Optimal Monetary Policy Under Financial Sector Risk

Scott Davis and Kevin X.D. Huang

Federal Reserve Bank of Dallas and Vanderbilt University

March 16, 2012

1 The views presented here are solely those of the authors and should not be interpreted as representing the views of the Federal Reserve Bank of Dallas or the Federal Reserve System.
Should a central bank respond to developments in financial markets?
Should a central bank respond to developments in financial markets?

- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
Should a central bank respond to developments in financial markets?

- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
- The financial crisis that began in 2007 brought the revival of volatility...
Should a central bank respond to developments in financial markets?

- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
- The financial crisis that began in 2007 brought the revival of volatility
  - Central banks have responded to short-term conditions in the financial markets (TALF program, QE, central bank swap lines, etc.)
Should a central bank respond to developments in financial markets?

- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
- The financial crisis that began in 2007 brought the revival of volatility
  - Central banks have responded to short-term conditions in the financial markets (TALF program, QE, central bank swap lines, etc.)
  - What is optimal monetary policy in a financial crisis?
Should a central bank respond to developments in financial markets?

- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
- The financial crisis that began in 2007 brought the revival of volatility
  - Central banks have responded to short-term conditions in the financial markets (TALF program, QE, central bank swap lines, etc.)
  - What is optimal monetary policy in a financial crisis?
  - Many of our earlier notions of optimal monetary policy were developed in models that ignored financial conditions. (Miller and Modigliani)
Should a central bank respond to developments in financial markets?
- 30 years of research and practice have shown the value of inflation targeting, and we have seen unprecedented levels of inflation and output stability, but...
- The financial crisis that began in 2007 brought the revival of volatility
  - Central banks have responded to short-term conditions in the financial markets (TALF program, QE, central bank swap lines, etc.)
- What is optimal monetary policy in a financial crisis?
- Many of our earlier notions of optimal monetary policy were developed in models that ignored financial conditions. (Miller and Modigliani)
- How does optimal policy change when financial conditions matter?
• Construct a quantitative business cycle model with shocks to financial sector risk.
Construct a quantitative business cycle model with shocks to financial sector risk.

Sticky prices and wages allow monetary policy to have a role in smoothing output fluctuations.
Construct a quantitative business cycle model with shocks to financial sector risk.

Sticky prices and wages allow monetary policy to have a role in smoothing output fluctuations.

How should the central bank respond to changes in home and foreign interbank lending spreads?
The Model - Overview

- 2 large open economies.
2 large open economies.
In each country there are:
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University) Monetary Policy and Financial Sector Risk March 16, 2012 4 / 54
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
2 large open economies.

In each country there are:

- **Firms**
  - hire labor from domestic households and
  - rent capital from domestic entrepreneurs to
  - produce a tradeable differentiable good
  - sets their output price according to a Calvo style price setting framework.
2 large open economies.

In each country there are:

- **Firms**
  - hire labor from domestic households and
  - rent capital from domestic entrepreneurs to
  - produce a tradeable differentiable good
  - sets their output price according to a Calvo style price setting framework.

- **Entrepreneurs**
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
    - sets their output price according to a Calvo style price setting framework.
  - Entrepreneurs
    - buy physical capital from capital builders and rent it to domestic firms.
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
    - sets their output price according to a Calvo style price setting framework.
  - Entrepreneurs
    - buy physical capital from capital builders and rent it to domestic firms.
    - finance this stock of capital partially through equity and partially through a physical capital loan from a bank.
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
    - sets their output price according to a Calvo style price setting framework.
  - Entrepreneurs
    - buy physical capital from capital builders and rent it to domestic firms.
    - finance this stock of capital partially through equity and partially through a physical capital loan from a bank.
  - Capital builders
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
    - sets their output price according to a Calvo style price setting framework.
  - Entrepreneurs
    - buy physical capital from capital builders and rent it to domestic firms.
    - finance this stock of capital partially through equity and partially through a physical capital loan from a bank.
  - Capital builders
    - capital accumulation technology displays diminishing marginal returns to investment
The Model - Overview

- 2 large open economies.
- In each country there are:
  - Firms
    - hire labor from domestic households and
    - rent capital from domestic entrepreneurs to
    - produce a tradeable differentiable good
    - sets their output price according to a Calvo style price setting framework.
  - Entrepreneurs
    - buy physical capital from capital builders and rent it to domestic firms.
    - finance this stock of capital partially through equity and partially through a physical capital loan from a bank.
  - Capital builders
    - capital accumulation technology displays diminishing marginal returns to investment
    - the relative price of physical capital is procyclical.
In each country there are: (con't)
In each country there are: (con't)

- Banks
In each country there are: (cont)

- Banks
  - make physical capital loans to entrepreneurs and working capital loans to firms.

Households purchase domestically produced and imported final goods for consumption and supply a differentiated type of labor to domestic firms and set wages according to a Calvo wage setting framework.
In each country there are: (con't)

- Banks
  - make physical capital loans to entrepreneurs and working capital loans to firms.
  - finance these assets partially through equity, and partially through household savings.
In each country there are: (con't)

- **Banks**
  - make physical capital loans to entrepreneurs and working capital loans to firms.
  - finance these assets partially through equity, and partially through household savings.

- **Households**
In each country there are: (con't)

- Banks
  - make physical capital loans to entrepreneurs and working capital loans to firms.
  - finance these assets partially through equity, and partially through household savings.

- Households
  - purchase domestically produced and imported final goods for consumption
The Model - Overview

- In each country there are: (con't)
  - Banks
    - make physical capital loans to entrepreneurs and working capital loans to firms.
    - finance these assets partially through equity, and partially through household savings.
  - Households
    - purchase domestically produced and imported final goods for consumption
    - supply a differentiated type of labor to domestic firms and set wages according to a Calvo wage setting framework.
The entrepreneurial sector is made up of a continuum of atomistic entrepreneurs.
The entrepreneurial sector is made up of a continuum of atomistic entrepreneurs.

In each period, an entrepreneur receives an idiosyncratic "shock" to their capital stock.
The entrepreneurial sector is made up of a continuum of atomistic entrepreneurs.

- In each period, an entrepreneur receives an idiosyncratic "shock" to their capital stock.
- Entrepreneur specific "shocks" introduce heterogeneity, but when averaged across all entrepreneurs they have no effect.
The entrepreneurial sector is made up of a continuum of atomistic entrepreneurs

- In each period, an entrepreneur receives an idiosyncratic "shock" to their capital stock
- Entrepreneur specific "shocks" introduce heterogeneity, but when averaged across all entrepreneurs they have no effect
- Some entrepreneurs receive a large "shock" to their capital stock and become insolvent
The entrepreneurial sector is made up of a continuum of atomistic entrepreneurs

- In each period, an entrepreneur receives an idiosyncratic "shock" to their capital stock
- entrepreneur specific "shocks" introduce heterogeneity, but when averaged across all entrepreneurs they have no effect
- some entrepreneurs receive a large "shock" to their capital stock and become insolvent

These financial frictions drive a countercyclical wedge between the rate at which entrepreneurs borrow, $r_t^e$, and the banks cost of capital, $r_t^b$. 
There is a continuum of atomistic banks.
There is a continuum of atomistic banks

banks hold a portfolio of physical capital loans.
There is a continuum of atomistic banks

- banks hold a portfolio of physical capital loans.
- due to bankruptcy in the entrepreneurial sector, some of these loans go into default.

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University) Monetary Policy and Financial Sector Risk March 16, 2012 7 / 54
There is a continuum of atomistic banks

- banks hold a portfolio of physical capital loans.
- due to bankruptcy in the entrepreneurial sector, some of these loans go into default.
- banks receive an idiosyncratic shock to their loan portfolio.
There is a continuum of atomistic banks

- banks hold a portfolio of physical capital loans.
- due to bankruptcy in the entrepreneurial sector, some of these loans go into default.
- banks receive an idiosyncratic shock to their loan portfolio.
- this shock introduces heterogeneity among banks with regard to their loan losses, but when averaged across all bank’s they have no effect.
The Model - Financial Frictions

- There is a continuum of atomistic banks
  - banks hold a portfolio of physical capital loans.
  - due to bankruptcy in the entrepreneurial sector, some of these loans go into default.
  - banks receive an idiosyncratic shock to their loan portfolio.
  - this shock introduces heterogeneity among banks with regard to their loan losses, but when averaged across all bank’s they have no effect.
  - some banks receive a large "shock", are over exposed to the non-preforming loans, and themselves become insolvent.
There is a continuum of atomistic banks

- banks hold a portfolio of physical capital loans.
- due to bankruptcy in the entrepreneurial sector, some of these loans go into default.
- banks receive an idiosyncratic shock to their loan portfolio.
- this shock introduces heterogeneity among banks with regard to their loan losses, but when averaged across all bank’s they have no effect.
- some banks receive a large "shock", are over exposed to the non-preforming loans, and themselves become insolvent.

These financial frictions drive a countercyclical wedge between the bank’s cost of capital, $r^b_t$, and the risk free rate, $i_t$. 
Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity
The Model - Related literature

- Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity, the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994).
- If there were no financial frictions but there was wage and price rigidity, the model would be a dynamic New Keynesian model, simply an international version of the model in Christiano, Eichenbaum, and Evans (2005).
- If there was price rigidity, as well as financial frictions in the entrepreneurial sector (but not in the banking sector), the model would be similar to the classic financial accelerator model in Bernanke, Gertler, and Gilchrist (1999).
- This model also incorporates financial frictions in the banking sector itself.
The Model - Related literature

- Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity, the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994).

- If there were no financial frictions but there was wage and price rigidity,

- If there was price rigidity, as well as financial frictions in the entrepreneurial sector (but not in the banking sector), the model would be similar to the classic financial accelerator model in Bernanke, Gertler, and Gilchrist (1999). This model also incorporates financial frictions in the banking sector itself.
The Model - Related literature

- Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity
  - the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994)

- If there were no financial frictions but there was wage and price rigidity
  - the model would be a dynamic New Keynesian model, simply an international version of the model in Christiano, Eichenbaum, and Evans (2005)
Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity, the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994).

If there were no financial frictions but there was wage and price rigidity, the model would be a dynamic New Keynesian model, simply an international version of the model in Christiano, Eichenbaum, and Evans (2005).

If there was price rigidity, as well as financial frictions in the entrepreneurial sector (but not in the banking sector),
The Model - Related literature

- Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity
  - the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994)

- If there were no financial frictions but there was wage and price rigidity
  - the model would be a dynamic New Keynesian model, simply an international version of the model in Christiano, Eichenbaum, and Evans (2005)

- If there was price rigidity, as well as financial frictions in the entrepreneurial sector (but not in the banking sector),
  - the model would be similar to the classic financial accelerator model in Bernanke, Gertler, and Gilchrist (1999).
The Model - Related literature

- Without financial frictions (the idiosyncratic shocks to individual entrepreneurs or individual banks) and without price and wage rigidity
  - the model would simply condense to an international real business cycle model (similar, but not exactly the same as Backus, Kydland and Kehoe 1994)

- If there were no financial frictions but there was wage and price rigidity
  - the model would be a dynamic New Keynesian model, simply an international version of the model in Christiano, Eichenbaum, and Evans (2005)

- If there was price rigidity, as well as financial frictions in the entrepreneurial sector (but not in the banking sector),
  - the model would be similar to the classic financial accelerator model in Bernanke, Gertler, and Gilchrist (1999).

- This model also incorporates financial frictions in the banking sector itself.
In each country there is a continuum of atomostic banks indexed $j$. 
In each country there is a continuum of atomostic banks indexed $j$.

At the beginning of the period, the value of a bank’s assets (their physical capital loan portfolio) is $B^e_t (j)$, on which they earn a gross interest rate of $(1 + r^e_t)$. 

However banks do not hold fully diversified loan portfolios, and in any given period some banks are overexposed to the set of entrepreneurs that declare bankruptcy.

The value of bank $j$’s end of period assets is $1 + \omega_{bt}(j) \xi^e_t (1 + r^e_t)B^e_t$. Where $\omega_{bt}(j)$ is lognormally distributed with mean 1 and standard deviation $\sigma_{bt}$. If banks held fully diversified loan portfolios and there was no heterogeneity across banks $\sigma_{bt} = 0$. 

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University) Monetary Policy and Financial Sector Risk March 16, 2012 9 / 54
In each country there is a continuum of atomostic banks indexed $j$.

At the beginning of the period, the value of a bank’s assets (their physical capital loan portfolio) is $B^e_t (j)$, on which they earn a gross interest rate of $(1 + r^e_t)$

- During the period, bankruptcies in the entrepreneurial sector, the end of the period the value of the average bank’s assets is $(1 - \zeta^e_t) (1 + r^e_t) B^e_t$
The Model - Financial Frictions

- In each country there is a continuum of atomostic banks indexed \( j \).
- At the beginning of the period, the value of a bank’s assets (their physical capital loan portfolio) is \( B_t^e (j) \), on which they earn a gross interest rate of \( (1 + r_t^e) \)
  - During the period, bankruptcies in the entrepreneurial sector, the end of the period the value of the average bank’s assets is \( (1 - \xi_t^e) (1 + r_t^e) B_t^e \)
- However banks do not hold fully diversified loan portfolios, and in any given period some banks are overexposed to the set of entrepreneurs that declare bankruptcy.
In each country there is a continuum of atomostic banks indexed $j$.

At the beginning of the period, the value of a bank’s assets (their physical capital loan portfolio) is $B_t^e (j)$, on which they earn a gross interest rate of $(1 + r_t^e)$

- During the period, bankruptcies in the entrepreneurial sector, the end of the period the value of the average bank’s assets is $(1 - \xi_t^e) (1 + r_t^e) B_t^e$

However banks do not hold fully diversified loan portfolios, and in any given period some banks are overexposed to the set of entrepreneurs that declare bankruptcy.

- The value of bank $j$’s end of period assets is $(1 - \omega_t^b (j) \xi_t^e) (1 + r_t^e) B_t^e$. 
The Model - Financial Frictions

- In each country there is a continuum of atomostic banks indexed \( j \).
- At the beginning of the period, the value of a bank’s assets (their physical capital loan portfolio) is \( B_t^e (j) \), on which they earn a gross interest rate of \( (1 + r_t^e) \)
  - During the period, bankruptcies in the entrepreneurial sector, the end of the period the value of the average bank’s assets is \( (1 - \zeta_t^e) (1 + r_t^e) B_t^e \)
- However banks do not hold fully diversified loan portfolios, and in any given period some banks are overexposed to the set of entrepreneurs that declare bankruptcy.
  - The value of bank \( j \)’s end of period assets is \( \left( 1 - \omega_t^b (j) \zeta_t^e \right) (1 + r_t^e) B_t^e \).
  - Where \( \omega_t^b (j) \) is lognormally distributed with mean 1 and standard deviation \( \sigma_t^b \). If banks held fully diversified loan portfolios and there was no heterogeneity across banks \( \sigma_t^b = 0 \)
The bank is insolvent if the end of period value of their assets is less than the end of period value of their liabilities:

\[
\left(1 - \omega^b_t(j) \xi^e_t \right) (1 + r^e_t) B^e_t < \left(1 + r^b_t \right) b^s_t(j)
\]

where \( r^b_t \) is the interest rate that the bank pays on its liabilities
The Model - Financial Frictions

- The bank is insolvent if the end of period value of their assets is less than the end of period value of their liabilities:

\[
\left(1 - \omega^b_t(j) \xi^e_t\right) (1 + r^e_t) B^e_t < \left(1 + r^b_t\right) b_s^t(j)
\]

where \( r^b_t \) is the interest rate that the bank pays on its liabilities.

- Prior to the realization of the idiosyncratic shock \( \omega^b_t(j) \) all banks are identical, so bank \( j \) is able to continue operations if:

\[
\omega^b_t(j) < \bar{\omega}_t^b = \frac{(1 + r^e_t) B^e_t - (1 + r^b_t) b^s_t}{\xi^e_t (1 + r^e_t) B^e_t}
\]
The bank is insolvent if the end of period value of their assets is less than the end of period value of their liabilities:

\[
\left(1 - \omega^b_t(j) \xi_t^e\right) (1 + r^e_t) B^e_t < \left(1 + r^b_t\right) b^s_t(j)
\]

where \(r^b_t\) is the interest rate that the bank pays on its liabilities.

Prior to the realization of the idiosyncratic shock \(\omega^b_t(j)\) all banks are identical, so bank \(j\) is able to continue operations if:

\[
\omega^b_t(j) < \bar{\omega}_t = \frac{(1 + r^e_t) B^e_t - (1 + r^b_t) b^s_t}{\xi_t^e (1 + r^e_t) B^e_t}
\]

Thus the number of banks that are insolvent is \(1 - G(\bar{\omega}_t^b; \sigma_t^b)\), where \(G\) is the c.d.f. of the lognormal distribution of \(\omega^b_t(j)\).
The spread between the bank’s cost of capital and the risk free rate is approximately:

\[ r_t^b - i_t \approx \frac{1}{G(\bar{\omega}_t^b, \sigma_t^b)} - 1 \]
The Model - Financial Frictions

- The spread between the bank’s cost of capital and the risk free rate is approximately:

\[ r_t^b - i_t \approx \frac{1}{G(\bar{\omega}_t^b; \sigma_t^b)} - 1 \]

- A first order Taylor approximation:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\omega_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)
The spread between the bank’s cost of capital and the risk free rate is approximately:

\[ r_t^b - i_t \approx \frac{1}{G(\bar{\omega}_t^b; \sigma_t^b)} - 1 \]

A first order Taylor approximation:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)

\( \bar{\omega}_t^b \) is proportional to the banking sector’s capital asset ratio.
The Model - Financial Frictions

- The spread between the bank’s cost of capital and the risk free rate is approximately:

\[ r^b_t - i_t \approx \frac{1}{G(\bar{\omega}^b_t, \sigma^b_t)} - 1 \]

- A first order Taylor approximation:

\[ r^b_t - i_t \approx (r^b_{ss} - i_{ss}) + g_1 \left( \frac{\bar{\omega}^b_t - \bar{\omega}^b_{ss}}{\bar{\omega}^b_{ss}} \right) + g_2 \left( \frac{\sigma^b_t - \sigma^b_{ss}}{\sigma^b_{ss}} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)

- \( \bar{\omega}^b_t \) is proportional to the banking sector’s capital asset ratio.
  - If the capital-asset ratio increases, \( \bar{\omega}^b_t \) increases
The spread between the bank's cost of capital and the risk free rate is approximately:

\[ r_t^b - i_t \approx \frac{1}{G(\bar{\omega}_t^b; \sigma_t^b)} - 1 \]

A first order Taylor approximation:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)

\( \bar{\omega}_t^b \) is proportional to the banking sector's capital asset ratio.

- If the capital-asset ratio increases, \( \bar{\omega}_t^b \) increases
- If \( \bar{\omega}_t^b \) increases, the spread falls.
The spread between the bank’s cost of capital and the risk free rate is approximately:

\[ r_t^b - i_t \approx \frac{1}{G(\bar{\omega}_t^b, \sigma_t^b)} - 1 \]

A first order Taylor approximation:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)

\( \bar{\omega}_t^b \) is proportional to the banking sector’s capital asset ratio.

- If the capital-asset ratio increases, \( \bar{\omega}_t^b \) increases
- If \( \bar{\omega}_t^b \) increases, the spread falls.
- **Balance sheets matter!**
The Model - Financial Frictions

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)
The Model - Financial Frictions

\[ r^b_t - i_t \approx (r^b_{ss} - i_{ss}) + g_1 \left( \frac{\omega^b_t - \omega^b_{ss}}{\bar{\omega}^b_{ss}} \right) + g_2 \left( \frac{\sigma^b_t - \sigma^b_{ss}}{\bar{\sigma}^b_{ss}} \right) \]

where \( g_1 < 0 \) and \( g_2 > 0 \)

- If \( \sigma^b_t \) increases, then the ex-ante uncertainty about the health of a particular bank’s assets increases.
\( r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \)

where \( g_1 < 0 \) and \( g_2 > 0 \)

- If \( \sigma_t^b \) increases, then the ex-ante uncertainty about the health of a particular bank’s assets increases.
- When \( \sigma_t^b \) increases, the spread increases.
The central bank sets the nominal risk free rate, $i_t$. 

The risk free rate is determined by the central bank according to a Taylor rule:

$$i_t = i_{ss} + \theta_i (i_t - i_{ss}) + (1 - \theta_i) \theta_p \pi_t + \theta_i \theta_y \hat{y}_t + \theta_i \theta_s s_t + \theta_i \theta_r (r^p_t - i_{ss}) + \theta_i \theta_{rf} (r^p_t - i_{ss})$$

where $s_t = S_t - 1$, $r^p_t = r^b_t i_t - r^b_{ss} i_{ss}$ and $r^p_t = r^b_t i_t - r^b_{ss} i_{ss}$.
- The central bank sets the nominal risk free rate, $i_t$.
- The risk free rate is determined by the central bank according to a Taylor rule:

$$i_t = i_{ss} + \theta_i (i_{t-1} - i_{ss}) + (1 - \theta_i) \left( \theta_p \pi_t + \theta_y \hat{y}_t + \theta_s s_t + \theta_r (r^b \hat{p}_t) + \theta_{rf} (r^b \hat{p}^*_t) \right)$$

where $s_t = \frac{S_t}{S_{t-1}} - 1$, $r^b \hat{p}_t = (r^b_t - i_t) - (r^b_{ss} - i_{ss})$ and $r^b \hat{p}^*_t = (r^b_t - i^*_t) - (r^b_{ss} - i^*_{ss})$
The central bank will minimize a loss function consisting of the variance of inflation, the output gap, and the difference in the nominal risk free rate.

\[ \mathcal{L} = \text{var} (\pi_t) + 0.5 \times \text{var} (\hat{y}_t) + 0.1 \times \text{var} (i_t - i_{t-1}) \]

where \( \pi_t \) is the quarterly inflation rate and \( \hat{y}_t \) is the output gap.
Results

- Do a grid search to find the optimal combination of $\theta_i$, $\theta_p$, $\theta_y$ and maybe $\theta_s$ that minimizes $\mathcal{L}$
Results

- Do a grid search to find the optimal combination of $\theta_i$, $\theta_p$, $\theta_y$ and maybe $\theta_s$ that minimizes $\mathcal{L}$
  - Set $\theta_r = \theta_{rf} = 0$
Endogenous vs. Exogenous changes in the spread:

\[ r^b_t - i_t \approx (r^b_{ss} - i_{ss}) + g_1 \left( \frac{\bar{\omega}^b_t - \bar{\omega}^b_{ss}}{\bar{\omega}^b_{ss}} \right) + g_2 \left( \frac{\sigma^b_t - \sigma^b_{ss}}{\sigma^b_{ss}} \right) \]
Results

- Endogenous vs. Exogenous changes in the spread:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\omega_t^b - \omega_{ss}^b}{\omega_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

- \( g_1 \left( \frac{\omega_t^b - \omega_{ss}^b}{\omega_{ss}^b} \right) \) are changes in the spread that occur because of changes in \( \omega_t^b \).
Endogenous vs. Exogenous changes in the spread:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

- \( g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) \) are changes in the spread that occur because of changes in \( \bar{\omega}_t^b \).
  - \( \bar{\omega}_t^b \) is determined by endogenous variables like debt ratios, interest rates, and bankruptcy rates.
Endogenous vs. Exogenous changes in the spread:

\[ r_t^b - i_t \approx (r_{ss}^b - i_{ss}) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

- \( g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) \) are changes in the spread that occur because of changes in \( \bar{\omega}_t^b \).
  - \( \bar{\omega}_t^b \) is determined by endogenous variables like debt ratios, interest rates, and bankruptcy rates.

- \( g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \) are changes in the spread that occur because of \( \sigma_t^b \).
Endogenous vs. Exogenous changes in the spread:

\[ r_t^b - i_t \approx \left( r_{ss}^b - i_{ss} \right) + g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) + g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \]

- \( g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) \) are changes in the spread that occur because of changes in \( \bar{\omega}_t^b \).
  - \( \bar{\omega}_t^b \) is determined by endogenous variables like debt ratios, interest rates, and bankruptcy rates

- \( g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \) are changes in the spread that occur because of \( \sigma_t^b \).
  - \( \sigma_t^b \) is an exogenous stochastic variable that describes the amount of ex-ante uncertainty in the banking sector.
Define $\Sigma$ as the ratio of the standard deviation of the financial sector shock to the standard deviation of the TFP shock.
Results

The optimal weight on the interbank lending spread

- Define $\Sigma$ as the ratio of the standard deviation of the financial sector shock to the standard deviation of the TFP shock.
  - As $\Sigma$ increases, financial sector shocks are more important for driving fluctuations in the business cycle.
## Optimal Taylor Rule Parameters

### Conventional Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\text{var}(r_{p_t})}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.709</td>
<td>0.417</td>
<td>0.746</td>
<td>–</td>
<td>0.0124</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.713</td>
<td>0.417</td>
<td>0.746</td>
<td>–</td>
<td>0.0345</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.726</td>
<td>0.429</td>
<td>0.748</td>
<td>–</td>
<td>0.0655</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.733</td>
<td>0.434</td>
<td>0.749</td>
<td>–</td>
<td>0.0966</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.762</td>
<td>0.452</td>
<td>0.752</td>
<td>–</td>
<td>0.1271</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.788</td>
<td>0.469</td>
<td>0.755</td>
<td>–</td>
<td>0.1569</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.822</td>
<td>0.494</td>
<td>0.759</td>
<td>–</td>
<td>0.1859</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.951</td>
<td>0.544</td>
<td>0.774</td>
<td>–</td>
<td>0.2099</td>
</tr>
</tbody>
</table>
## Optimal Taylor Rule Parameters

### Conventional Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\text{var}(r_{p_t}^b)}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
</table>

### $\theta_s \neq 0$

- $\Sigma = 0$
  - 1.641 0.375 0.741 0.154 0.0126 12.26%
  - $\Sigma = 0.025$
    - 1.650 0.385 0.743 0.156 0.0347 12.36%
  - $\Sigma = 0.050$
    - 1.667 0.396 0.745 0.153 0.0656 12.65%
  - $\Sigma = 0.075$
    - 1.681 0.406 0.746 0.146 0.0967 13.13%
  - $\Sigma = 0.100$
    - 1.719 0.434 0.751 0.145 0.1274 13.75%
  - $\Sigma = 0.125$
    - 1.751 0.457 0.755 0.139 0.1573 14.51%
  - $\Sigma = 0.150$
    - 1.785 0.480 0.754 0.134 0.1864 15.47%
  - $\Sigma = 0.175$
    - 1.838 0.513 0.760 0.129 0.2138 16.43%
Step 2: Now do the same grid search, but allow $\theta_r$ and $\theta_{rf}$ to vary
## Optimal Taylor Rule Parameters

Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\theta_{rf}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.709</td>
<td>0.417</td>
<td>0.746</td>
<td>$-$</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.713</td>
<td>0.417</td>
<td>0.746</td>
<td>$-$</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.726</td>
<td>0.429</td>
<td>0.748</td>
<td>$-$</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.737</td>
<td>0.430</td>
<td>0.749</td>
<td>$-$</td>
<td>$-0.343$</td>
<td>0.000</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.754</td>
<td>0.439</td>
<td>0.756</td>
<td>$-$</td>
<td>$-0.484$</td>
<td>$-0.049$</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.768</td>
<td>0.440</td>
<td>0.759</td>
<td>$-$</td>
<td>$-0.548$</td>
<td>$-0.112$</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.777</td>
<td>0.441</td>
<td>0.762</td>
<td>$-$</td>
<td>$-0.584$</td>
<td>$-0.147$</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.797</td>
<td>0.444</td>
<td>0.768</td>
<td>$-$</td>
<td>$-0.612$</td>
<td>$-0.172$</td>
</tr>
</tbody>
</table>
### Optimal Taylor Rule Parameters

Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_s \neq 0$</th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\theta_{rf}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Sigma = 0$</td>
<td>1.641</td>
<td>0.375</td>
<td>0.741</td>
<td>0.154</td>
<td>0.000</td>
<td>0.000</td>
<td>12.26%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.650</td>
<td>0.385</td>
<td>0.743</td>
<td>0.156</td>
<td>0.000</td>
<td>0.000</td>
<td>12.36%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.667</td>
<td>0.396</td>
<td>0.745</td>
<td>0.153</td>
<td>0.000</td>
<td>0.000</td>
<td>12.65%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.665</td>
<td>0.394</td>
<td>0.746</td>
<td>0.154</td>
<td>-0.370</td>
<td>0.000</td>
<td>12.94%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.673</td>
<td>0.394</td>
<td>0.749</td>
<td>0.159</td>
<td>-0.526</td>
<td>0.000</td>
<td>13.13%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.677</td>
<td>0.391</td>
<td>0.752</td>
<td>0.165</td>
<td>-0.597</td>
<td>-0.028</td>
<td>13.31%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.693</td>
<td>0.398</td>
<td>0.756</td>
<td>0.176</td>
<td>-0.643</td>
<td>-0.049</td>
<td>13.48%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.704</td>
<td>0.400</td>
<td>0.760</td>
<td>0.183</td>
<td>-0.671</td>
<td>-0.067</td>
<td>13.66%</td>
</tr>
</tbody>
</table>
Results
The optimal weight on the home and foreign interbank lending spreads

- Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.
Results
The optimal weight on the home and foreign interbank lending spreads

- Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.
  - If the coefficients on the output gap and the inflation rate are optimally chosen, putting weight on the endogenous component of the spread is suboptimal.

- Exogenous fluctuations in the spread may contain information not already found in the output gap and inflation.
  - There is a benefit to putting weight on the exogenous component of the home and foreign interbank spreads.

- When $\sum > 0$, optimal policy balances the cost of putting weight on the endogenous component of the spread against the benefit of putting weight on the exogenous component of the spread.
Results

The optimal weight on the home and foreign interbank lending spreads

- Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.
  - If the coefficients on the output gap and the inflation rate are optimally chosen, putting weight on the endogenous component of the spread is suboptimal.
  - When $\Sigma = 0$, the optimal coefficients $\theta_r$ and $\theta_{rf}$ are zero.

- Exogenous fluctuations in the spread may contain information not already found in the output gap and inflation.
  - There is a benefit to putting weight on the exogenous component of the home and foreign interbank spreads.
  - When $\Sigma > 0$, optimal policy balances the cost of putting weight on the endogenous component of the spread against the benefit of putting weight on the exogenous component of the spread.
The optimal weight on the home and foreign interbank lending spreads

- Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.
  - If the coefficients on the output gap and the inflation rate are optimally chosen, putting weight on the endogenous component of the spread is suboptimal.
  - When $\Sigma = 0$, the optimal coefficients $\theta_r$ and $\theta_{rf}$ are zero.

- Exogenous fluctuations in the spread may contain information not already found in the output gap and inflation.
Results
The optimal weight on the home and foreign interbank lending spreads

- Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.
  - If the coefficients on the output gap and the inflation rate are optimally chosen, putting weight on the endogenous component of the spread is suboptimal.
  - When $\Sigma = 0$, the optimal coefficients $\theta_r$ and $\theta_{rf}$ are zero.

- Exogenous fluctuations in the spread may contain information not already found in the output gap and inflation.
  - There is a benefit to putting weight on exogenous component of the home and foreign interbank spreads.
Endogenous fluctuations in the spread contain no new information that is not already contained in the output gap and the inflation rate.

- If the coefficients on the output gap and the inflation rate are optimally chosen, putting weight on the endogenous component of the spread is suboptimal.
- When $\Sigma = 0$, the optimal coefficients $\theta_r$ and $\theta_{rf}$ are zero.

Exogenous fluctuations in the spread may contain information not already found in the output gap and inflation.

- There is a benefit to putting weight on exogenous component of the home and foreign interbank spreads.
- When $\Sigma > 0$, optimal policy balances the cost of putting weight on the endogenous component of the spread against the benefit of putting weight on the exogenous component of the spread.
Results
The optimal weight on the home and foreign interbank lending spreads

If $\Sigma > 0$ and the central bank is putting weight on the home and foreign interbank lending spread, putting weight on the nominal exchange rate will make the central bank want to reduce the weight it places on the foreign spread and increase the weight it places on the home spread.
Results

The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.

- Following a home financial shock, the home country will start to go into recession and the home nominal exchange rate will depreciate. If the home central bank is targeting the nominal exchange rate, it will raise the risk free rate.

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University, Monetary Policy and Financial Sector Risk, March 16, 2012)
Results

The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.
  - This is exactly what it would have done if reacting to the foreign financial shock.
Results
The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.
  - This is exactly what it would have done if reacting to the foreign financial shock.
  - Following a foreign financial shock, there is no trade-off between financial stability and exchange rate stability.
Results
The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.
  - This is exactly what it would have done if reacting to the foreign financial shock.
  - Following a foreign financial shock, there is no trade-off between financial stability and exchange rate stability.

- Following a home financial shock, the home country will start to go into recession and the home nominal exchange rate will depreciate. If the home central bank is targeting the nominal exchange rate, it will raise the risk free rate.
Results

The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.
  - This is exactly what it would have done if reacting to the foreign financial shock.
  - Following a foreign financial shock, there is no trade-off between financial stability and exchange rate stability.

- Following a home financial shock, the home country will start to go into recession and the home nominal exchange rate will depreciate. If the home central bank is targeting the nominal exchange rate, it will raise the risk free rate.
  - This is the exact opposite of what it would have done if reacting to the home financial shock.
Results

The optimal weight on the home and foreign interbank lending spreads

- Following a foreign financial shock, the foreign country will start to go into recession and the home nominal exchange rate will appreciate. If the home central bank is targeting the nominal exchange rate, it will cut the risk free rate.
  - This is exactly what it would have done if reacting to the foreign financial shock.
  - Following a foreign financial shock, there is no trade-off between financial stability and exchange rate stability.
- Following a home financial shock, the home country will start to go into recession and the home nominal exchange rate will depreciate. If the home central bank is targeting the nominal exchange rate, it will raise the risk free rate.
  - This is the exact opposite of what it would have done if reacting to the home financial shock.
  - Following a home financial shock, there is a trade-off between financial stability and exchange rate stability.
Suppose that the central bank can distinguish between the endogenous and exogenous movements in the spread and the two components enter the Taylor rule separately:

\[
i_t = i_{ss} + \theta_i (i_{t-1} - i_{ss}) + (1 - \theta_i) \left( \theta_P \pi_t + \theta_y \hat{y}_t + \theta_s s_t \right) + \theta_{rf}^e r^e_t + \theta_{rf}^x r^x_t + \theta_{endo}^e \hat{r}_t^e + \theta_{endo}^x \hat{r}_t^x + \theta_{exo}^e \hat{r}_t^e + \theta_{exo}^x \hat{r}_t^x \]

where \( r^e_t = g_1 \left( \frac{\bar{\omega}_t^b - \bar{\omega}_{ss}^b}{\bar{\omega}_{ss}^b} \right) \) and \( r^x_t = g_2 \left( \frac{\sigma_t^b - \sigma_{ss}^b}{\sigma_{ss}^b} \right) \).
Optimal Taylor Rule Parameters
Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta_s = 0 : )</td>
<td>( \Sigma = 0 )</td>
<td>1.709</td>
<td>0.417</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.025 )</td>
<td>1.788</td>
<td>0.467</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.050 )</td>
<td>1.736</td>
<td>0.432</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.075 )</td>
<td>1.737</td>
<td>0.430</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.100 )</td>
<td>1.746</td>
<td>0.432</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.125 )</td>
<td>1.785</td>
<td>0.455</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.150 )</td>
<td>1.816</td>
<td>0.469</td>
</tr>
<tr>
<td></td>
<td>( \Sigma = 0.175 )</td>
<td>1.888</td>
<td>0.506</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters
Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>( \theta_{r}^{\text{endo}} )</th>
<th>( \theta_{rf}^{\text{endo}} )</th>
<th>( \theta_{r}^{\text{exo}} )</th>
<th>( \theta_{rf}^{\text{exo}} )</th>
<th>( \sqrt{\frac{\text{var}(rp_{t}^{b})}{\text{var}(GDP_{t})}} )</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta_s = 0 ):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Sigma = 0 )</td>
<td>0.000</td>
<td>0.000</td>
<td>na</td>
<td>na</td>
<td>1.24%</td>
</tr>
<tr>
<td>( \Sigma = 0.025 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.696</td>
<td>-0.246</td>
<td>3.33%</td>
</tr>
<tr>
<td>( \Sigma = 0.050 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.816</td>
<td>-0.340</td>
<td>6.23%</td>
</tr>
<tr>
<td>( \Sigma = 0.075 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.813</td>
<td>-0.351</td>
<td>9.20%</td>
</tr>
<tr>
<td>( \Sigma = 0.100 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.811</td>
<td>-0.359</td>
<td>12.11%</td>
</tr>
<tr>
<td>( \Sigma = 0.125 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.826</td>
<td>-0.388</td>
<td>14.99%</td>
</tr>
<tr>
<td>( \Sigma = 0.150 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.858</td>
<td>-0.406</td>
<td>17.76%</td>
</tr>
<tr>
<td>( \Sigma = 0.175 )</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.944</td>
<td>-0.434</td>
<td>20.39%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters
Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.641</td>
<td>0.375</td>
<td>0.741</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.641</td>
<td>0.375</td>
<td>0.741</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.659</td>
<td>0.384</td>
<td>0.745</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.665</td>
<td>0.390</td>
<td>0.746</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.679</td>
<td>0.393</td>
<td>0.748</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.689</td>
<td>0.398</td>
<td>0.749</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.706</td>
<td>0.403</td>
<td>0.752</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.749</td>
<td>0.428</td>
<td>0.757</td>
</tr>
</tbody>
</table>
## Optimal Taylor Rule Parameters

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>θ_r^{endo}</th>
<th>θ_r^{endo}</th>
<th>θ_r^{exo}</th>
<th>θ_r^{exo}</th>
<th>\sqrt{\frac{\text{var}(r_p^b)}{\text{var}(\text{GDP}_t)}}</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ_s \neq 0:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Σ = 0</td>
<td>0.000</td>
<td>0.000</td>
<td>na</td>
<td>na</td>
<td>1.26%</td>
</tr>
<tr>
<td>Σ = 0.025</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.726</td>
<td>−0.124</td>
<td>3.32%</td>
</tr>
<tr>
<td>Σ = 0.050</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.828</td>
<td>−0.216</td>
<td>6.21%</td>
</tr>
<tr>
<td>Σ = 0.075</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.850</td>
<td>−0.201</td>
<td>9.17%</td>
</tr>
<tr>
<td>Σ = 0.100</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.837</td>
<td>−0.226</td>
<td>12.08%</td>
</tr>
<tr>
<td>Σ = 0.125</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.865</td>
<td>−0.211</td>
<td>14.94%</td>
</tr>
<tr>
<td>Σ = 0.150</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.883</td>
<td>−0.214</td>
<td>17.68%</td>
</tr>
<tr>
<td>Σ = 0.175</td>
<td>0.000</td>
<td>0.000</td>
<td>−0.922</td>
<td>−0.231</td>
<td>20.38%</td>
</tr>
</tbody>
</table>

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University)
Responses to a home financial shock

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads
Responses to a foreign financial shock

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads

Figure:
Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University) Monetary Policy and Financial Sector Risk

March 16, 2012 32 / 54
Optimal monetary policy under financial sector risk:
Optimal monetary policy under financial sector risk:

- Does the central bank want to include the interbank lending spread in its Taylor rule?
Optimal monetary policy under financial sector risk:

- Does the central bank want to include the interbank lending spread in its Taylor rule?
  - Maybe
Optimal monetary policy under financial sector risk:

Does the central bank want to include the interbank lending spread in its Taylor rule?

- Maybe
  - React to fluctuations in the interbank lending spread that are due to exogenous financial shocks.
Optimal monetary policy under financial sector risk:

Does the central bank want to include the interbank lending spread in its Taylor rule?

- Maybe
  - React to fluctuations in the interbank lend spread that are due to exogenous financial shocks.
  - Ignore fluctuations in the spread that are due to movements in balance sheet ratios, loan losses, etc.
Optimal monetary policy under financial sector risk:
Optimal monetary policy under financial sector risk:
How will the optimal Taylor rule weights change when the central bank also targets the nominal exchange rate?
Optimal monetary policy under financial sector risk:

How will the optimal Taylor rule weights change when the central bank also targets the nominal exchange rate?

In response to a foreign financial shock, there is no trade-off between targeting the exchange rate and targeting the foreign interbank spread.

In response to a home financial shock, there is a trade-off between targeting the exchange rate and targeting the home interbank spread.

If the central bank is targeting the exchange rate, it needs to increase the weight it places on the home interbank spread.
Optimal monetary policy under financial sector risk:

How will the optimal Taylor rule weights change when the central bank also targets the nominal exchange rate?

- In response to a foreign financial shock, there is no trade-off between targeting the exchange rate and targeting the foreign interbank spread.
  - When also targeting the exchange rate, the central bank can reduce the weight it places on the foreign interbank spread.

In response to a home financial shock, there is a trade-off between targeting the exchange rate and targeting the home interbank spread.

- If the central bank is targeting the exchange rate, it needs to increase the weight it places on the home interbank spread.
Optimal monetary policy under financial sector risk:

How will the optimal Taylor rule weights change when the central bank also targets the nominal exchange rate?

- In response to a foreign financial shock, there is no trade-off between targeting the exchange rate and targeting the foreign interbank spread.
  - When also targeting the exchange rate, the central bank can reduce the weight it places on the foreign interbank spread.

- In response to a home financial shock, there is a trade-off between targeting the exchange rate and targeting the home interbank spread.
Optimal monetary policy under financial sector risk:

How will the optimal Taylor rule weights change when the central bank also targets the nominal exchange rate?

- In response to a foreign financial shock, there is no trade-off between targeting the exchange rate and targeting the foreign interbank spread.
  - When also targeting the exchange rate, the central bank can reduce the weight it places on the foreign interbank spread.

- In response to a home financial shock, there is a trade-off between targeting the exchange rate and targeting the home interbank spread.
  - If the central bank is targeting the exchange rate, it needs to increase the weight it places on the home interbank spread.
## Optimal Taylor Rule Parameters - High Trade

### Conventional Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_s$</th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\text{var}(rp^b_t)}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.579</td>
<td>0.332</td>
<td>0.741</td>
<td>–</td>
<td>0.0132</td>
<td>12.18%</td>
</tr>
<tr>
<td>0.025</td>
<td>1.579</td>
<td>0.332</td>
<td>0.741</td>
<td>–</td>
<td>0.0364</td>
<td>12.27%</td>
</tr>
<tr>
<td>0.050</td>
<td>1.589</td>
<td>0.337</td>
<td>0.742</td>
<td>–</td>
<td>0.0689</td>
<td>12.54%</td>
</tr>
<tr>
<td>0.075</td>
<td>1.606</td>
<td>0.352</td>
<td>0.744</td>
<td>–</td>
<td>0.102</td>
<td>12.97%</td>
</tr>
<tr>
<td>0.100</td>
<td>1.629</td>
<td>0.368</td>
<td>0.747</td>
<td>–</td>
<td>0.1345</td>
<td>13.55%</td>
</tr>
<tr>
<td>0.125</td>
<td>1.645</td>
<td>0.379</td>
<td>0.749</td>
<td>–</td>
<td>0.1662</td>
<td>14.27%</td>
</tr>
<tr>
<td>0.150</td>
<td>1.687</td>
<td>0.407</td>
<td>0.754</td>
<td>–</td>
<td>0.1972</td>
<td>15.08%</td>
</tr>
<tr>
<td>0.175</td>
<td>1.719</td>
<td>0.430</td>
<td>0.758</td>
<td>–</td>
<td>0.2274</td>
<td>16.00%</td>
</tr>
</tbody>
</table>
### Optimal Taylor Rule Parameters - High Trade

#### Conventional Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\operatorname{var}(rp^b_t)}{\operatorname{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.548</td>
<td>0.309</td>
<td>0.741</td>
<td>0.599</td>
<td>0.0135</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.552</td>
<td>0.309</td>
<td>0.741</td>
<td>0.591</td>
<td>0.0364</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.558</td>
<td>0.318</td>
<td>0.742</td>
<td>0.585</td>
<td>0.0691</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.580</td>
<td>0.333</td>
<td>0.745</td>
<td>0.561</td>
<td>0.102</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.607</td>
<td>0.353</td>
<td>0.748</td>
<td>0.536</td>
<td>0.1347</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.640</td>
<td>0.377</td>
<td>0.753</td>
<td>0.510</td>
<td>0.1667</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.678</td>
<td>0.405</td>
<td>0.758</td>
<td>0.496</td>
<td>0.198</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.717</td>
<td>0.430</td>
<td>0.763</td>
<td>0.485</td>
<td>0.2279</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade

Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_s = 0 :$</th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\theta_{rf}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Sigma = 0$</td>
<td>1.579</td>
<td>0.332</td>
<td>0.741</td>
<td>−</td>
<td>0.000</td>
<td>0.000</td>
<td>12.18%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.579</td>
<td>0.332</td>
<td>0.741</td>
<td>−</td>
<td>0.000</td>
<td>0.000</td>
<td>12.27%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.589</td>
<td>0.337</td>
<td>0.742</td>
<td>−</td>
<td>0.000</td>
<td>0.000</td>
<td>12.54%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.594</td>
<td>0.340</td>
<td>0.744</td>
<td>−</td>
<td>−0.160</td>
<td>−0.121</td>
<td>12.87%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.616</td>
<td>0.352</td>
<td>0.750</td>
<td>−</td>
<td>−0.260</td>
<td>−0.232</td>
<td>13.05%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.621</td>
<td>0.351</td>
<td>0.752</td>
<td>−</td>
<td>−0.315</td>
<td>−0.286</td>
<td>13.23%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.638</td>
<td>0.358</td>
<td>0.757</td>
<td>−</td>
<td>−0.346</td>
<td>−0.321</td>
<td>13.38%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.653</td>
<td>0.364</td>
<td>0.761</td>
<td>−</td>
<td>−0.364</td>
<td>−0.343</td>
<td>13.55%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade
Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th></th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\theta_{rf}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.548</td>
<td>0.309</td>
<td>0.741</td>
<td>0.599</td>
<td>0.000</td>
<td>0.000</td>
<td>11.86%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.552</td>
<td>0.309</td>
<td>0.741</td>
<td>0.591</td>
<td>0.000</td>
<td>0.000</td>
<td>11.96%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.558</td>
<td>0.318</td>
<td>0.742</td>
<td>0.585</td>
<td>0.000</td>
<td>0.000</td>
<td>12.23%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.563</td>
<td>0.320</td>
<td>0.744</td>
<td>0.578</td>
<td>$-0.258$</td>
<td>$-0.031$</td>
<td>12.54%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.567</td>
<td>0.323</td>
<td>0.746</td>
<td>0.563</td>
<td>$-0.339$</td>
<td>$-0.146$</td>
<td>12.74%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.578</td>
<td>0.327</td>
<td>0.749</td>
<td>0.562</td>
<td>$-0.383$</td>
<td>$-0.215$</td>
<td>12.89%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.598</td>
<td>0.336</td>
<td>0.756</td>
<td>0.603</td>
<td>$-0.434$</td>
<td>$-0.213$</td>
<td>13.00%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.609</td>
<td>0.337</td>
<td>0.757</td>
<td>0.576</td>
<td>$-0.457$</td>
<td>$-0.231$</td>
<td>13.15%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th></th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.579</td>
<td>0.332</td>
<td>0.741</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.594</td>
<td>0.340</td>
<td>0.744</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.895</td>
<td>0.543</td>
<td>0.801</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.648</td>
<td>0.373</td>
<td>0.756</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.614</td>
<td>0.351</td>
<td>0.749</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.642</td>
<td>0.366</td>
<td>0.754</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.660</td>
<td>0.373</td>
<td>0.756</td>
<td>-</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.688</td>
<td>0.388</td>
<td>0.760</td>
<td>-</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade
Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_{r}^{endo}$</th>
<th>$\theta_{rf}^{endo}$</th>
<th>$\theta_{r}^{exo}$</th>
<th>$\theta_{rf}^{exo}$</th>
<th>$\frac{\text{var}(r_{b,t})}{\text{var}(GDP_{t})}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_{s} = 0:$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>0.000</td>
<td>0.000</td>
<td>$na$</td>
<td>$na$</td>
<td>1.32%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.418$</td>
<td>$-0.395$</td>
<td>3.54%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.251$</td>
<td>$-1.030$</td>
<td>6.82%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.516$</td>
<td>$-0.471$</td>
<td>9.83%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.502$</td>
<td>$-0.454$</td>
<td>12.99%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.520$</td>
<td>$-0.468$</td>
<td>16.08%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.516$</td>
<td>$-0.492$</td>
<td>19.11%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>0.000</td>
<td>0.000</td>
<td>$-0.533$</td>
<td>$-0.504$</td>
<td>22.06%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th></th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.548</td>
<td>0.309</td>
<td>0.741</td>
<td>0.599</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.548</td>
<td>0.305</td>
<td>0.741</td>
<td>0.599</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.546</td>
<td>0.304</td>
<td>0.740</td>
<td>0.596</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.560</td>
<td>0.311</td>
<td>0.743</td>
<td>0.595</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.579</td>
<td>0.321</td>
<td>0.748</td>
<td>0.786</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.579</td>
<td>0.321</td>
<td>0.748</td>
<td>0.556</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.607</td>
<td>0.336</td>
<td>0.753</td>
<td>0.595</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.614</td>
<td>0.337</td>
<td>0.754</td>
<td>0.618</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - High Trade

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta^\text{endo}_r$</th>
<th>$\theta^\text{endo}_{rf}$</th>
<th>$\theta^\text{exo}_r$</th>
<th>$\theta^\text{exo}_{rf}$</th>
<th>$\sqrt{\frac{\text{var}(rp^b_t)}{\text{var}(\text{GDP}_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>0.000</td>
<td>0.000</td>
<td>na</td>
<td>na</td>
<td>1.35%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.460</td>
<td>-0.321</td>
<td>3.54%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.573</td>
<td>-0.315</td>
<td>6.63%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.588</td>
<td>-0.315</td>
<td>9.78%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.762</td>
<td>-0.151</td>
<td>12.84%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.516</td>
<td>-0.401</td>
<td>16.05%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.595</td>
<td>-0.344</td>
<td>19.02%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.610</td>
<td>-0.342</td>
<td>21.95%</td>
</tr>
</tbody>
</table>
Responses to a home financial shock - High Trade

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads

Figure: Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University) Monetary Policy and Financial Sector Risk
March 16, 2012 43 / 54
Responses to a foreign financial shock - High Trade

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads

Figure:
**Optimal Taylor Rule Parameters - Foreign Borrowing**

**Conventional Taylor Rule**

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\text{var}(r_{bp_t})}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0$ :</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.659</td>
<td>0.377</td>
<td>0.745</td>
<td>$-$</td>
<td>0.0128</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.665</td>
<td>0.382</td>
<td>0.746</td>
<td>$-$</td>
<td>0.033</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.676</td>
<td>0.387</td>
<td>0.747</td>
<td>$-$</td>
<td>0.0618</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.693</td>
<td>0.398</td>
<td>0.749</td>
<td>$-$</td>
<td>0.0912</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.715</td>
<td>0.414</td>
<td>0.751</td>
<td>$-$</td>
<td>0.1205</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.733</td>
<td>0.425</td>
<td>0.753</td>
<td>$-$</td>
<td>0.1492</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.780</td>
<td>0.456</td>
<td>0.759</td>
<td>$-$</td>
<td>0.1773</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.814</td>
<td>0.481</td>
<td>0.763</td>
<td>$-$</td>
<td>0.2049</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - Foreign Borrowing

Conventional Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\sqrt{\frac{\text{var}(rp_t^b)}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>1.594</td>
<td>0.341</td>
<td>0.739</td>
<td>0.149</td>
<td>0.0132</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.600</td>
<td>0.346</td>
<td>0.740</td>
<td>0.154</td>
<td>0.033</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.610</td>
<td>0.351</td>
<td>0.741</td>
<td>0.151</td>
<td>0.0616</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.625</td>
<td>0.367</td>
<td>0.744</td>
<td>0.156</td>
<td>0.0912</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.648</td>
<td>0.383</td>
<td>0.747</td>
<td>0.162</td>
<td>0.1203</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.683</td>
<td>0.406</td>
<td>0.751</td>
<td>0.165</td>
<td>0.1489</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.713</td>
<td>0.426</td>
<td>0.756</td>
<td>0.168</td>
<td>0.1768</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.761</td>
<td>0.458</td>
<td>0.762</td>
<td>0.172</td>
<td>0.2041</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - Foreign Borrowing

Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>( \theta_s = 0 ) :</th>
<th>( \theta_p )</th>
<th>( \theta_y )</th>
<th>( \theta_i )</th>
<th>( \theta_s )</th>
<th>( \theta_r )</th>
<th>( \theta_{rf} )</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Sigma = 0 )</td>
<td>1.659</td>
<td>0.377</td>
<td>0.745</td>
<td>—</td>
<td>0.000</td>
<td>0.000</td>
<td>11.04%</td>
</tr>
<tr>
<td>( \Sigma = 0.025 )</td>
<td>1.665</td>
<td>0.382</td>
<td>0.746</td>
<td>—</td>
<td>0.000</td>
<td>0.000</td>
<td>11.13%</td>
</tr>
<tr>
<td>( \Sigma = 0.050 )</td>
<td>1.676</td>
<td>0.387</td>
<td>0.747</td>
<td>—</td>
<td>0.000</td>
<td>0.000</td>
<td>11.38%</td>
</tr>
<tr>
<td>( \Sigma = 0.075 )</td>
<td>1.693</td>
<td>0.398</td>
<td>0.749</td>
<td>—</td>
<td>—0.143</td>
<td>—0.139</td>
<td>11.72%</td>
</tr>
<tr>
<td>( \Sigma = 0.100 )</td>
<td>1.695</td>
<td>0.394</td>
<td>0.751</td>
<td>—</td>
<td>—0.261</td>
<td>—0.253</td>
<td>11.99%</td>
</tr>
<tr>
<td>( \Sigma = 0.125 )</td>
<td>1.717</td>
<td>0.406</td>
<td>0.756</td>
<td>—</td>
<td>—0.320</td>
<td>—0.320</td>
<td>12.22%</td>
</tr>
<tr>
<td>( \Sigma = 0.150 )</td>
<td>1.748</td>
<td>0.420</td>
<td>0.762</td>
<td>—</td>
<td>—0.361</td>
<td>—0.357</td>
<td>12.46%</td>
</tr>
<tr>
<td>( \Sigma = 0.175 )</td>
<td>1.769</td>
<td>0.427</td>
<td>0.766</td>
<td>—</td>
<td>—0.385</td>
<td>—0.385</td>
<td>12.73%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - Foreign Borrowing
Include spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_s \neq 0 :$</th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
<th>$\theta_r$</th>
<th>$\theta_{rf}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Sigma = 0$</td>
<td>1.594</td>
<td>0.341</td>
<td>0.739</td>
<td>0.149</td>
<td>0.000</td>
<td>0.000</td>
<td>10.58%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.600</td>
<td>0.346</td>
<td>0.740</td>
<td>0.154</td>
<td>0.000</td>
<td>0.000</td>
<td>10.67%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.610</td>
<td>0.351</td>
<td>0.741</td>
<td>0.151</td>
<td>0.000</td>
<td>0.000</td>
<td>10.93%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.621</td>
<td>0.359</td>
<td>0.744</td>
<td>0.156</td>
<td>$-0.133$</td>
<td>$-0.145$</td>
<td>11.27%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.624</td>
<td>0.361</td>
<td>0.745</td>
<td>0.157</td>
<td>$-0.235$</td>
<td>$-0.259$</td>
<td>11.53%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.635</td>
<td>0.361</td>
<td>0.748</td>
<td>0.159</td>
<td>$-0.286$</td>
<td>$-0.321$</td>
<td>11.77%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.656</td>
<td>0.373</td>
<td>0.753</td>
<td>0.162</td>
<td>$-0.316$</td>
<td>$-0.360$</td>
<td>12.01%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.675</td>
<td>0.379</td>
<td>0.757</td>
<td>0.165</td>
<td>$-0.337$</td>
<td>$-0.387$</td>
<td>12.28%</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - Foreign Borrowing

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0:$</td>
<td>$\Sigma = 0$</td>
<td>1.659</td>
<td>0.377</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.025$</td>
<td>1.709</td>
<td>0.410</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.050$</td>
<td>1.733</td>
<td>0.425</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.075$</td>
<td>1.707</td>
<td>0.407</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.100$</td>
<td>1.699</td>
<td>0.398</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.125$</td>
<td>1.734</td>
<td>0.418</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.150$</td>
<td>1.764</td>
<td>0.427</td>
</tr>
<tr>
<td></td>
<td>$\Sigma = 0.175$</td>
<td>1.802</td>
<td>0.452</td>
</tr>
</tbody>
</table>
Optimal Taylor Rule Parameters - Foreign Borrowing

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta^\text{endo}_r$</th>
<th>$\theta^\text{endo}_r$</th>
<th>$\theta^\text{exo}_r$</th>
<th>$\theta^\text{exo}_rf$</th>
<th>$\sqrt{\frac{\text{var}(rp^b_t)}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s = 0 :$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>0.000</td>
<td>0.000</td>
<td>na</td>
<td>na</td>
<td>1.28%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.447</td>
<td>-0.443</td>
<td>3.21%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.550</td>
<td>-0.563</td>
<td>5.96%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.545</td>
<td>-0.545</td>
<td>8.80%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.538</td>
<td>-0.550</td>
<td>11.62%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.553</td>
<td>-0.574</td>
<td>14.42%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.589</td>
<td>-0.581</td>
<td>17.08%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.616</td>
<td>-0.608</td>
<td>19.79%</td>
</tr>
</tbody>
</table>

*Davis and Huang (Federal Reserve Bank of D. Monetary Policy and Financial Sector Risk* March 16, 2012 50 / 54
Optimal Taylor Rule Parameters - Foreign Borrowing

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta_s \neq 0$ :</th>
<th>$\theta_p$</th>
<th>$\theta_y$</th>
<th>$\theta_i$</th>
<th>$\theta_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Sigma = 0$</td>
<td>1.594</td>
<td>0.341</td>
<td>0.739</td>
<td>0.149</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>1.600</td>
<td>0.346</td>
<td>0.740</td>
<td>0.154</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>1.612</td>
<td>0.353</td>
<td>0.742</td>
<td>0.151</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>1.625</td>
<td>0.359</td>
<td>0.744</td>
<td>0.152</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>1.621</td>
<td>0.356</td>
<td>0.744</td>
<td>0.156</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>1.625</td>
<td>0.356</td>
<td>0.744</td>
<td>0.156</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>1.663</td>
<td>0.378</td>
<td>0.751</td>
<td>0.161</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>1.694</td>
<td>0.392</td>
<td>0.755</td>
<td>0.163</td>
</tr>
</tbody>
</table>
### Optimal Taylor Rule Parameters - Foreign Borrowing

Include exogenous and endogenous spreads in the Taylor Rule

<table>
<thead>
<tr>
<th>$\theta^{endo}_r$</th>
<th>$\theta^{endo}_{rf}$</th>
<th>$\theta^{exo}_r$</th>
<th>$\theta^{exo}_{rf}$</th>
<th>$\sqrt{\frac{\text{var}(r_p^b)}{\text{var}(GDP_t)}}$</th>
<th>Rel. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_s \neq 0$:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma = 0$</td>
<td>0.000</td>
<td>0.000</td>
<td>na</td>
<td>na</td>
<td>1.32%</td>
</tr>
<tr>
<td>$\Sigma = 0.025$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.381</td>
<td>-0.427</td>
<td>3.21%</td>
</tr>
<tr>
<td>$\Sigma = 0.050$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.457</td>
<td>-0.519</td>
<td>5.95%</td>
</tr>
<tr>
<td>$\Sigma = 0.075$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.469</td>
<td>-0.523</td>
<td>8.78%</td>
</tr>
<tr>
<td>$\Sigma = 0.100$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.473</td>
<td>-0.512</td>
<td>11.58%</td>
</tr>
<tr>
<td>$\Sigma = 0.125$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.461</td>
<td>-0.531</td>
<td>14.36%</td>
</tr>
<tr>
<td>$\Sigma = 0.150$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.482</td>
<td>-0.546</td>
<td>17.09%</td>
</tr>
<tr>
<td>$\Sigma = 0.175$</td>
<td>0.000</td>
<td>0.000</td>
<td>-0.490</td>
<td>-0.576</td>
<td>19.73%</td>
</tr>
</tbody>
</table>
Responses to a home financial shock - Foreign Borrowing

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads

![Graph of Output Gap vs Quarters](image1)

![Graph of Inflation vs Quarters](image2)

![Graph of Investment vs Quarters](image3)

![Graph of Risk Free Rate vs Quarters](image4)

![Graph of Physical capital loan spreads vs Quarters](image5)

![Graph of Interbank spreads vs Quarters](image6)
Responses to a foreign financial shock - Foreign Borrowing

Solid line - Ramsey, Dashed line - Taylor w/o spreads, Line with stars - Taylor w/ spreads

- Output Gap
- Inflation
- Investment
- Risk Free Rate
- Physical capital loan spreads
- Interbank spreads

Davis and Huang (Federal Reserve Bank of Dallas and Vanderbilt University)