DSGE Modelling and Financial Frictions

Cristiano Cantore, University of Surrey
Matteo Ghilardi, University of Surrey
Paul Levine, University of Surrey
Joseph Pearlman, City University

April 13, 2013

The NK Model

- Consists of RBC core and a nominal side consisting of
  - Prices set by the retail sector who convert wholesale output into differentiated goods
  - Price stickiness in the form of staggered Calvo-type or Rotemberg price setting
  - A nominal interest rate set by the CB in the form of simple Taylor rules
- Simplest 'workhorse model' has only labour as the fop as is analytically tractable (Woodford's book)
- Can add wage stickiness, capacity utilization (Smets-Wouters 03, 07)

Model Interconnections

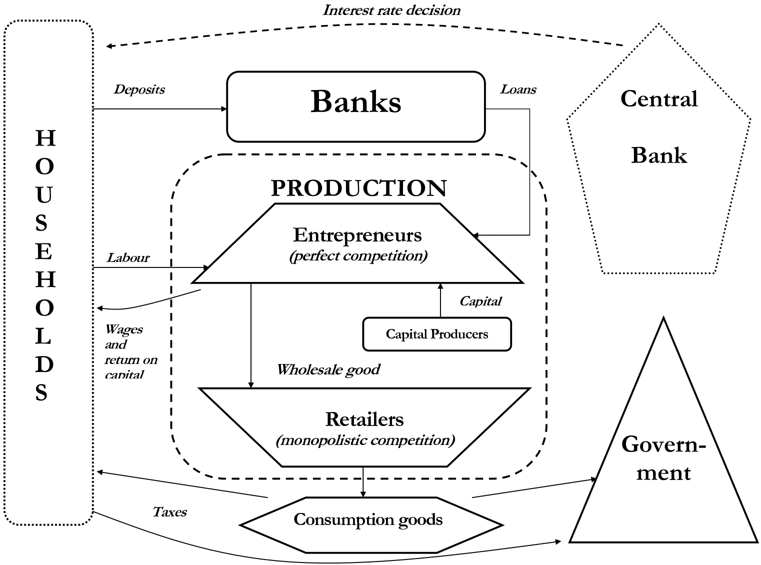


Figure: **A Model with a Banking Sector**

Macro-Literature on Financial Frictions

- The Cost Channel - [Faia(2008)]
- The Financial Accelerator: 'Costly State Verification' - [Bernanke *et al.*(1999)] (BGG)
- The Financial Accelerator: 'Costly Enforcement' - [Gertler and Kiyotaki(2009)] (GK), [Gertler *et al.*(2010)], [Gertler and Karadi(2011)]
- Collateral Constraint - [Kiyotaki and Moore(2007)], [Brozoza-Brzezina *et al.*(2013)]
- An exogenous probability of non-bank private sector **default** is introduced by [Wickens(2011)].
- Default is also present in BGG and implicitly in [Cúrdia and Woodford(2010)] who allow for 'bad loans'.

Micro-Literature and Bridging the Gap

- Pioneered by [Diamond and Dybvig(1983)] this focuses on how maturity mismatch in banking.
- The combination of short term liabilities and partially illiquid long term assets, opens up the possibility of **bank runs**.
- Bank runs lead to inefficient asset liquidation along with a general loss of banking services.
- A recent paper with this approach is [Angeloni and Faia(2012)] who adapt [Diamond(2000)] and [Diamond and Rajan(2000)] (themselves a development of Diamond and Dybvig) to a DSGE setting.
- A first attempt to **integrate** both approaches in a DSGE model is [Gertler and Kiyotaki(2012)].

The Key Relationship

- **Expected discounted spread =0**
- That is $\underbrace{1 = E_t[\Lambda_{t,t+1} R^{ex}_{t+1}]}_{\text{Euler Consumption Eqn}} = E_t[\Lambda_{t,t+1} R_{k,t+1}]$

where $\Lambda_{t,t+1} = \frac{\beta \Lambda_{C,t+1}}{\Lambda_{C,t}}$ is the $[t, t+1]$ stochastic discount factor and the return on capital is given by

$$R_{k,t} = \frac{Z_t + (1-\delta)Q_t}{Q_{t-1}}$$

where gross profits per unit of capital are

$$Z_t = \frac{P^W_t (Y^W_t - \frac{W_t}{P_t} h_t)}{P_t K_t} = (1-\alpha)\frac{P^W_t}{P_t}\frac{Y^W_t}{K_{t-1}}$$

(assuming CD technology) and the ex post real interest rate is

$$R^{ex}_t = \frac{R_{n,t-1}}{\Pi_t}$$

The GK Model with Financial Frictions

- Replace $E_t[\Lambda_{t,t+1} R^{ex}_{t+1}] = E_t[\Lambda_{t,t+1} R_{k,t+1}]$ with a banking sector that introduces a wedge between these expected returns
- Given a certain deposit level, a bank can lend frictionlessly to non-financial firms against their future profits, so firms are offering to banks a state contingent security.
- The activity of the bank can be summarized in two phases.
  1. Banks raise deposits from households.
  2. Banks uses the deposits to make loans to firms.

Banking sequence of events

1. Banks raise deposits, d_t from households at a real deposit net rate R^{ex}_{t+1} over the interval $[t, t+1]$
2. Banks make loans to firms.
3. Loans are s_t at a price Q_t. The asset against which the loans are obtained is end-of-period capital K_t. Capital depreciates at a rate δ in each period.

Bank Balance Sheet and Net Worth Accumulation

- $Q_t s_t = n_t + d_t$, where LHS is assets, RHS liabilities.
- $n_t = R_{k,t} Q_{t-1} s_{t-1} - R_t^{ex} d_{t-1}$ is net worth.
- Thus $Q_t s_t + R_t^{ex} d_{t-1} = R_{k,t} Q_{t-1} s_{t-1} + d_t$ is the bank's budget constraint.
- Also $n_t = R_t^{ex} n_{t-1} + (R_{k,t} - R_t^{ex}) Q_{t-1} s_{t-1}$. Net worth at the end of period t equals the gross return at the real riskless rate plus the excess return over the latter on the assets.
- In a richer model inter-bank lending and outside equity can be added to the balance sheet.

The Banker's Objective

- There is a consolidated households of bankers and workers. If bankers lasted for ever the financial constraint would eventually cease to bind.
- Banks exit and become workers with probability $1 - \sigma_B$ per period, Workers become banks with the same probability keeping proportions fixed.
- The banker's objective in GK is at the end of period t to maximize expected terminal wealth

$$V_t = E_t \sum_{i=1}^{\infty} (1 - \sigma_B) \sigma_B^{i-1} \Lambda_{t,t+i} n_{t+i}$$

where $\Lambda_{t,t+1+i}$ is the $[t, t+i]$ stochastic discount factor corresponding to the consumer's optimization problem.
- If we allowed the two groups to be distinct agents we could introduce differing appetites for risk as in [Wickens(2011)].

Endogenous Constraint on the Banks

- After a bank obtains funds, the banks manager may transfer a fraction of assets to her family.
- Households therefore limit the funds they lend to banks.
- In order to ensure that bankers do not divert funds the following incentive constraint must hold:

$$V_t \geq \Theta_t Q_t s_t \tag{1}$$

  where $1 - \Theta_t$ is the fraction of funds that can be reclaimed by creditors. Thus for households to be willing to supply funds, the banks franchise value V_t must be at least as large as its gain from diverting funds.
- Assume constraint is either always binding or absent as in basic NK. Current research considers *an occasionally binding constraint*.

The Banker's Optimization Problem and Solution

- Bankers maximize V_t by optimally choosing a lending path $\{s_{t+i}\}$ subject to the net worth equation and and the incentive constraint
- To solve this problem we guess a solution of the form:

$$V_t = V_t(s_t, d_t) = \nu_{s,t} s_t - \nu_{d,t} d_t = \mu_{s,t} Q_t s_t + \nu_{d,t} n_t \qquad (2)$$

  using the balance sheet to eliminate d_t, where $\nu_{s,t}$, and $\nu_{d,t}$ are the marginal values of the asset at the end of period t; $\mu_{s,t} \equiv \frac{\nu_{s,t}}{Q_t} - \nu_{d,t}$ is the excess value of bank assets over deposits.
- Next we perform the optimization $\max_{s_t} V_t(s_t, n_t)$ subject to the IC constraint (1) given n_t. The solution is:

$$\begin{aligned} \mu_{s,t} &= \max\left\{0,\ \Theta_B - \frac{\nu_{d,t}}{\phi_t}\right\} \\ \phi_t &\equiv \frac{Q_t s_t}{n_t} \text{ ('leverage')} \\ \text{Hence } V_t &= [\mu_{s,t}\phi_t + \nu_{d,t}] n_t \qquad (3) \end{aligned}$$

Solution of Banker's Problem

- Next write the Bellman equation for a given path for n_t as

$$\begin{aligned} V_t(s_t, n_t) &= E_t\Lambda_{t,t+1}[(1-\sigma_B)n_{t+1} + \sigma_B \max_{s_t} V_{t+1}(s_{t+1}, n_{t+1})] \\ &\equiv E_t\Lambda_{t,t+1}\Omega_{t+1}n_{t+1} \\ &= E_t\Lambda_{t,t+1}\Omega_{t+1}[R_{k,t+1}Q_t s_t - R^{ex}_{t+1}d_t] \qquad (4) \end{aligned}$$

  defining $\Omega_t = 1 - \sigma_B + \sigma_B(\nu_{d,t} + \phi_t\mu_{s,t})$, the shadow value of a unit of net worth, and using (3) and the definition of net worth, $n_t = R_{k,t}Q_{t-1}s_{t-1} - R^{ex}_t d_{t-1}$.
- Comparing (4) with (2) and equating coefficients of s_t and d_t, we arrive at the determination of $\nu_{s,t}$ and $\nu_{d,t}$:

$$\begin{aligned} \nu_{d,t} &= E_t\Lambda_{t,t+1}\Omega_{t+1}R^{ex}_{t+1} \\ \nu_{s,t} &= E_t\Lambda_{t,t+1}\Omega_{t+1}Q_t R_{k,t+1} \end{aligned}$$

  Hence

$$\mu_{s,t} \equiv \frac{\nu_{s,t}}{Q_t} - \nu_{d,t} = E_t\Lambda_{t,t+1}\Omega_{t+1}(R_{k,t+1} - R^{ex}_{t+1}) \quad (5)$$

Aggregation

- Aggregating up to N_t etc, accounting for banks that quit and enter, the balance sheet and aggregate leverage are:

$$\begin{aligned} Q_t S_t &= N_t + D_t \\ \phi_t &= \frac{Q_t S_t}{N_t} \end{aligned}$$

- At the aggregate level net worth is the sum of existing (old) bankers and new bankers:

$$N_t = N_{o,t} + N_{n,t}$$

where

$$N_{o,t} = \sigma_B \{ (Z_t + (1-\delta) Q_t) S_{t-1} - R_t^{ex} D_{t-1} \}$$

- To allow new bankers to operate with some net worth, we assume that the family transfers to each one a fraction ξ_B of the value value of assets of the exiting bank implying:

$$N_{n,t} = \xi_B [Z_t + (1-\delta) Q_t] S_{t-1}$$

- This completes the banking model.

Summary

- Aggregating up to N_t etc, accounting for banks that quit and enter – the latter beginning operation with a net worth transferred as a fraction ξ_B of the assets of exiting banks.
- Now an *expected spread* emerges if the IC constraint binds: $\mu_{s,t} = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{k,t+1} - R^{ex}_{t+1}) > 0$ where $\mu_{s,t}$ given by

$$
\begin{aligned}
\mu_{s,t} &= \max \left\{ 0,\ \Theta_B - \frac{\nu_{d,t}}{\phi_t} \right\} \\
\phi_t &\equiv \frac{Q_t S_t}{N_t} \ (\text{`leverage'}) \\
\nu_{d,t} &= E_t \Lambda_{t,t+1} \Omega_{t+1} R^{ex}_{t+1} \\
\Omega_t &= 1 - \sigma_B + \sigma_B (\nu_{d,t} + \phi_t \mu_{s,t}) \ (\text{shadow price of net worth})
\end{aligned}
$$

- Given K_t, aggregate net worth accumulates according to

$$
\begin{aligned}
N_t &= R_{k,t} (\sigma_B + \xi_B) Q_{t-1} S_{t-1} - \sigma_B R^{ex}_t D_{t-1} \\
D_t &= Q_t S_t - N_t \\
S_t &= K_t
\end{aligned}
$$

Calibration of the GK Model

- Three financial variables to calibrate σ_B, Θ_B and ξ_B. Following Gertler and Kiyotaki (2010):
- Choose the value of σ_B so that that bankers survive 10 years (40 periods) on average.
- Allow for an economy-wide leverage ratio in the steady state of 4
- Allow for an average credit spread in the steady state of 1% per year

Parameter	Calibrated Value
Θ_B	0.4121
ξ_B	0.0033

Table: GK Model. Calibrated Parameters

Steady states of NK and GK Compared

- We can compare steady states of NK and GK

Variable	GK	NK
C	0.3758	0.3831
Y	0.6944	0.7356
h	0.3417	0.3504
Λ	-183.646	-185.446

Table: **Steady States of NK and GK Compared**

- Thus financial frictions are welfare-enhancing in the steady state! Why? External Habit.
- Similarly inflation is welfare-enhancing in the steady state.

BGG Model

- In a 'costly state verification model' due originally to [Townsend(1979)], risk neutral entrepreneurs borrow from a financial intermediary holding household deposits.
- Entrepreneurs (firms) purchase capital from capital producers at a price Q_t and combine it with labour through a production technology to produce wholesale output.
- In order to ensure they cannot grow out of the financial constraint, entrepreneurs exit with probability σ_E as for banks in GK.
- As we shall see this setup introduces a wedge between the expected ex-ante riskless rate, $E_t[R^{ex}_{t+1}]$ and the expected return on capital $E_t[R_{k,t+1}]$.

The Entrepreneur and Default

- The entrepreneur seeks loans l_t to bridge the gap between its net worth $n_{E,t}$ and the expenditure on new capital $Q_t k_t$. Thus

$$l_t = Q_t k_t - n_{E,t}$$

where net worth accumulates according to

$$n_{E,t} = R_{k,t} Q_{t-1} k_{t-1} - R_{l,t} l_{t-1}$$

where $R_{l,t}$ is the loan rate to be decided in the contract.

- In each period an idiosyncratic capital quality shock, ψ_t results in a return $R_{k,t}\psi_t$ which is the entrepreneur's private information. Default in period $t+1$ occurs when $n_{E,t+1} < 0$, i.e., when the shock falls below a threshold $\bar{\psi}_{t+1}$ given by

$$\bar{\psi}_{t+1} = \frac{R_{l,t+1} l_t}{R_{k,t+1} Q_t k_t}$$

- If ψ is drawn from a density $f(\psi)$, the probability of default is:

$$p(\bar{\psi}) = \int_{\psi_{min}}^{\bar{\psi}_{t+1}} f(\psi) d\psi$$

The Bank's IC Constraint

- In the event of default the bank receives the assets of the firm and pays a proportion μ of monitoring costs.
- Otherwise the bank receives the full payment on its loans, $R_{l,t+1} l_t$ where $R_{l,t}$ is the agreed loan rate at time t.
- Then the bank's incentive compatibility (IC) constraint at time t is

$$E_t \Big[\underbrace{(1-\mu) R_{k,t+1} Q_t k_t \int_{\psi_{min}}^{\bar{\psi}_{t+1}} \psi f(\psi) d\psi}_{\text{default}} \quad + \quad \underbrace{(1 - p(\bar{\psi}_{t+1})) R_{l,t+1} l_t}_{\text{no default}}$$

$$\geq \quad R^{ex}_{t+1} l_t \Big]$$

- The lhs is the expected return from the contract averaged over all realizations of the shock, the rhs is the return from a riskless bond.

The Entrepreneur's Optimal Contract

- The entrepreneur's optimal contract then solves

$$\max_{\bar{\psi}_{t+1},k_t} E_t\left[\left(1-\Gamma(\bar{\psi}_{t+1})\right)R_{k,t+1}Q_t k_t\right]$$

  given initial net worth $n_{E,t}$, subject to the IC constraint above where $1-\Gamma(\bar{\psi}_{t+1})$ is the fraction of capital returns she receives given the threshold $\bar{\psi}_{t+1}$ where the lender's share is:

$$\Gamma(\bar{\psi}_{t+1}) \equiv \int_{\psi_{min}}^{\bar{\psi}_{t+1}} \psi f(\psi)d\psi + \bar{\psi}_{t+1}(1-p(\bar{\psi}_{t+1}))$$

- The IC constraint which can then be written as

$$E_t\left[R_{k,t+1}Q_t k_t\left[\Gamma(\bar{\psi}_{t+1})-\mu G(\bar{\psi}_{t+1})\right] \geq R^{ex}_{t+1}(Q_t k_t - n_{E,t})\right]$$

  where $\mu G(\bar{\psi}_{t+1})$ are monitoring costs given by:

$$G(\bar{\psi}_{t+1}) \equiv \int_{\psi_{min}}^{\bar{\psi}_{t+1}} \psi f(\psi)d\psi$$

The External Risk Premium and Aggregation

- The solution to this problem is

$$E_t[R_{k,t+1}] = E_t[\rho(\bar{\psi}_{t+1})R^{ex}_{t+1}]$$

where the premium on external finance, $\rho(\bar{\psi}_{t+1})$ is given by

$$\rho(\bar{\psi}_{t+1}) = F\left(\Gamma'(\bar{\psi}_{t+1}), \Gamma(\bar{\psi}_{t+1}), G(\bar{\psi}_{t+1}), G'(\bar{\psi}_{t+1}), \mu\right)$$

- Aggregating, entrepreneurs exit with prob $1-\sigma_B$, transfer a proportion ξ_E of wealth to new entrants and consume

$$C_{E,t} = (1-\sigma_E)(1-\xi_E)(1-\Gamma(\bar{\psi}_t))R_{k,t}Q_{t-1}K_{t-1}$$

- Aggregate net worth then accumulates according to

$$N_{E,t} = (\sigma_E + \xi_E)(1-\Gamma(\bar{\psi}_t))R_{k,t}Q_{t-1}K_{t-1}$$

- The resource constraint becomes

$$Y_t = C_t + C_{E,t} + G_t + I_t + \mu G(\bar{\psi}_t))R_{k,t}Q_{t-1}K_{t-1}$$

- The equilibrium is completed with the aggregate IC constraint

$$R_{k,t}Q_{t-1}K_{t-1}\left[\Gamma(\bar{\psi}_t) - \mu G(\bar{\psi}_t)\right] = R^{ex}_t(Q_{t-1}K_{t-1} - N_{E,t-1})$$

Calibration of BGG

- Our Choice of density function is a uniform distribution on support $\psi \in [1-A, 1+A]$; i.e.,
- Financial parameters to calibrate are A, σ_E, ξ_E and μ.
- Calibrate to hit four targets: a default probability $p(\bar{\psi}) = 0.02$, $\rho(\bar{\psi}) = 1.0025$ corresponding to a credit spread of 100 basis points as in GK, an entrepreneur leverage $\frac{QK}{N_E} = 2$ and entrepreneurial consumption $\frac{C_E}{Y} = 0.1$.
- Then calibrated parameters are:

Parameter	Calibrated Value
A	0.5218
σ_E	0.97700
ξ_E	0.0160
μ	0.0098

Table: BGG Model. Calibrated Parameters

Comparison of IRFs of NK, GK and BGG

- Shocks to technology - decompose into shock to trend and temporary shock about trend
- Shocks to government spending, policy function and mark-up
- An aggregate capital quality shock ψ_{t+1}, which wipes out or enhances capital available in period t going into period $t+1$. Capital accumulation becomes

$$K_t = \psi_{t+1}[(1-\delta)K_{t-1} + (1-c(X_t))I_t]$$

  resulting in a gross return on capital

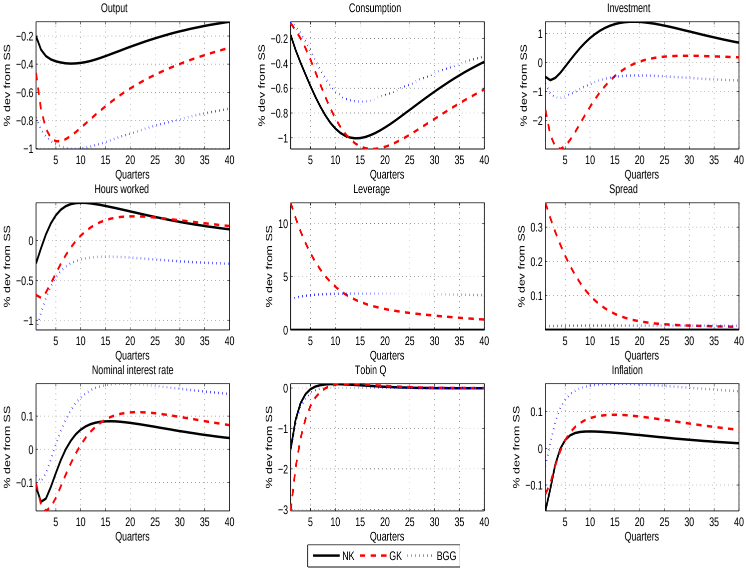
$$R_{k,t} = \psi_t \frac{Z_t + (1-\delta)Q_t}{Q_{t-1}}$$

- $S_t = [(1-\delta)K_{t-1} + (1-c(X_t))I_t]$ is now 'capital in process' which is transformed into capital for next period's production according to $K_t = \psi_{t+1} S_t$ and evolves according to

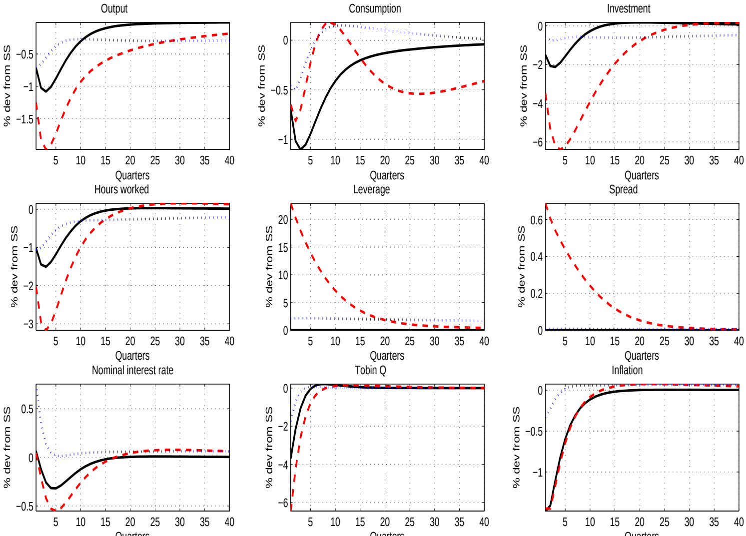
$$S_t = (1-\delta)\psi S_{t-1} + (1-c(X_t))I_t$$

- The capital quality shock also affects the balance sheet of the banks (GK) or entrepreneurs (BGG).

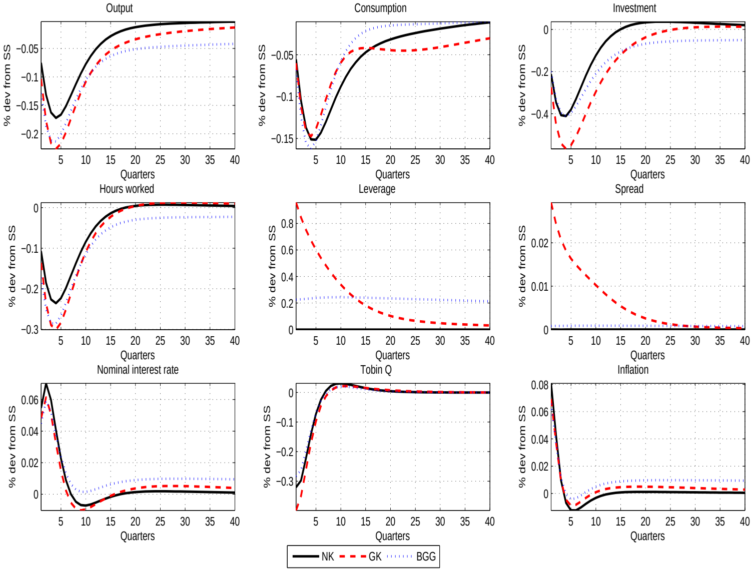
Capital Quality Shock with Conventional Taylor Rule



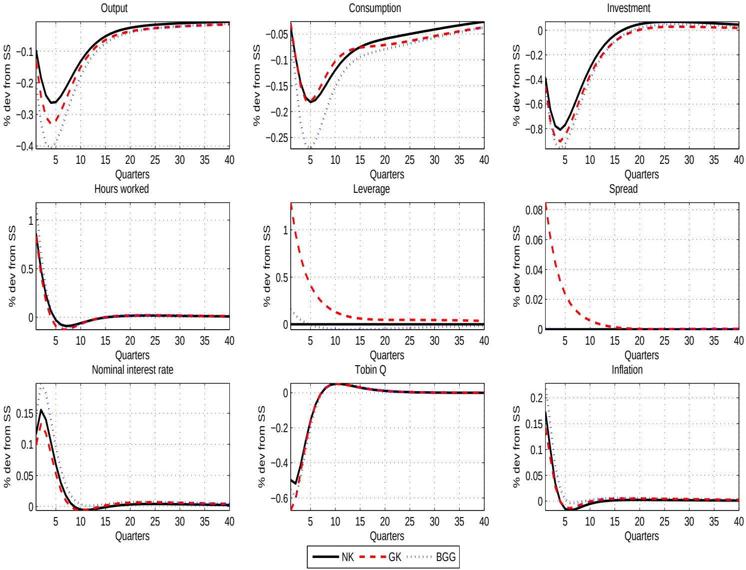
Monetary Policy Shock with Conventional Taylor Rule



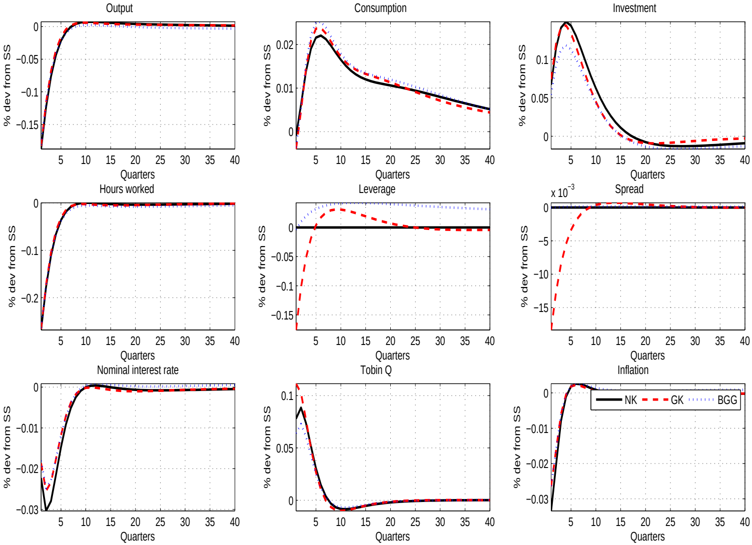
Mark-up Shock with Conventional Taylor Rule



Technology Shock with Conventional Taylor Rule



Gov Spending Shock with Conventional Taylor Rule



The Collateral Constraint Kiyotaki-Moore-Type Model

- A ‘collateral constraints’ model in the spirit of KM as in [Brozoza-Brzezina *et al.*(2013)].
- As in BGG an entrepreneur purchases capital from capital producers at a price Q_t and rents it to wholesale producers, or produces the good herself.
- Entrepreneurs consume in every period and can raise their net worth by lowering their consumption.
- The setup is more general than BGG in one sense that any degree of risk averseness is assumed.

Entrepreneur: Utility and Budget constraint

- Given external habit $\chi_E C_{E,t-1}$, the entrepreneur at time 0 maximize $E_t[\sum_0^\infty \beta_E^t \Lambda_t^E(C_{E,t}^j)]$ where

$$\Lambda_t^E(C_{E,t}) = \frac{(C_{E,t} - \chi_E C_{E,t-1})^{1-\sigma_E}}{1-\sigma_E}$$

  where $\sigma_E \geq 0$, $\sigma_E = 0$ being the risk-neutral base as in BGG. The discount rate $\beta_E < \beta$ for households captures a probability of exit for the entrepreneur.
- Two constraints: the first is a budget constraint in real terms

$$C_{E,t} + Q_t K_t + R_{L,t}^{ex} L_{t-1} = R_{k,t} Q_{t-1} K_{t-1} + T_{E,t} + L_t$$

  where L_t denotes loans in real terms and $T_{E,t}$ are transfers from households to entrepreneurs.
- Now net worth is given by

$$N_{E,t} = R_{k,t} Q_{t-1} K_{t-1} + T_{E,t} - C_{E,t} - R_{L,t}^{ex} L_{t-1} = Q_t K_t + L_t$$

  The important cf with GK or BGG is *net worth can be raised by the entrepreneur choosing to reduce her consumption.*

Entrepreneur: Collateral Constraint

- The second constraint is a collateral constraint in nominal terms

$$R_{L,t}L_t \leq m_t E_t[\Pi_{t+1} Q_{t+1}(1-\delta)K_t]$$

  This says that end-of-period t capital sold in period $t+1$ after further depreciation provides the collateral for the loan.

- Define leverage as

$$\phi_t \equiv \frac{Q_t K_t}{N_{E,t}} = \frac{Q_t K_t}{Q_t K_t - L_t} = \frac{1}{1 - \frac{L_t}{Q_t K_t}}$$

  which is proportional to an alternative measure of leverage, the liability to asset ratio for the entrepreneur, $\frac{L_t}{Q_t K_t}$.

First Order Conditions, Resource Constraint and Banks

- Let Θ_t be the multiplier on the CC. Then foc are:

$$
\begin{aligned}
1 &= E_t\left[\beta_E \frac{\Lambda^E_{C,t+1}}{\Lambda^E_{C,t}} R_{k,t+1} + \frac{\Theta_t}{\Lambda^E_{C,t}} m_t \Pi_{t+1} \frac{Q_{t+1}}{Q_t}(1-\delta)\right] \\
1 &= E_t\left[\beta_E \frac{\Lambda^E_{C,t+1}}{\Lambda^E_{C,t}} R^{ex}_{L,t+1} + \frac{\Theta_t}{\Lambda^E_{C,t}} R_{L,t}\right]
\end{aligned}
$$

- The resource constraint

$$Y_t = C_t + C_{E,t} + I_t + G_t$$

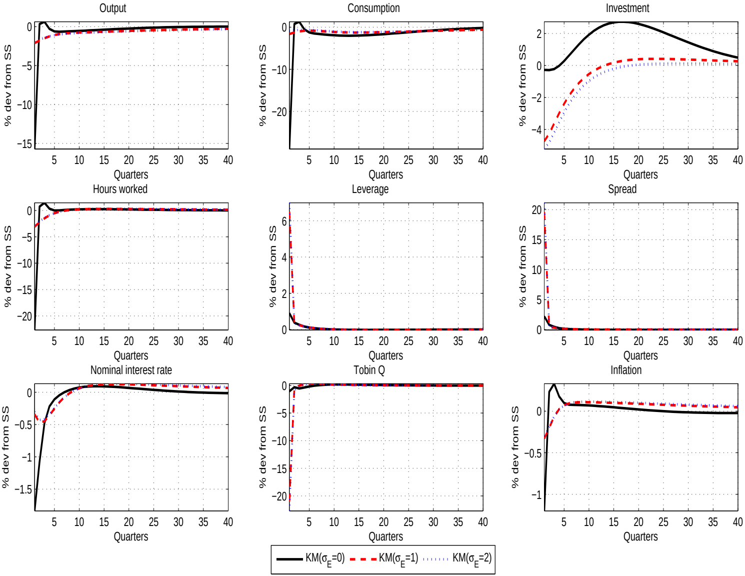
- A monopolistically competitive banking sector (which plays a minor role) closes the model

$$R_{L,t} = \frac{1}{1 - 1/\zeta_{L,t}} R_{n,t}$$

Calibration of KM Model

- There are five additional parameters to set or calibrate, m, β_E, σ_E, χ_E and ζ_L.
- As in [Brozoza-Brzezina *et al.*(2013)] we set the loan to value ratio at $m = 0.25$ [Monacelli(2009)].
- ζ_L plays only a little role, we set to to give a mark-up 1.002 so $\zeta_L = 500$.
- To compare the KM model with BGG we assume the entrepreneur is risk neutral with $\sigma_E = 0$.
- The final two parameters are calibrated to hit the same targets for spread and $\frac{C_E}{Y}$ as in BGG. Results are $\beta_E = 0.9788$ and $T_E = 0.0309$.
- But the dynamic properties of the KM model are crucially dependent on the choice of σ_E as the following Figure shows. The $\sigma_E = 0$ case yields plausible swings in spread and leverage but a big swing in total consumption. The opposite is true for $\sigma_E = 1$ and $\sigma_E = 2$.

Capital Quality Shock with Conventional Taylor Rule



Dynare Software

- The code for all the banking models is in the folder **Banking_Models** along with the NK model for comparison.
- Dynare File **BGG_RES_Course.mod** is set up with an external steady state that calibrates ϱ, β, A, σ_E, ξ_E and μ using fsolve and an external steady state function.
- File **GK_RES_Course.mod** is set up with an external steady state that calibrates ϱ, β, Θ_B and ξ_B using fsolve and an external steady state function.
- File **KM_RES_Course.mod** is set up with an external steady state that calibrates ϱ, β, β_E and T_E using fsolve and an external steady state function.
- Matlab programs to compare irfs are provided.

Exercises

1. Consider the flexi-price case. You can compute the irfs for our four models, NK, GK, BGG and KM, in this case without setting up new models by letting the contract parameter ξ get very small.
2. Returning to the NK model compare the irfs of NK, GK and BGG and GK, BGG and KM with an implementable Taylor rule. You will see that the picture changes somewhat. Only for the monetary and capital quality shocks do we see accentuation, so the form of the monetary policy is crucial.
3. Introduce a new forward-looking variable $\Pi L_t \equiv \Pi_{t+1}$ in Dynare and consider a forward looking conventional Taylor-type rule feeding back on Π_{t+1}. Compare irfs across NK, GK and BGG for this new rule

Bayesian Estimation of Structural Parameters

Parameters	Models		
	GK	**BGG**	**KM($\sigma_E = 1.5$)**
ρ_A	0.6839	0.7593	0.8325
ρ_G	0.9299	0.9478	0.6747
ρ_{MS}	0.5634	0.5228	0.5476
ρ_ψ	0.9540	0.9667	0.9183
ϕ_X	2.2024	3.6473	0.3290
σ_c	2.3966	1.9606	0.7400
χ	0.7738	0.8806	0.7073
ξ	0.3350	0.3655	0.1984
γ_p	0.3699	0.3428	0.3986
α_π	2.7220	2.4866	2.8692
α_r	0.6487	0.6556	0.4492
α_y	0.1520	0.1840	0.0603
ML	-127.338556	-93.612833	-251.341045

Table: Estimation Results using financial data

Bayesian Estimation of Shocks

Parameters	Models		
	GK	**BGG**	**KM ($\sigma_E = 1.5$)**
Shocks			
ϵ_a	0.0979	0.1777	0.4952
ϵ_G	1.6710	2.1118	1.5062
ϵ_{MPS}	0.2525	0.2266	0.4052
ϵ_{MS}	0.0833	0.0746	0.0647
ϵ_A	0.6807	0.6503	0.8814
ϵ_ψ	0.0665	0.0650	0.1357

Table: Estimation Results using financial data

Second Moments

Model	Output	Inflation	Interest rate	Baa
Standard Deviation				
Data	0.5432	0.2392	0.5952	0.5199
GK Model	0.5921	0.2416	0.3059	0.9007
BGG Model	0.6378	0.2704	0.3126	0.6862
KM Model	0.6591	0.2643	0.3024	3.4386
Cross-correlation with Output				
Data	1.0000	-0.2013	0.1140	0.1352
GK Model	1.0000	-0.1448	-0.1842	0.4371
BGG Model	1.000	-0.1353	-0.1410	0.5166
KM Model	1.0000	-0.0472	-0.2113	0.4124
Autocorrelations (Order=1)				
Data	0.1526	0.5364	0.9462	0.9517
GK Model	0.1690	0.4122	0.8122	-0.0908
BGG Model	0.1743	0.5481	0.8509	0.0705
KM Model	0.1191	0.4112	0.7720	-0.4970

Some Current Research on FF by CIMS

- Model Comparisons on the full SW07 set-up
- Model with bank-firm as well as household-bank FF
- Model with inter-bank lending and outside equity
- Macro-prudential regulation
- Integrating micro-finance and macro-accelerator approaches
- Endogenous growth and FF
- Fiscal-Monetary interactions with FF
- Occasionally Binding IC Constraint

Angeloni, I. and Faia, E. (2012).
Capital Regulation and Monetary Policy with Fragile Banks.
Journal of Monetary Economics.
Forthcoming.

Bernanke, B., Gertler, M., and Gilchrist, S. (1999).
The Financial Accelerator in Quantitative Business Cycles.
In M. Woodford and J. B. Taylor, editors, *Handbook of Macroeconomics, vol. 1C*. Amsterdam: Elsevier Science.

Brozoza-Brzezina, M., Kolasa, M., and Makarski, K. (2013).
The Anatomy of Standard DSGE Models with Financial Frictions.
Journal of Economic Dynamics and Control, **37**, 32 – 51.

Cúrdia, V. and Woodford, M. (2010).
Credit spreads and monetary policy.
Journal of Money, Credit and Banking, **42**, 3–35.

Diamond, D. W. and Dybvig, P. (1983).
Bank Runs, Deposit Insurance and Liquidity.

Journal of Political Economy, **91**, 401 – 419.

Diamond, D. W. and Rajan, R. (2000).
Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking.
Journal of Political Economy, **109**(6), 287 – 327.

Diamond, D. W. R. R. (2000).
A Theory of Bank Capital.
Journal of Finance, **LV**(6).

Faia, E. (2008).
Optimal Monetary Policy with Credit-Augmented Liquidity Cycles.
Mimeo.

Gertler, M. and Karadi, P. (2011).
A Model of Unconventional Monetary Policy.
Journal of Monetary Economics, **58**(1), 17– 34.

Gertler, M. and Kiyotaki, N. (2009).

Financial Intermediation and Credit Policy in Business Cycle Analysis.
Mimeo and forthcoming chapter in the Handbook of Macroeconomics, Elsevier, 2010.

Gertler, M. and Kiyotaki, N. (2012).
Banking, Liquidity and Bank Runs in an Infinite Horizon Economy.
Mimeo, NYU and Princeton University.

Gertler, M., Kiyotaki, N., and Queralto, A. (2010).
Financial Crises, Bank Risk Exposure and Government Financial Policy.
Mimeo.

Kiyotaki, N. and Moore, J. (2007).
Credit Cycles.
Journal of Political Economy, **105**(2), 211 – 248.

Monacelli, T. (2009).
New Keynesian Models, durable goods and collareral constraints.

Journal of Monetary Economics, **56**(2), 242 – 254.

Townsend, R. M. (1979).
Optimal Contracts and Competitive Markets with Costly State Verification.
Journal of Economic Theory, **21**(2), 265 – 293.

Wickens, M. R. (2011).
A dsge model of banks and financial intermediation with default risk.
CEPR Discussion Papers 8556, C.E.P.R. Discussion Papers.