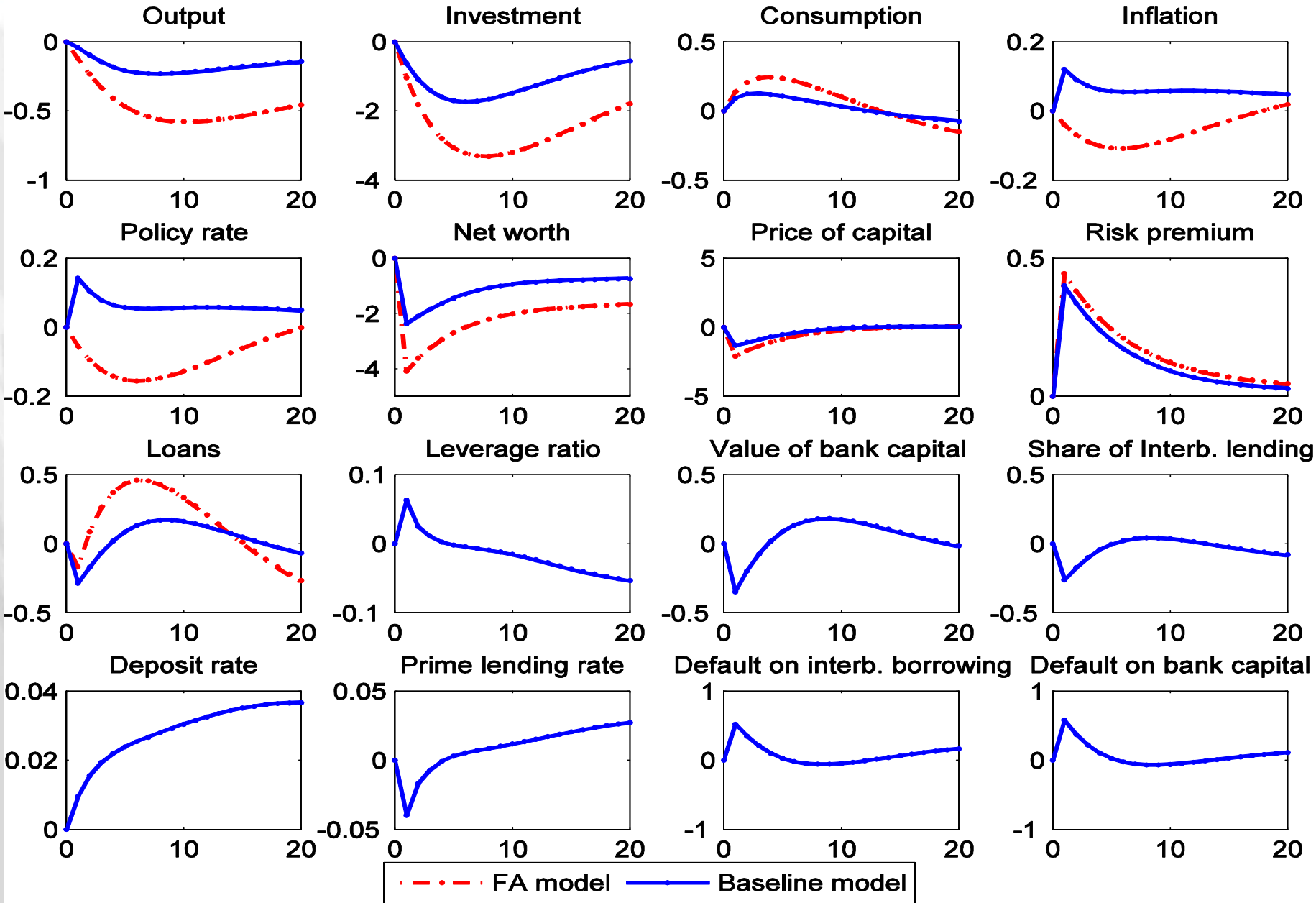
Figure 2: Responses to Riskiness shocks



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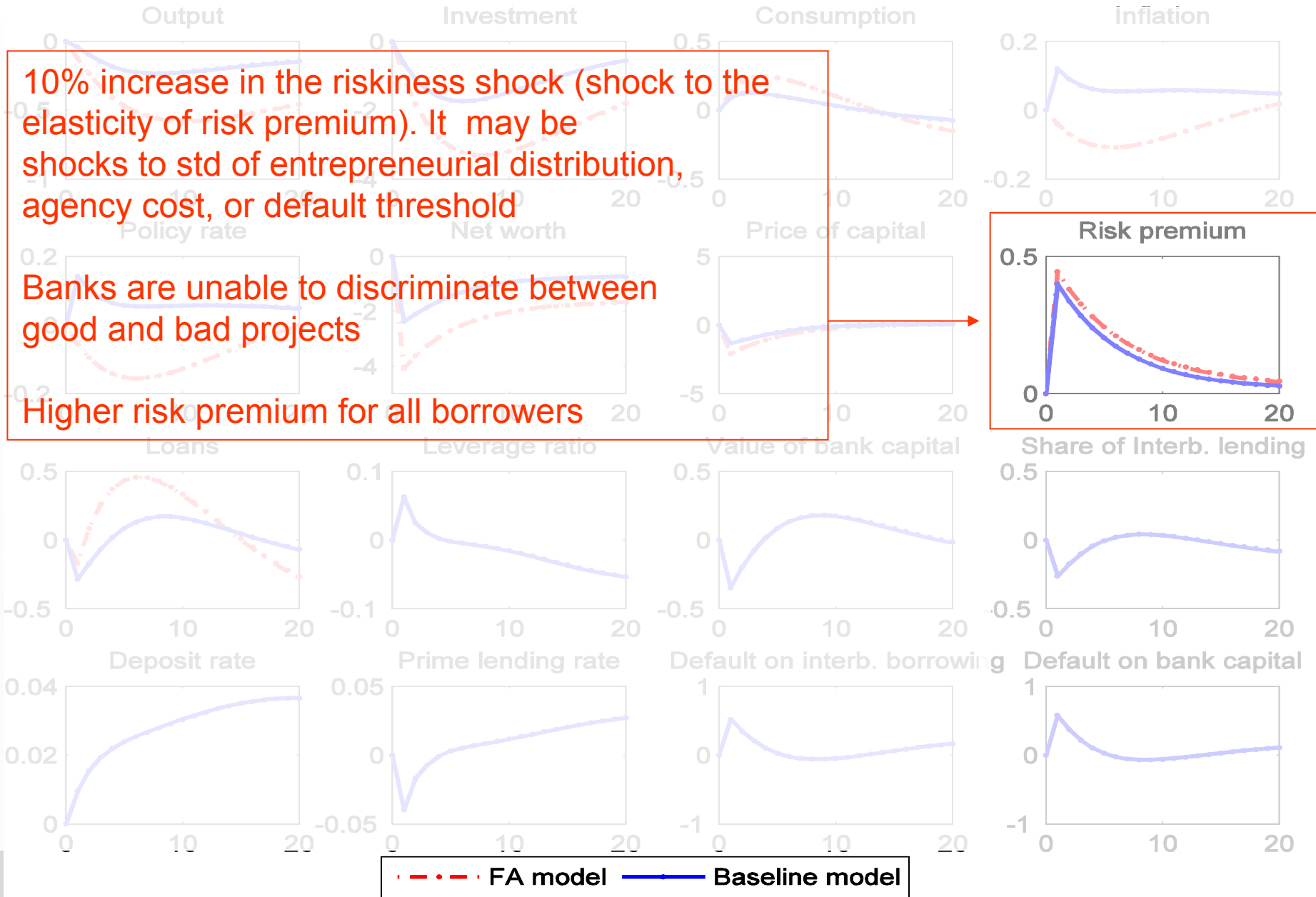

10% increase in the riskiness shock (shock to the elasticity of risk premium). It may be shocks to std of entrepreneurial distribution, agency cost, or default threshold

Banks are unable to discriminate between good and bad projects

Higher risk premium for all borrowers

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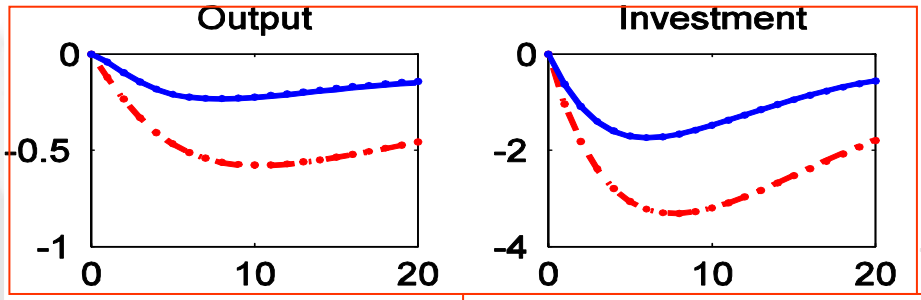
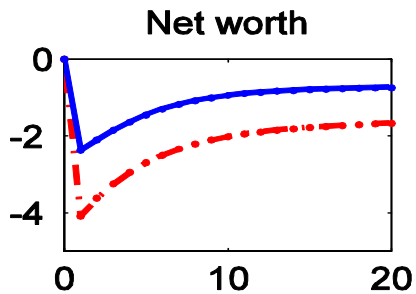
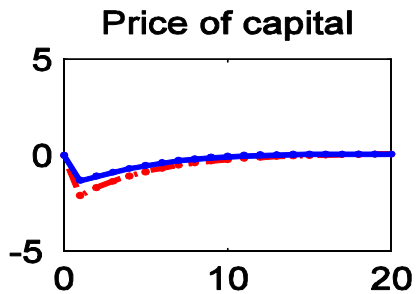
Figure 2: Responses to Riskiness shocks

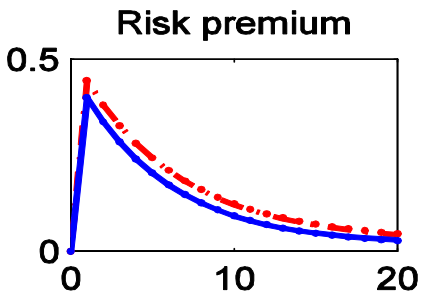


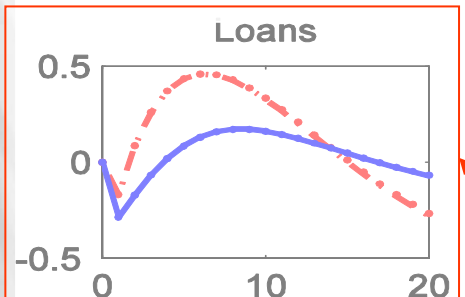
Higher risk premium lowers net worth. Thus, investment and output

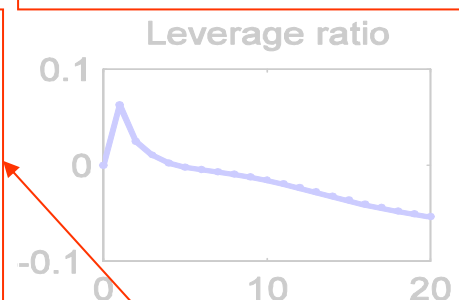
Drops are lower in the model with banks.

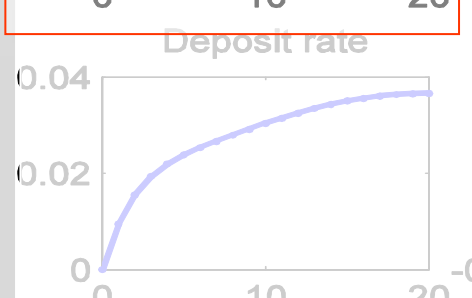


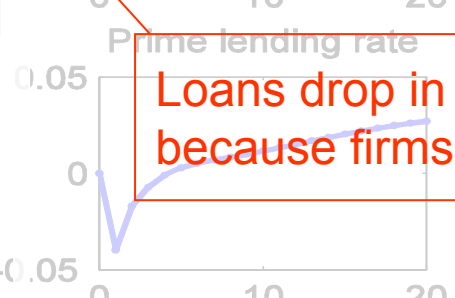


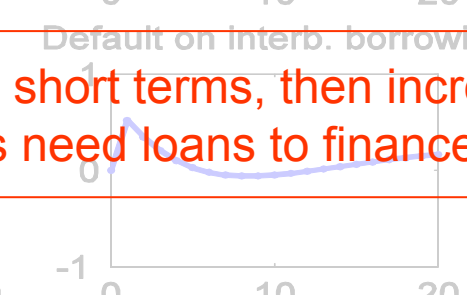


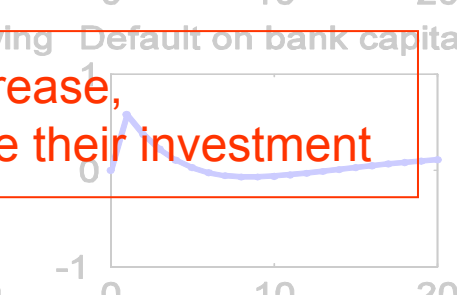












Loans drop in short terms, then increase, because firms need loans to finance their investment

FA model — Baseline model

Figure 2: Responses to Riskiness shocks

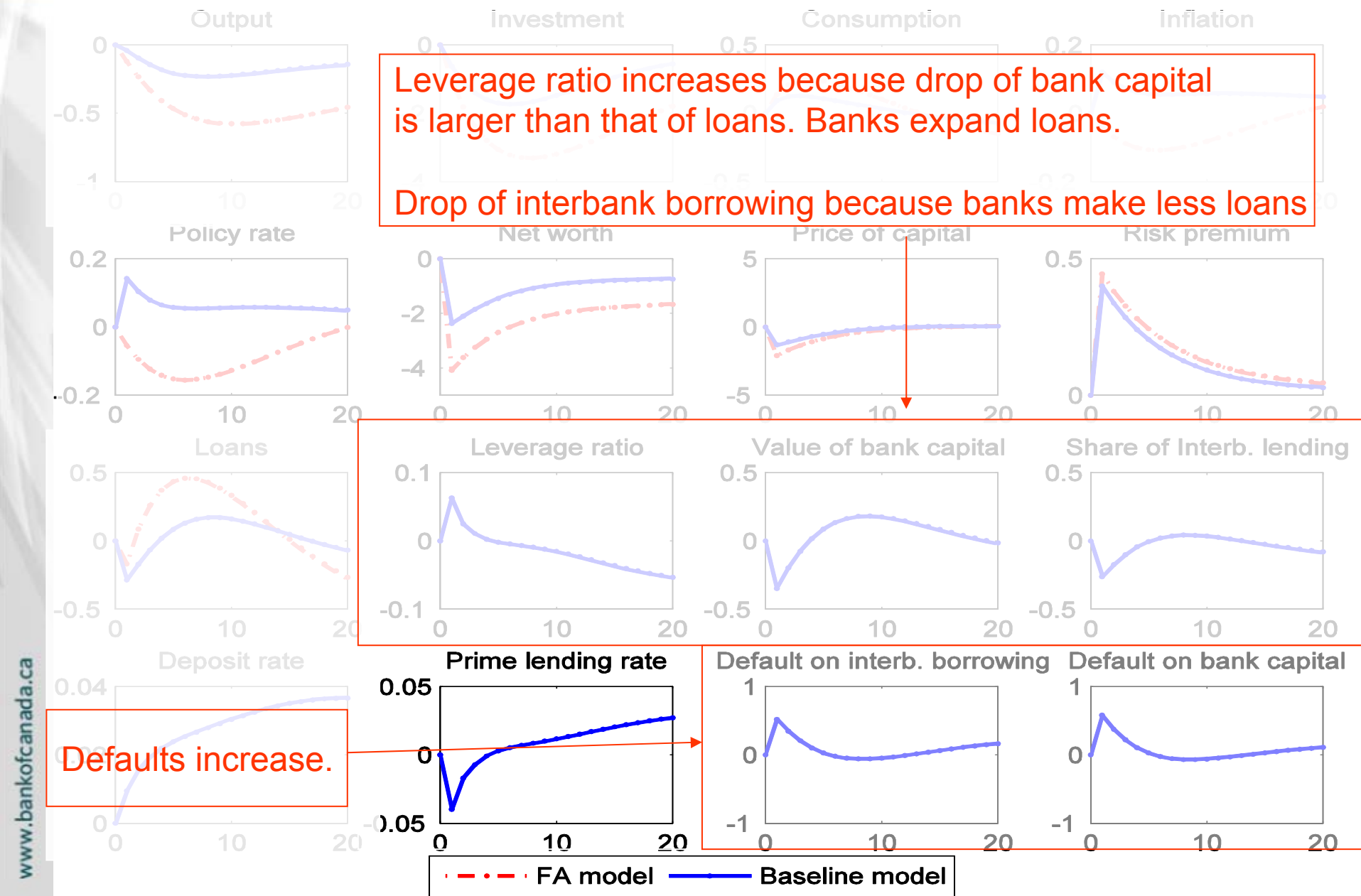


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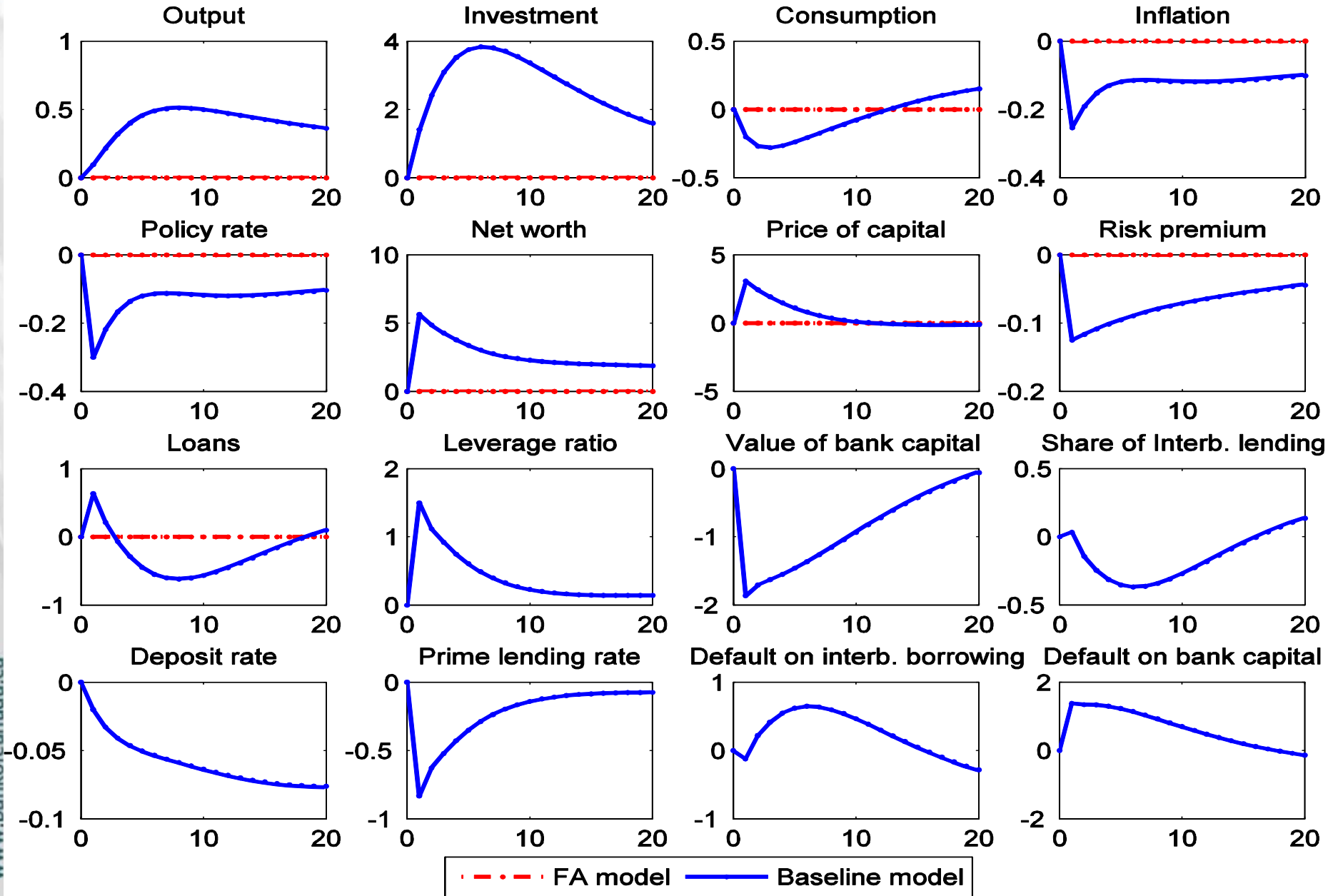
Figure 3: Financial Intermediation Shocks



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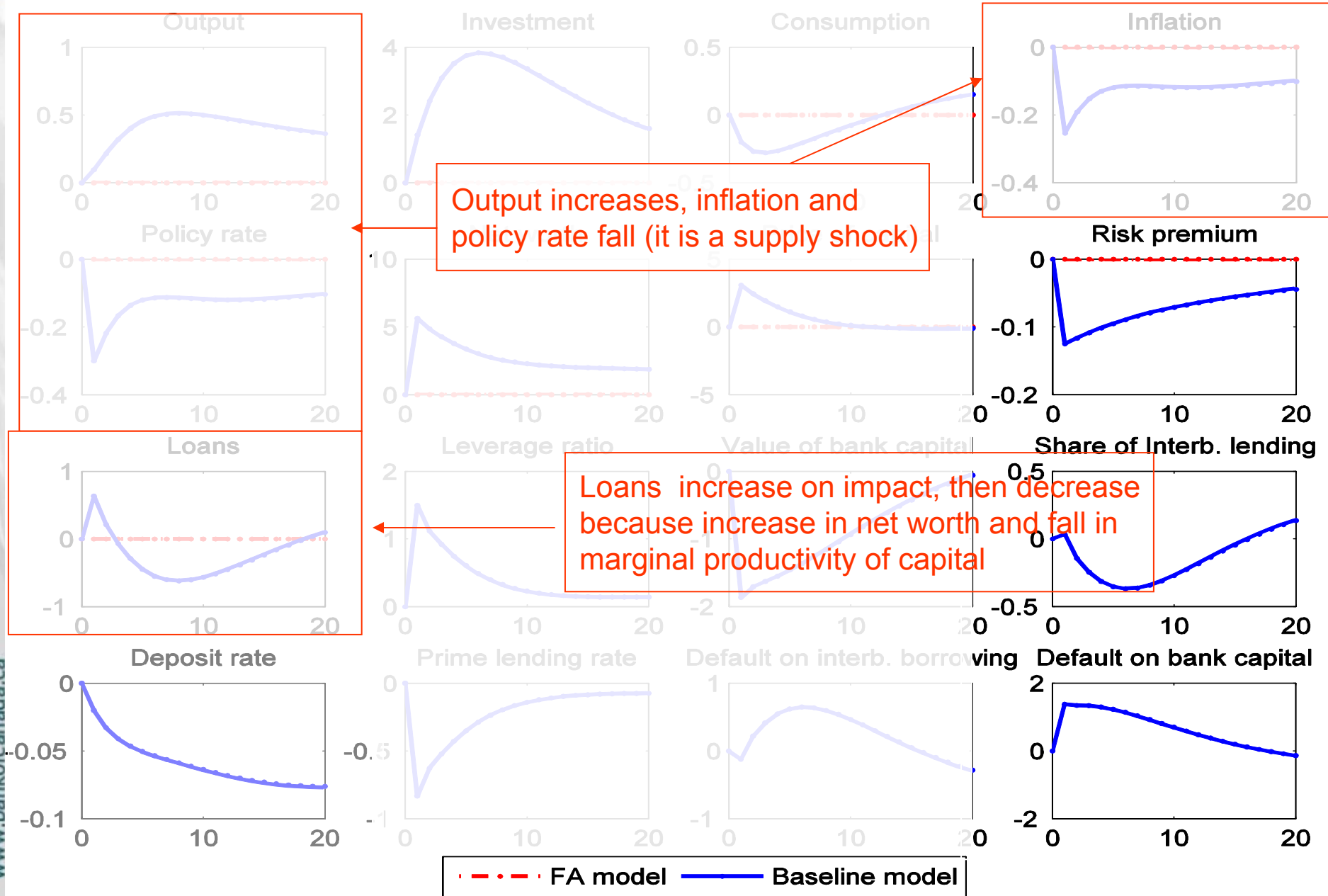

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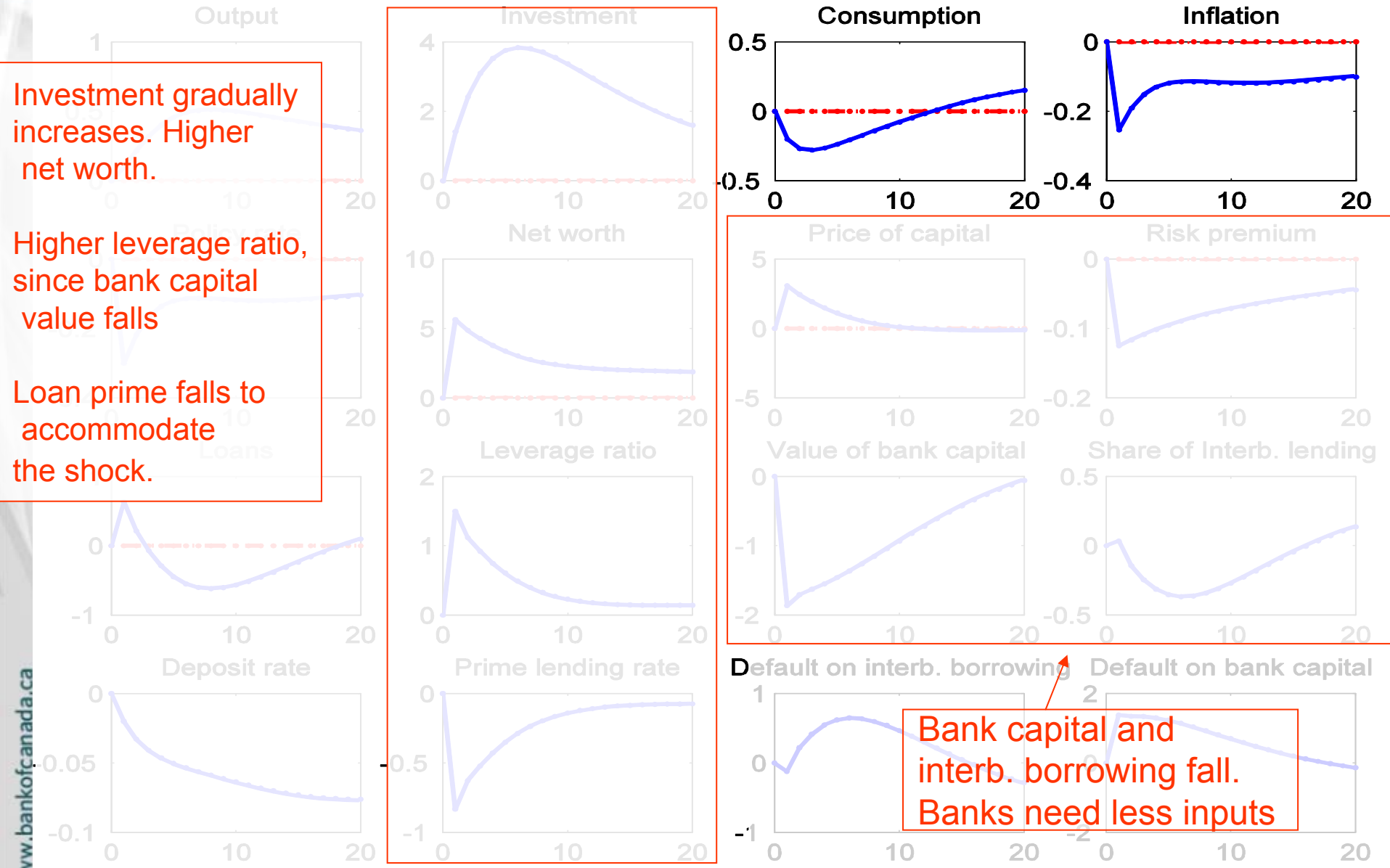

Investment gradually increases. Higher net worth.

Higher leverage ratio, since bank capital value falls

Loan prime falls to accommodate the shock.

Bank capital and interb. borrowing fall. Banks need less inputs

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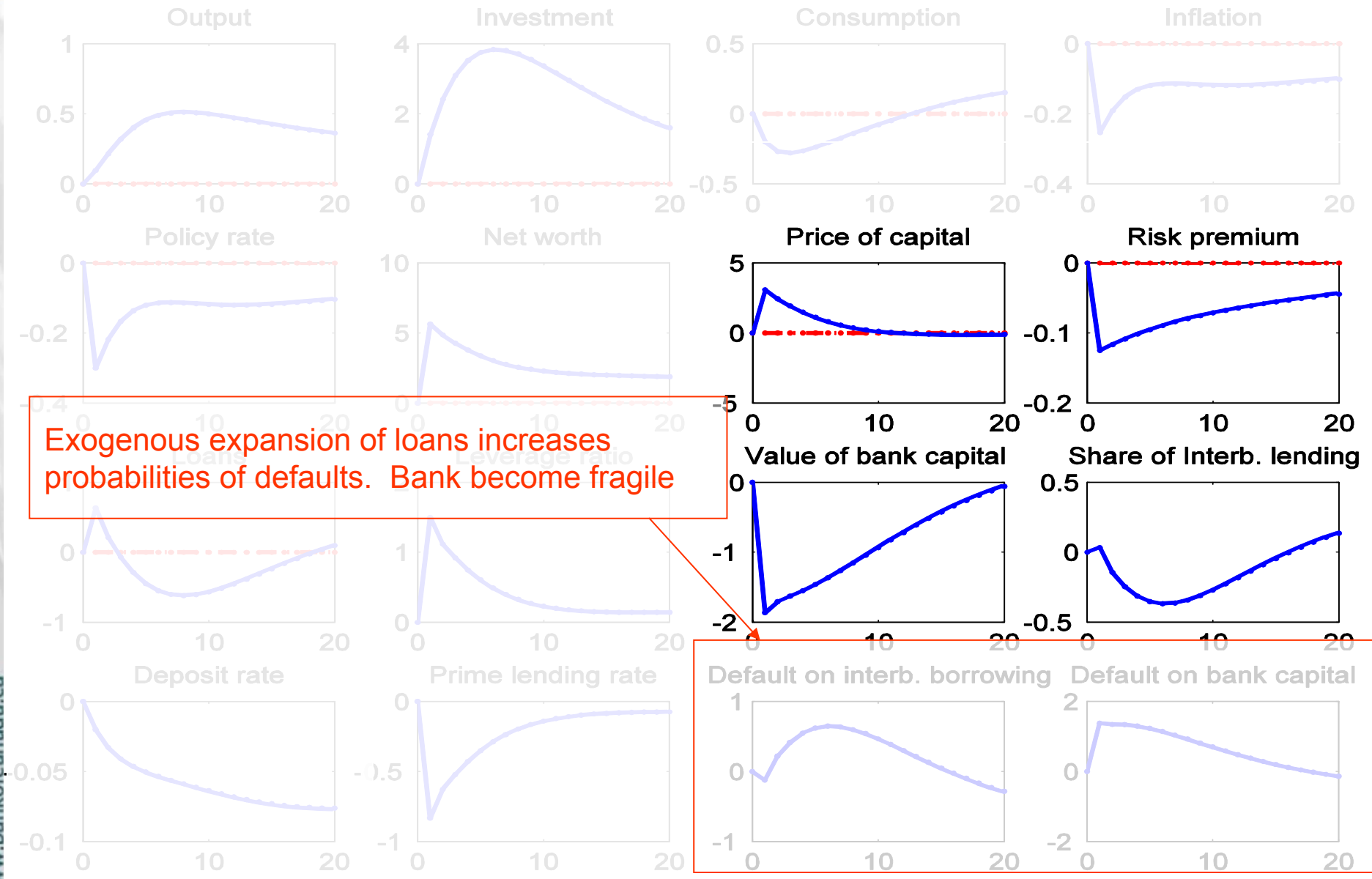
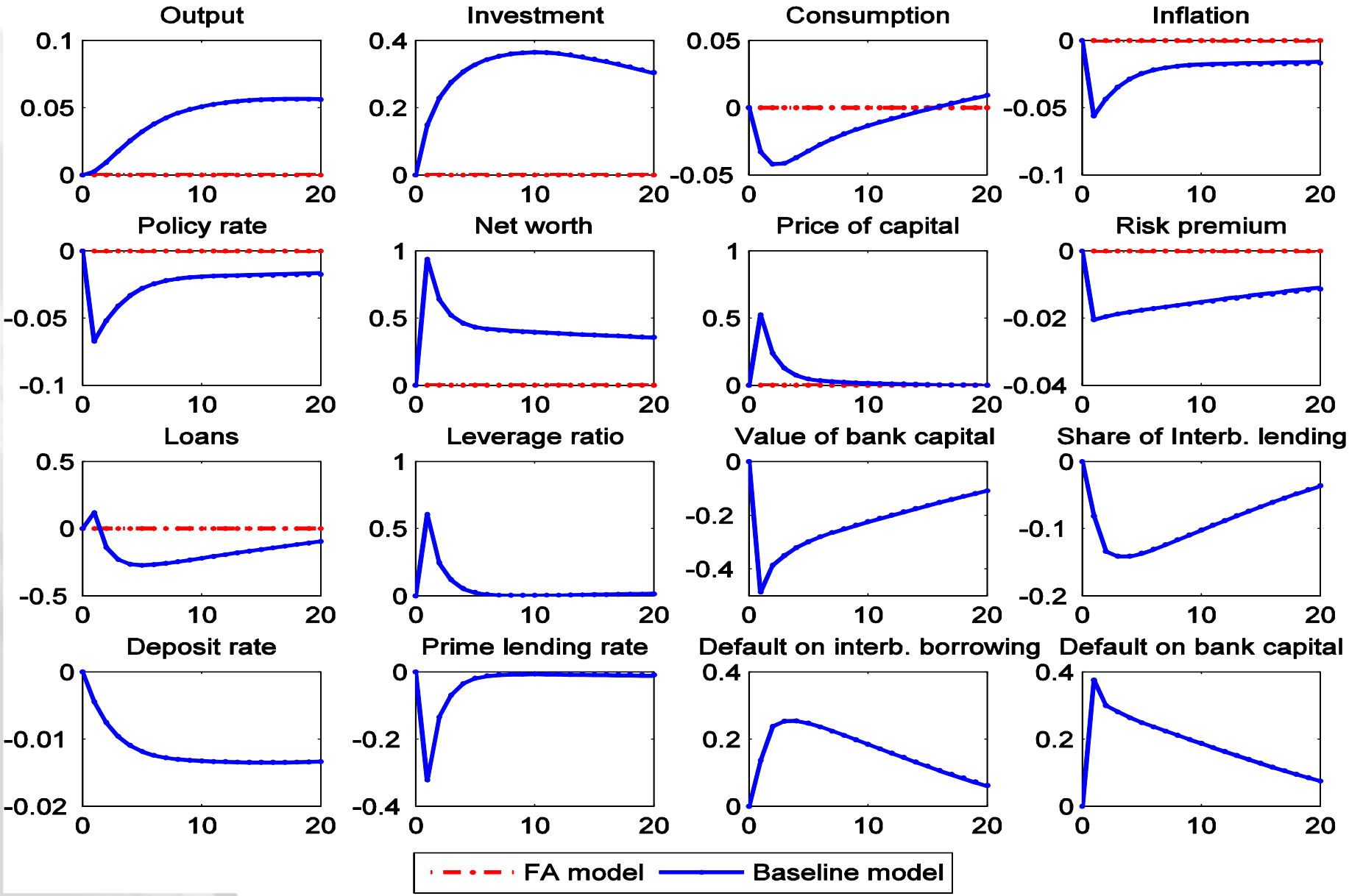


Unconventional monetary policy shocks

Figure 4: Monetary Injection Shocks



BANK OF CANADA
BANQUE DU CANADA

Figure 4: Monetary Injection Shocks

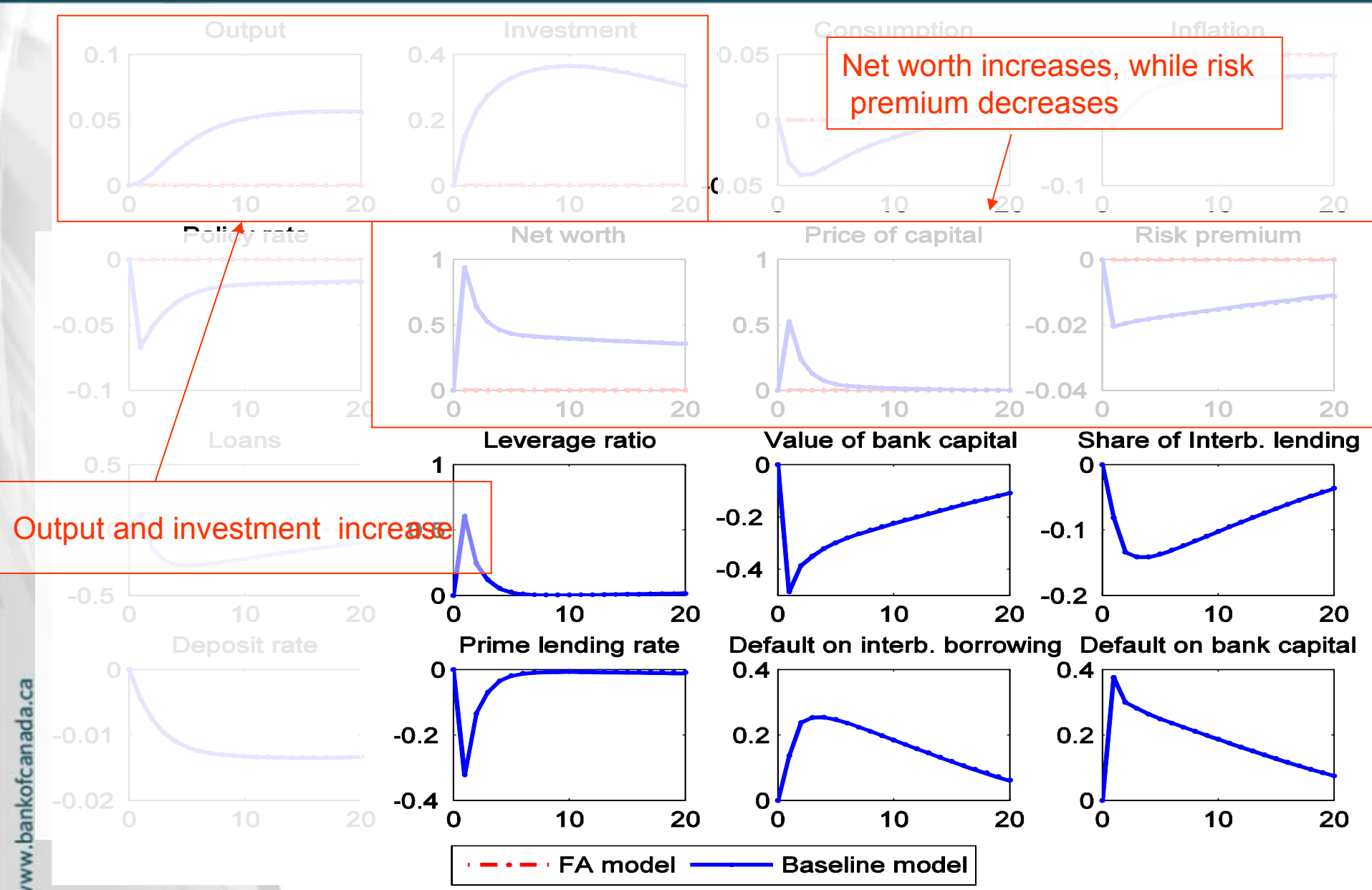
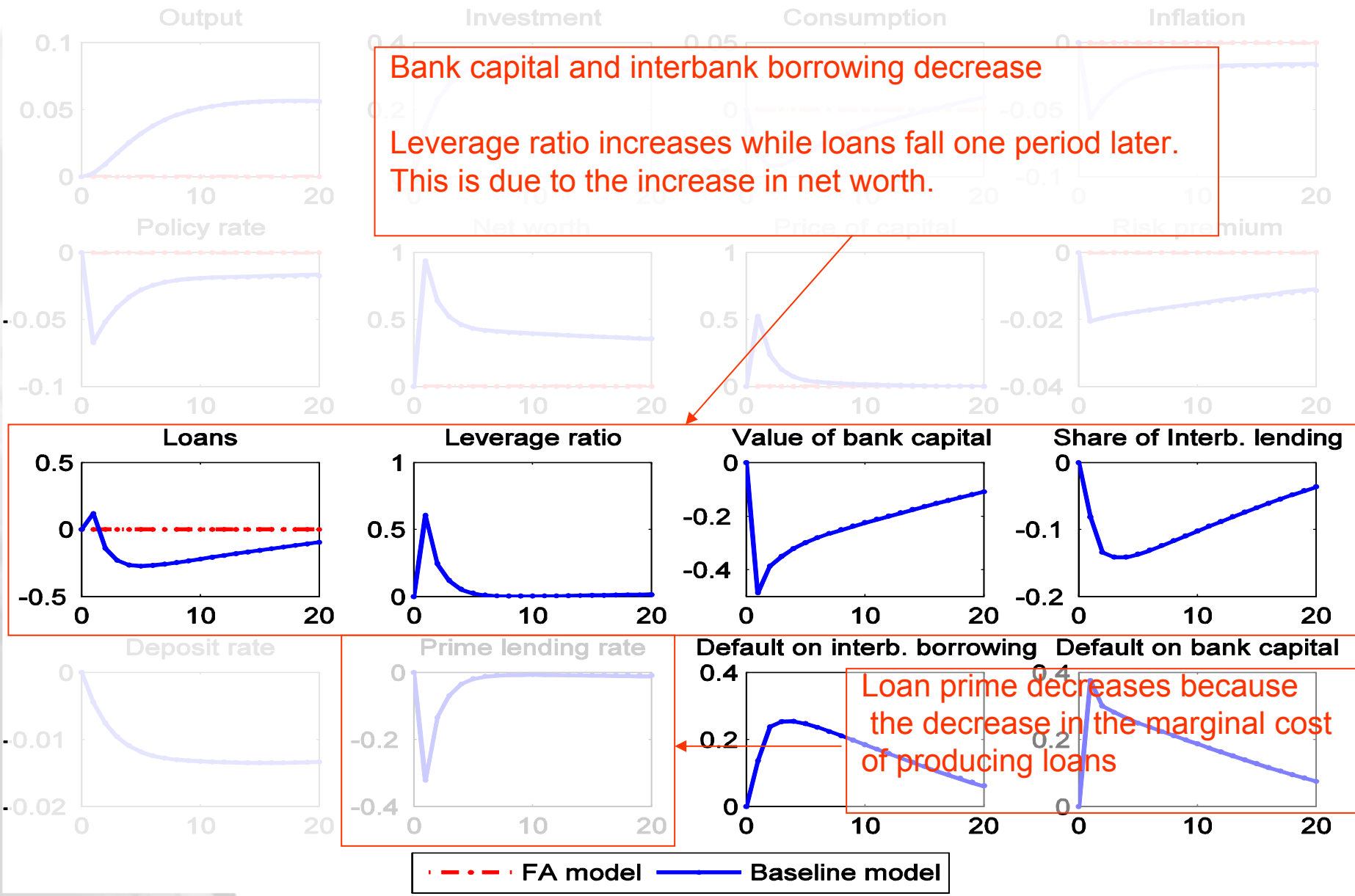


Figure 4: Monetary Injection Shocks

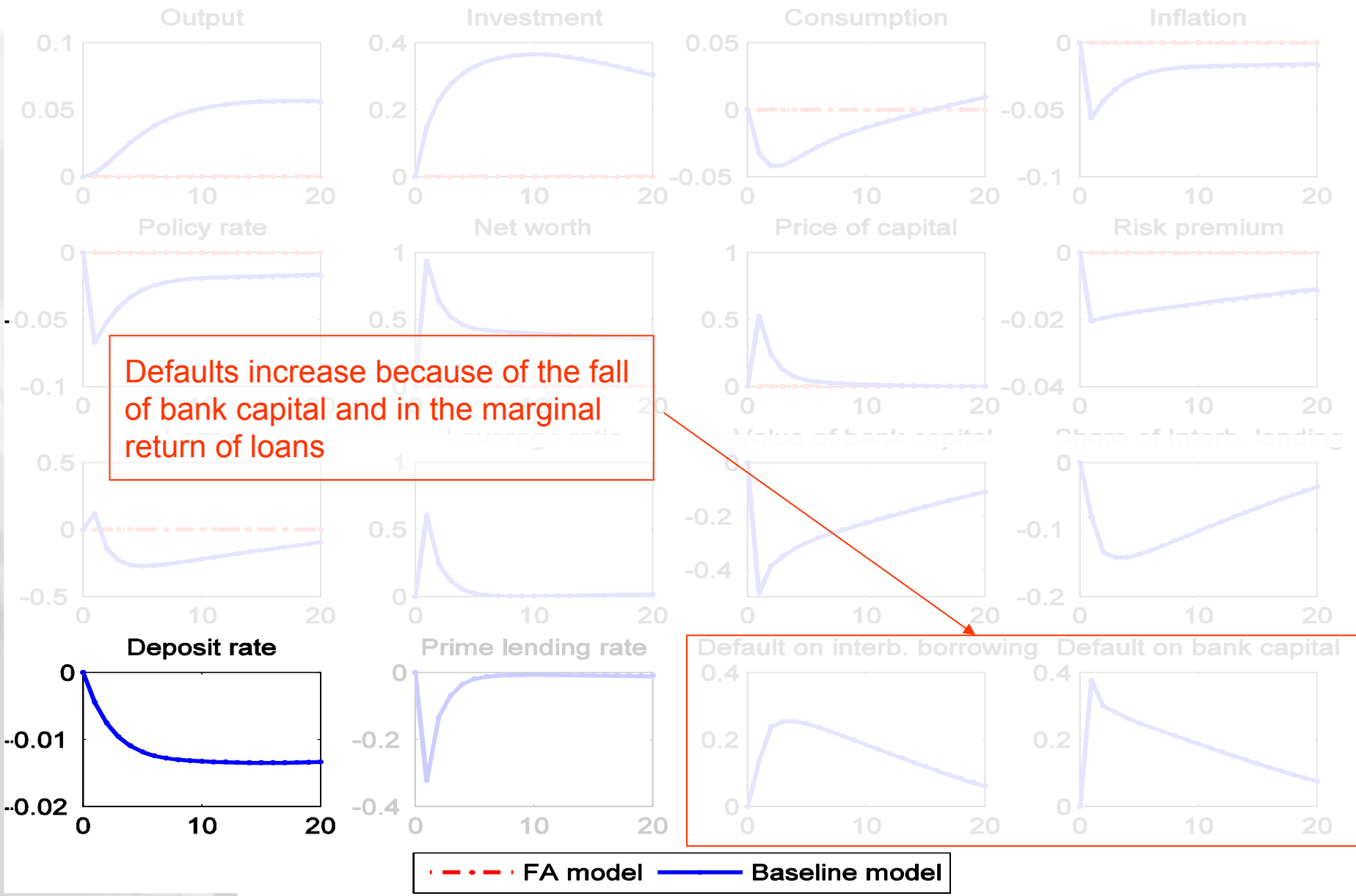


Bank capital and interbank borrowing decrease

Leverage ratio increases while loans fall one period later. This is due to the increase in net worth.

Loan prime decreases because the decrease in the marginal cost of producing loans

Figure 4: Monetary Injection Shocks



Conclusion

- We propose a micro-founded framework to model active banks and an interbank market: new sources of fluctuations and propagation mechanisms
- We examine the role of banks and financial shocks in the US business cycles
- Main findings are that:
  - The banking sector affects the propagation of real shocks
  - Financial shocks largely account for US business cycles
  - Bank leverage ratio is procyclical
  - unconventional monetary policies have modest impacts

Future Work

- Estimation the model
- Incorporating credit to households
- Extending the approach to the international interbank market
- Addressing different monetary policy and financial stability issues: such as bank capital regulation (counter-cyclicality of bank leverage)