



**The Global Integrated Monetary and Fiscal Model:  
Introduction and Applications with Stronger  
Macro-Financial Linkages**

Jaromir Benes, Ondra Kamenik, Michael Kumhof,  
Douglas Laxton, Dirk Muir, and Susanna Mursula

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Stronger Macro-Financial Linkages

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## **Outline of the Presentation**

1. High Level Overview of the GIMF
2. Modelling Macro-Financial Linkages - BGG
3. New Model Properties

## High Level Overview of the GIMF

- GIMF is the Global Integrated Monetary and Fiscal model.
- Uses a Blanchard-Weil-Buiter overlapping generations framework to incorporate both fiscal and monetary policy, in a multi-country setting.

## GIMF as a Policy Tool

- Monetary policy = inflation targeting, nominal exchange rate targeting.
  - Other targeting regimes are possible.
- Fiscal policy = debt targeting; deficit targeting; tax rates available on labour and capital income; value added tax on consumption.
  - tax smoothing.
- Monetary and fiscal policy can be examined in a rich economic framework.

## Economic Structure of the GIMF

- Agents face a consumption-leisure choice – agents can be forward looking or liquidity constrained.
  - subject to their budget constraint – forward-looking consumers hold government debt and net foreign assets.
- Net foreign assets are internationally-traded bonds, denominated in a single numeraire currency  $\implies$  incomplete markets.
  - U.S. dollar serves as numeraire in most applications of GIMF.

## *Production*

- Firms are monopolistically competitive.
- Production is multilayered.
  - factors of production are combined to produce intermediate tradable and nontradable goods.
  - intermediate goods are combined to produce final consumption and investment goods.



## *International Features*

- some intermediate goods and all final goods are tradable internationally.
- the model tracks bilateral trade flows in all goods.
- there can be country risk premia (relative to a numeraire country, such as the United States).

## *Other Features*

- GIMF can be used at either an annual or quarterly frequency.
- nominal price stickiness; nominal wage stickiness.
- more features will be described, in detail, throughout the day.
- This presentation illustrates a new development in the GIMF model - macro-financial linkages.

## Macro-Financial Linkages in the GIMF

- We have introduced a financial sector into GIMF, focusing on the demand side of credit, modelled on:
  - Bernanke, Gertler and Gilchrist (1999) – the financial accelerator.
  - Christiano, Motto, and Rostagno (2003) – their representation of the banking sector.

## What is the Financial Accelerator?

- Introduce an endogenous risk premium to the cost of financing by firms, relative to the risk-free interest rate.
  - There are **information asymmetries** between lenders and borrowers that lead to increased monitoring costs, and extra costs to projects financed by funds external to the firm.
- **Firms**, producing tradable and non-tradable goods, are risk neutral and have finite expected lifetimes. They borrow from **financial intermediaries** to finance a fraction of their capital acquisitions.

## What is the Financial Accelerator? (cont'd)

- **Information asymmetry** and **costly state verification** mean **financial intermediaries** charge an **external financing premium** to firms, which is inversely related to the firms' **degree of leverage**.

– **Leverage** = ratio of corporate debt to a firm's net worth.

- **Financial intermediaries**, aside from their auditing function, serve only as a conduit between households and firms – solely taking deposits and making loans.

⇒ Negative shocks to the economy, which can decrease firms' cash flow and net worth, raising premia on external financing.

## BGG in the Context of a Macroeconomic Model

- The BGG financial accelerator is often formulated and solved in a partial equilibrium setting, so that a linearized version of the resulting firm maximization problem can be introduced into a larger model of the economy.
- With GIMF, we have incorporated the fully non-linear representation of the BGG financial accelerator.
  - there are some modifications, but the underlying stories we tell with our financial accelerator are fundamentally the same as BGG.

## *Advantages of the Nonlinear Representation*

- No longer confined to having only a negative relationship between leverage and the external financing premium (predicated on some arbitrary functional form).
- If we can solve the full nonlinear model, the response of the financial sector is more extreme in the presence of higher leverage.
  - for example, an economy with a leverage ratio of 100% reacts more strongly (proportionately) to negative shocks than an economy with 50% leverage.

## *Advantages of the Nonlinear Representation (cont'd)*

- We have richer stories that we can tell about:
  - the cost of firms' bankruptcies to financial intermediaries.
  - the probability of bankruptcy of firms at any point in time.
  - the level of the external financing premium, which is inverse to the firms' leverage.
  - the equity premium required by investors.



## *Disadvantages of the Nonlinear Representation*

- the full nonlinear representation is very difficult to solve for shocks of the magnitude that interest us.
- one solution – numeric linearization of the entire model around a steady state.
  - lose the nonlinear response of the model to leverage and some other variables.
  - retain the full menu of features (i.e. bankruptcy costs, probability of bankruptcy).

## Properties of the New Financial Sector in the GIMF

- Look at the GIMF with BGG, in a two-country context – Canada and the United States.
  - Canada is 6.5% of GDP, while the United States is 93.5%.
  - Trade flows for Canada are decent – 80% of exports go to, and 55% of imports come from, the United States.
  - Under 20% of U.S. trade is accounted for – roughly 15% of exports go to, and 20% of imports come from, Canada.

## **Properties of the New Financial Sector (cont'd)**

- We will consider shocks that hit the United States, and discuss their effects over the first 4 years.
- We will then look at the effects in Canada, and any exacerbation of the effects by the new financial sector.

## A Temporary Increase in the Corporate Risk Premium

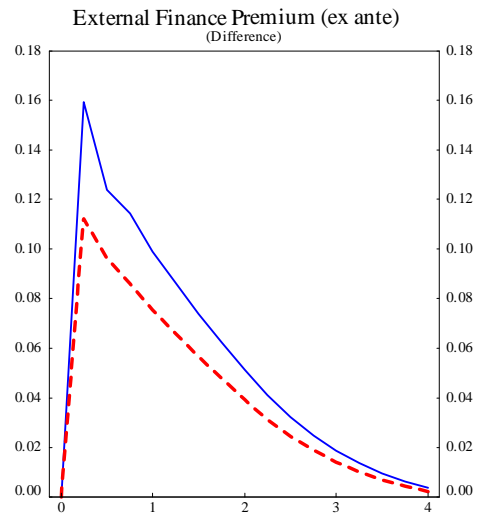
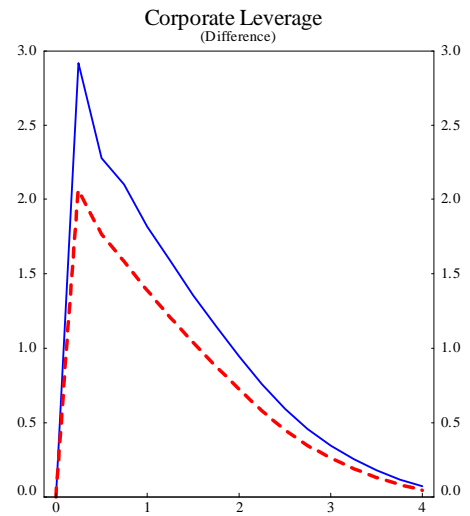
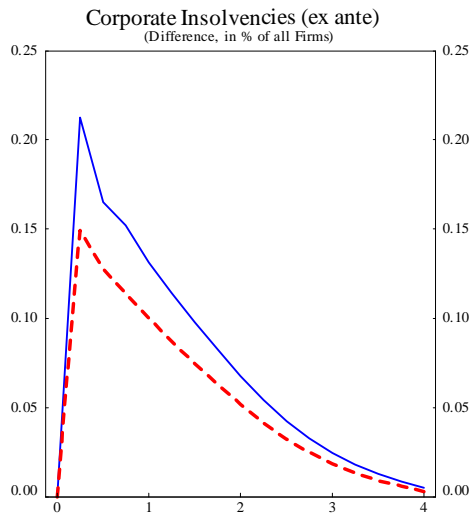
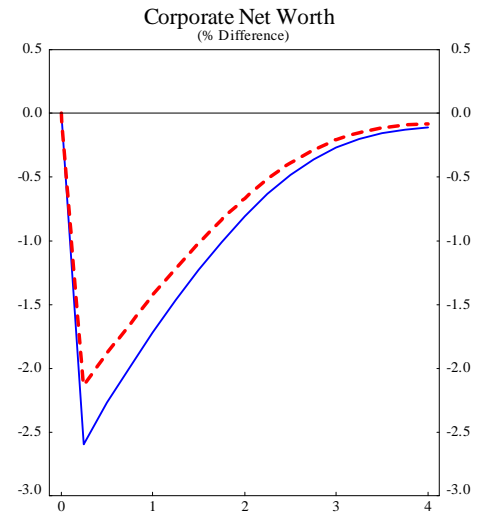
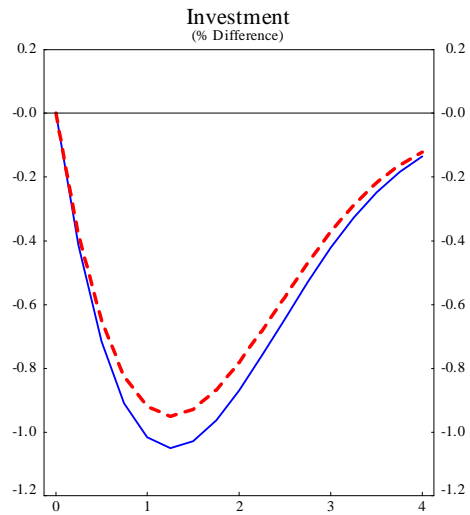
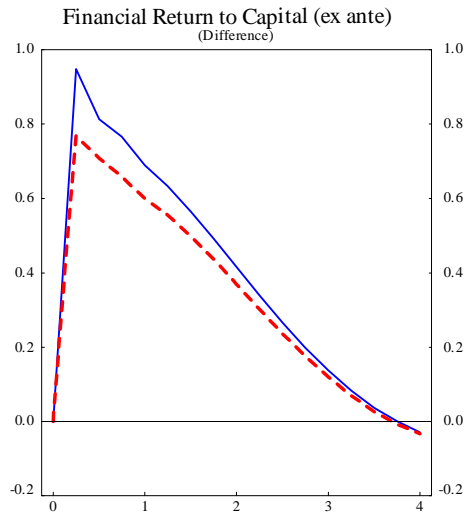
- There is a temporary, but persistent, 25 basis point increase in the spread between
  - the private corporate interest rate;
  - the public interest rate (which is both the policy rate, and the rate of return on domestic government debt).

## *United States - Financial Sector*

- For firms, the increase in the spread leads to a higher cost for loans – drives down net worth, increases leverage.
- Also drives down investment by roughly 1% – reinforces fall in net worth.
- As leverage increases from 100% to 102.5% (economy wide), there is an increase of the external finance premium of around 14 bp.
- Probability of bankruptcies increase by almost 0.2%age pts.

## United States: Increase in the Exogenous Private / Public Interest Rate Spread in the United States

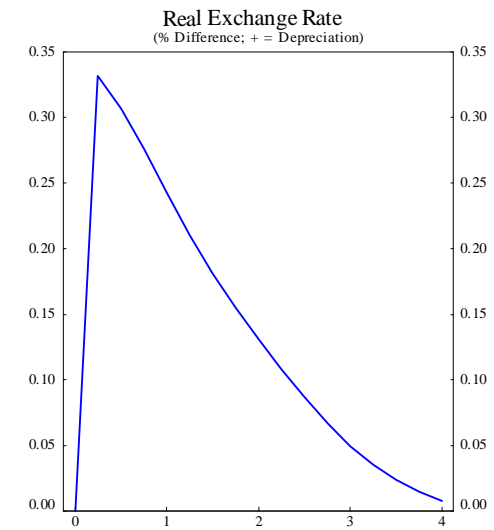
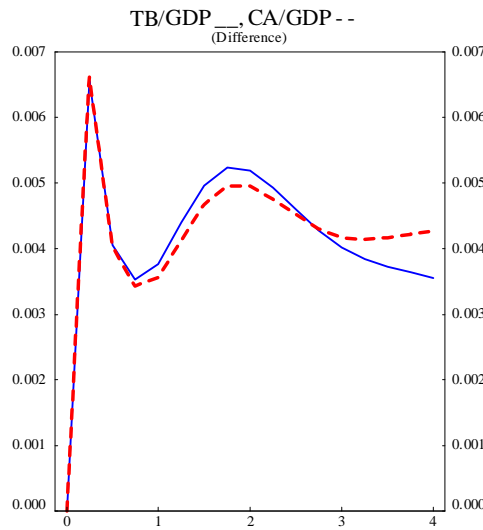
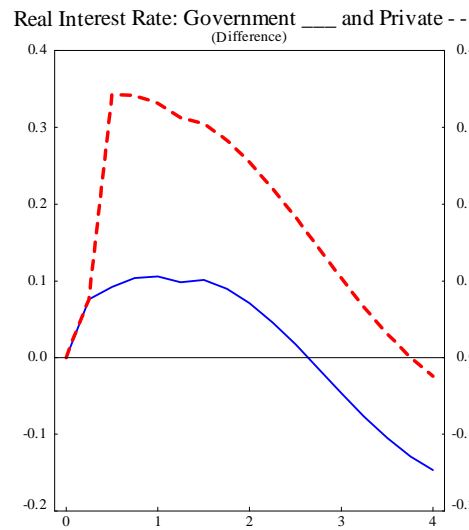
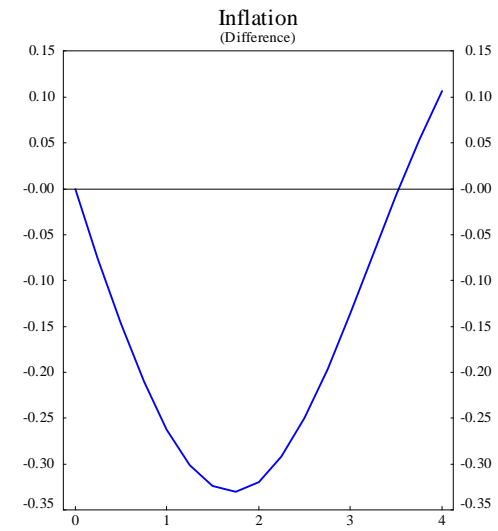
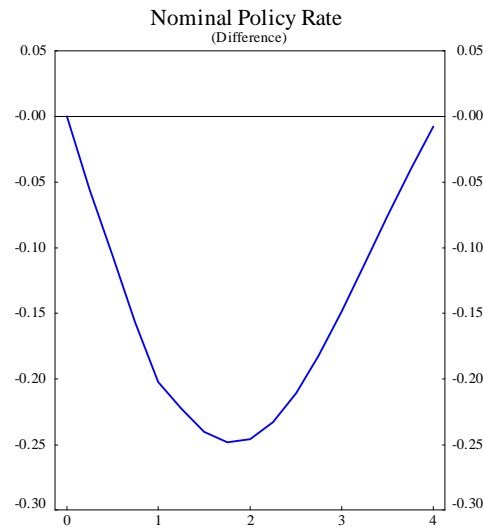
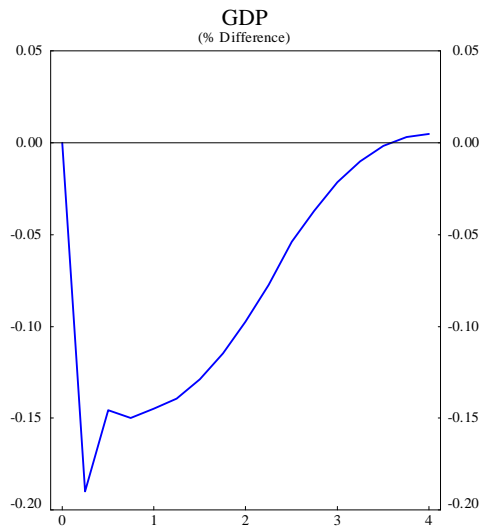
Tradables \_\_ and Nontradables - -



## *United States - Overall*

- GDP falls overall by 0.2% – weaker investment, lower consumer wealth as firms deteriorate.
- Monetary policy can try to offset this – fall in policy rate of 25bp by year 2; but still cannot prevent financial difficulties.
- Mild depreciation leads to very small improvement in current account.

## United States: Increase in the Exogenous Private / Public Interest Rate Spread in the United States

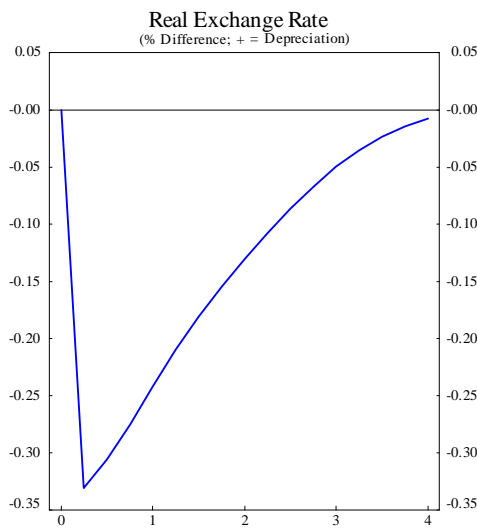
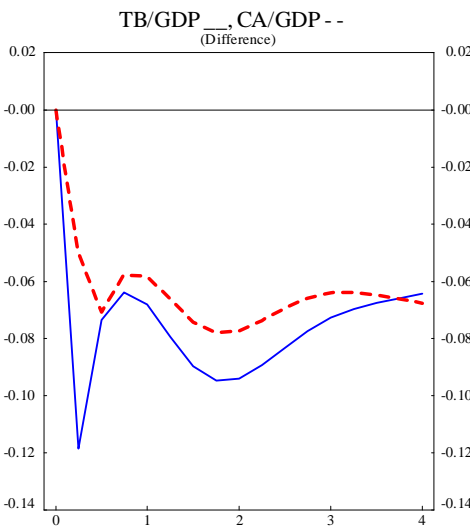
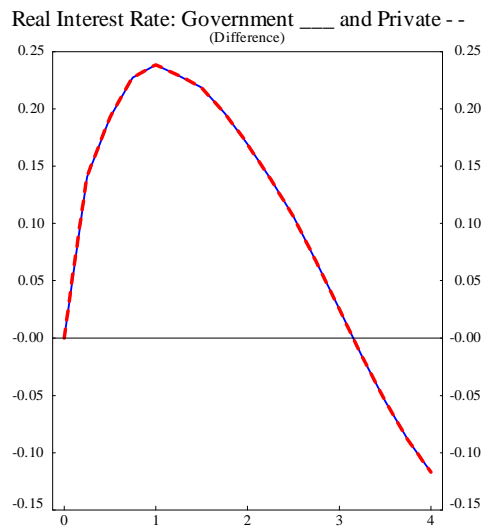
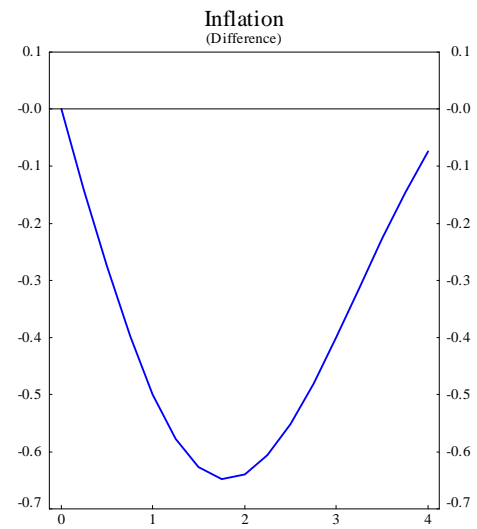
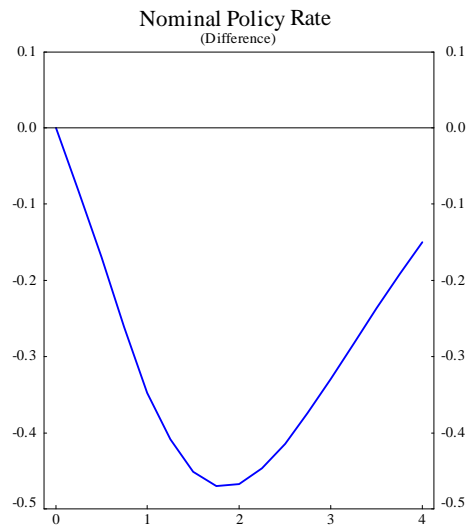
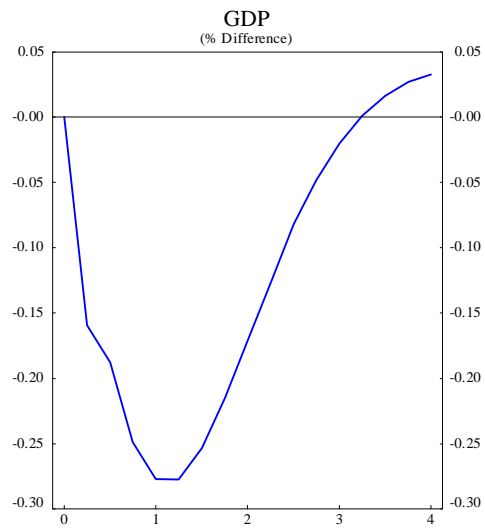




## *Spillovers in Canada - Overall*

- Exchange rate appreciates, slight deterioration of the trade balance.
- Leads to fall in inflation, rise in real interest rate, undone by monetary policy with a slight delay, since it is an unanticipated surprise.
- Higher real interest rate leads to fall in investment by 0.7%.

## Canada: Increase in the Exogenous Private / Public Interest Rate Spread in the United States



## *Spillovers in Canada - Financial Sector*

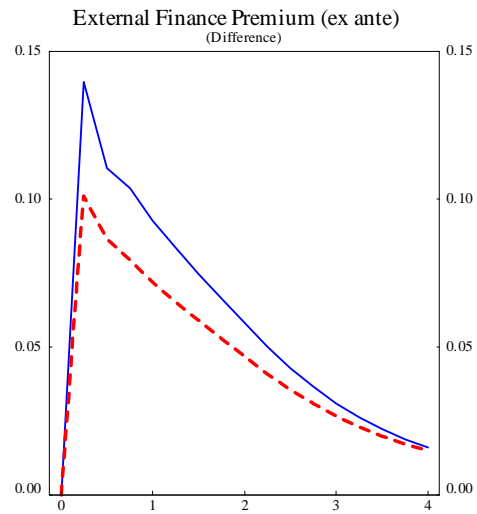
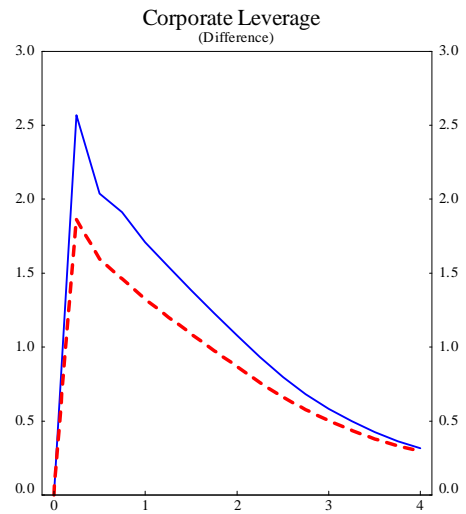
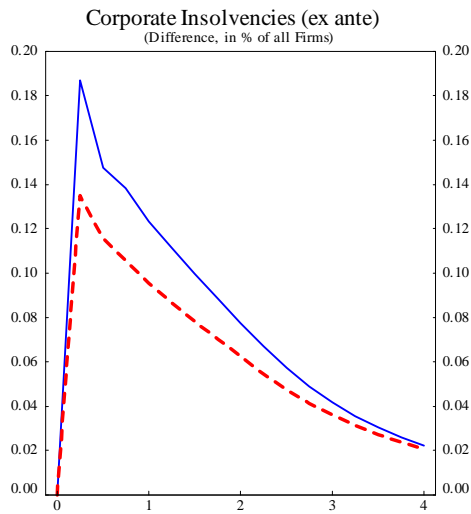
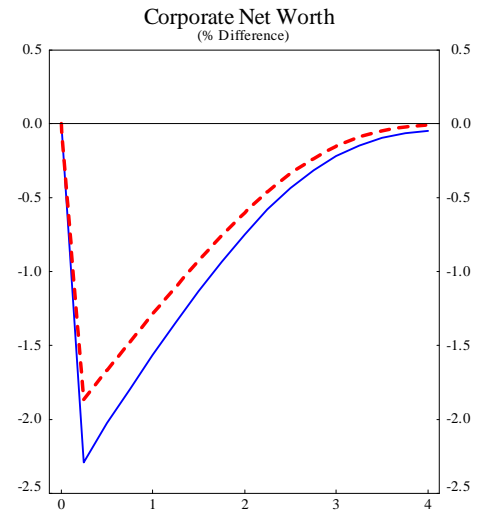
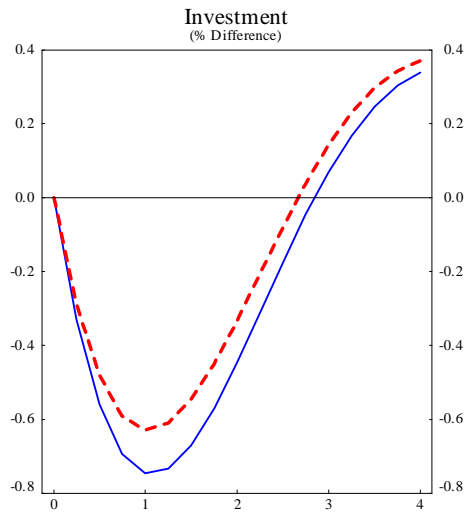
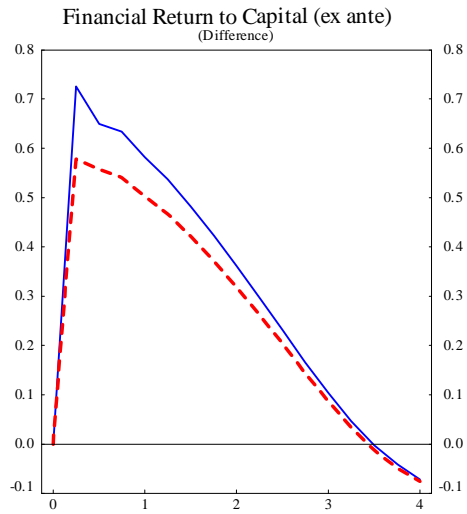
- Financial sector exacerbates this, with same channels as in the United States.

**This is a common theme in all shocks – the financial accelerator magnifies the spillover effects in Canada.**

- There would still be negative spillovers in Canada, but they are accelerated by the BGG mechanism.
- External finance premium increases by roughly 10 bp; probability of bankruptcy up by roughly 0.15% economy-wide.

## Canada: Increase in the Exogenous Private / Public Interest Rate Spread in the United States

Tradables -- and Nontradables - -

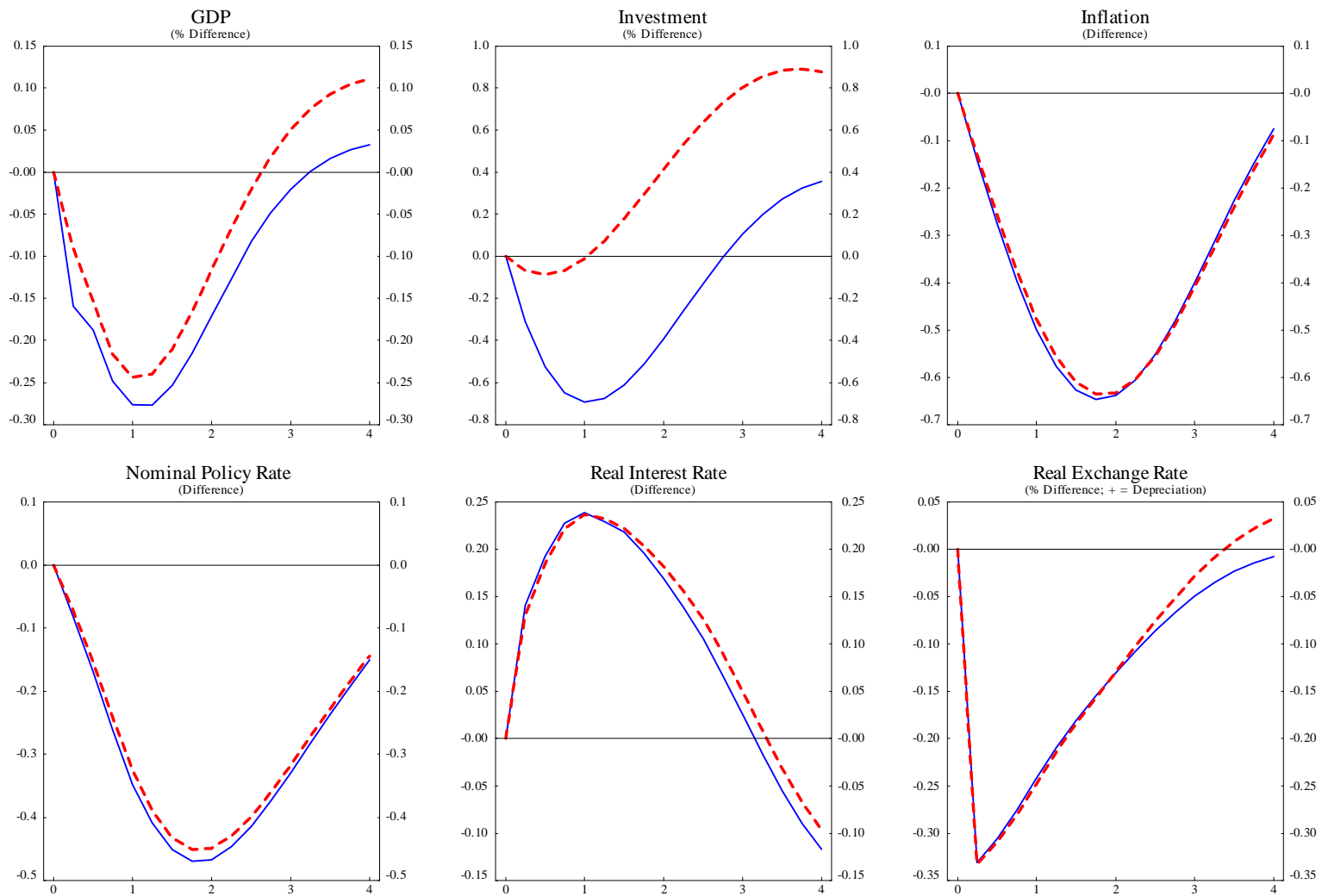


## *Canada - Decomposing the Effects of the Financial Sector*

- The following graphs show the Canadian response with and without the financial sector based on the BGG financial accelerator.
- The lack of an external financing premium means investment would be much stronger.
  - monetary policy would be more effective in undoing the spillovers of the shock from the United States.

# Increase in the Exogenous Private / Public Interest Rate Spread in the United States

— With a financial sector; - - without a financial sector



## *A Temporary Increase in the Cost of Firm Bankruptcies to Lenders*

- When a firm goes bankrupt, a certain percentage of the firm's assets are irretrievably lost, resulting in a deadweight loss to the lender.
- We assume a temporary, but persistent, increase in that deadweight loss by all firms.
  - Could result from effects of regulations that reduce the retrievability of bankrupt firms' assets – for example, "mark to market" pricing in the subprime mortgage crisis.
- To show the nonlinear model, we consider only a very small shock – it is the relative magnitudes, not the absolute, that matter in the results.

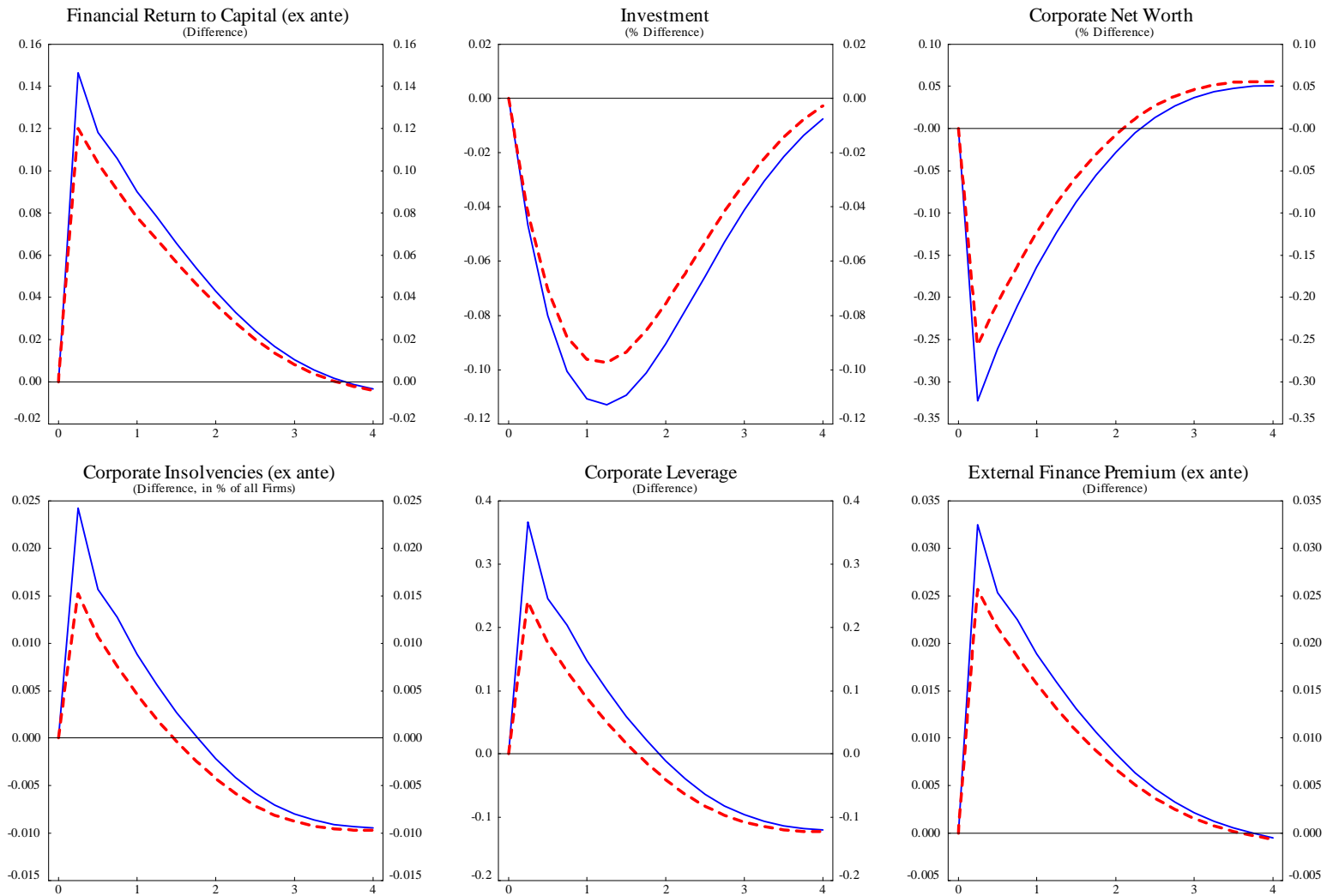
## *United States - Financial Sector*

- The external financing premium increases directly from the shock – drives a wedge between the private and corporate interest rates  $\implies$  increase in higher loan costs, drives down net worth, increases leverage.
  - External financing premium increase is reinforced by:
    - increase of leverage by 0.3 percentage pts.
    - 0.1% fall in investment that reinforces fall in net worth.
- $\therefore$  Increase in the probability of bankruptcy for firms.



## United States: Temporary But Persistent Increase in Bankruptcy Costs in the United States

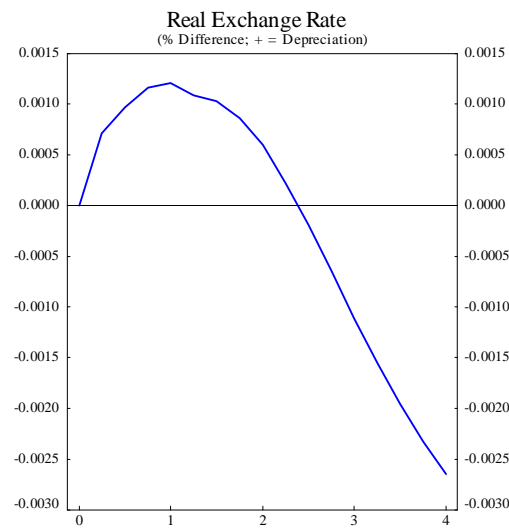
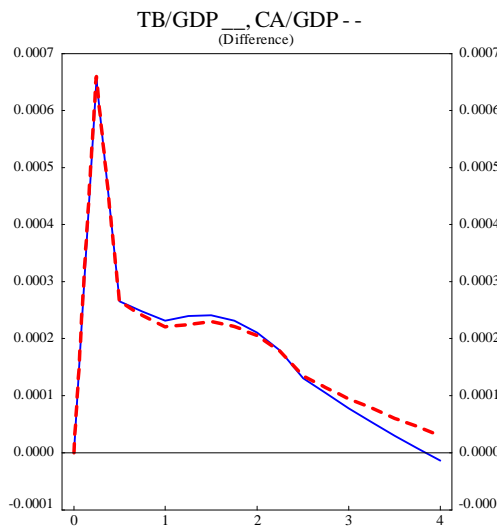
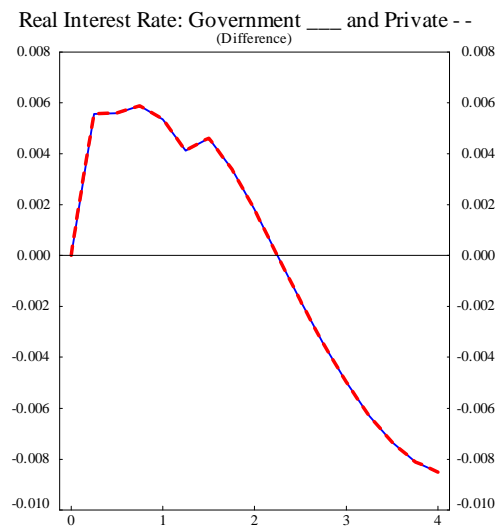
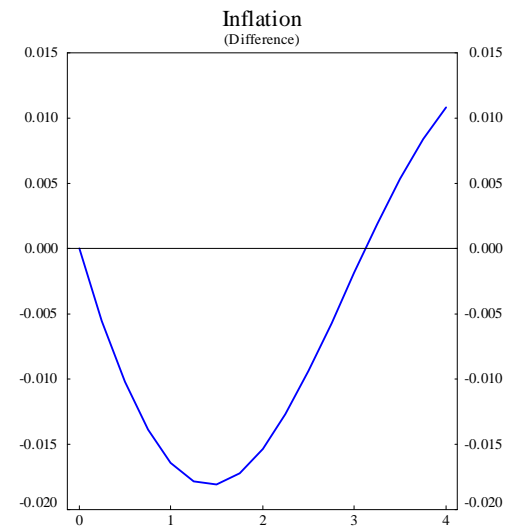
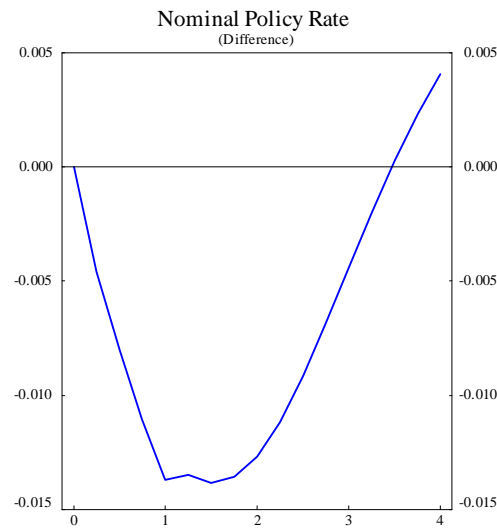
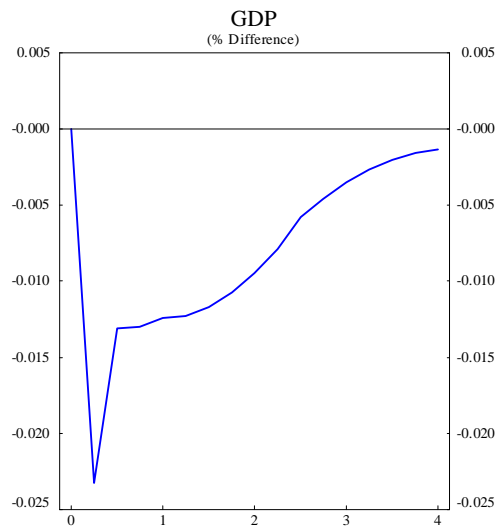
Tradables \_\_\_ and Nontradables - -



## *United States - Overall*

- GDP falls overall by 0.01% – weaker investment, lower consumer wealth as firms deteriorate.
- Monetary policy can try to offset this – fall in policy rate of 1bp by year 2; but still cannot prevent financial difficulties.
- Mild depreciation leads to very small improvement in current account.

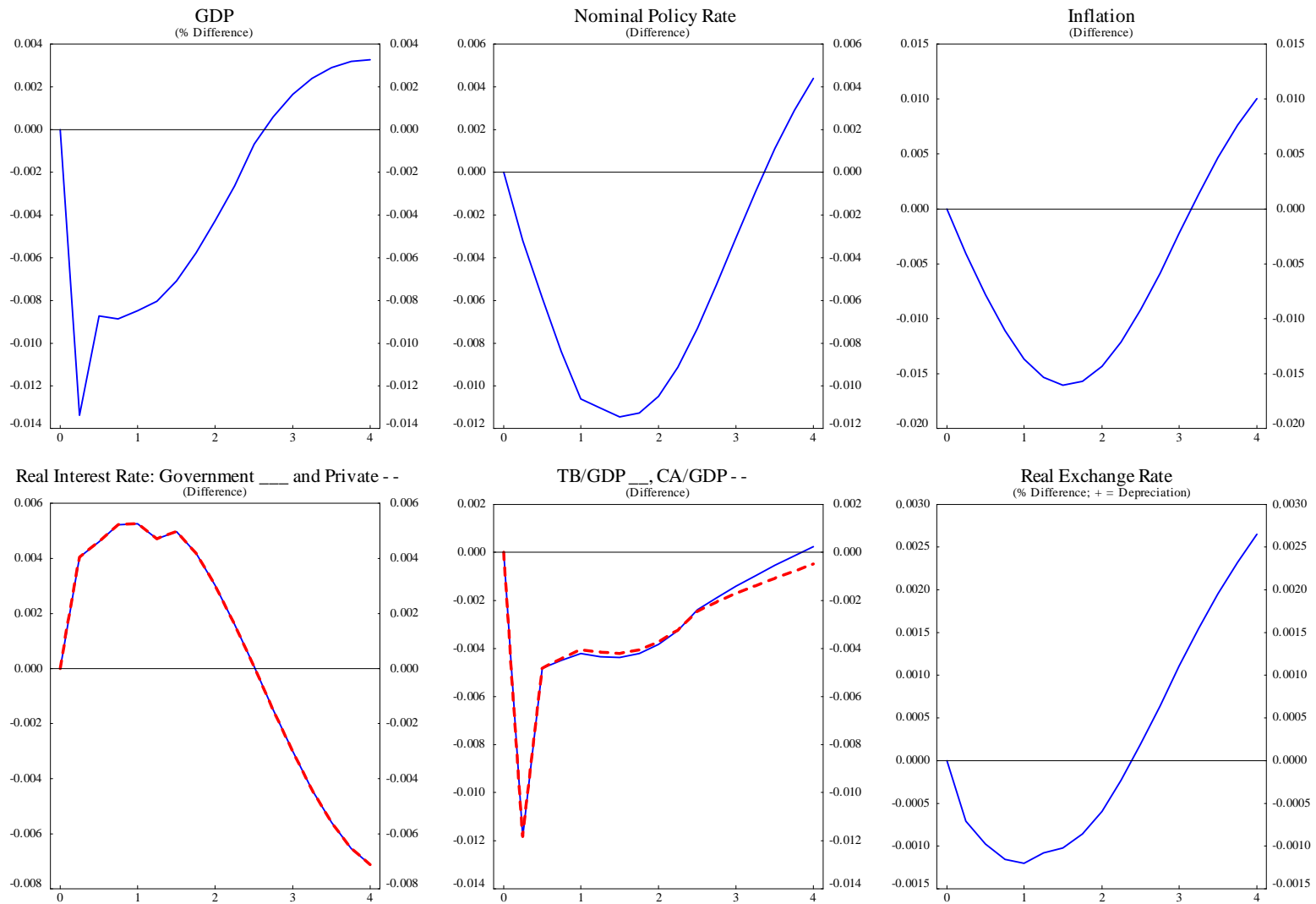
## United States: Temporary But Persistent Increase in Bankruptcy Costs in the United States



## *Spillovers in Canada*

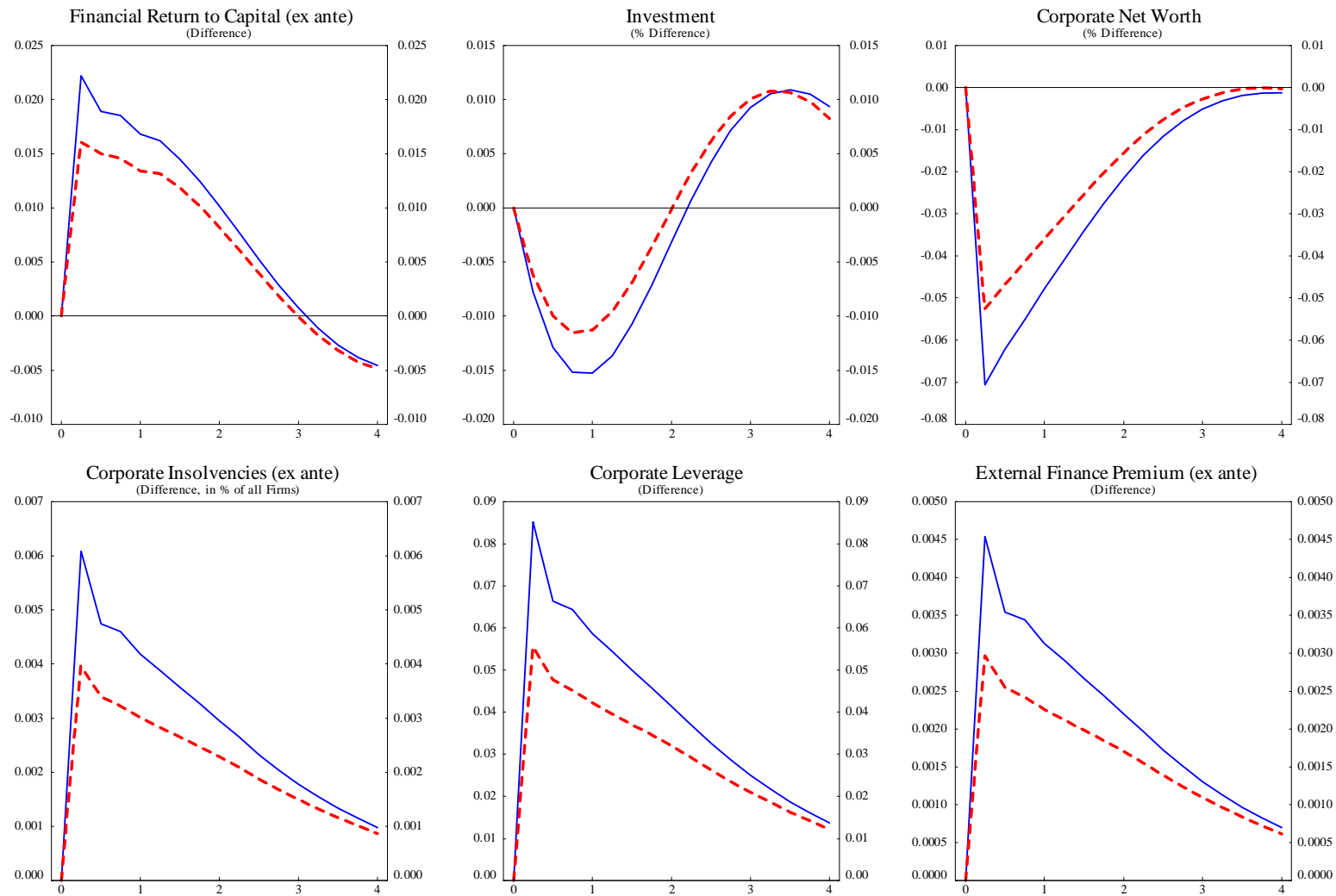
- Again, spillovers come mostly through the trade channel, that put downward pressure on the economy. Most important feature is the rise in the real interest rate, leading to a fall in investment.
- Here, again, the new financial sector leads to a worsening of the situation in Canada – accelerator effect of higher corporate leverage.
- We will no longer consider the results in Canada – story is the same.

## Canada: Temporary But Persistent Increase in Bankruptcy Costs in the United States



# Canada: Temporary But Persistent Increase in Bankruptcy Costs in the United States

Tradables \_\_\_ and Nontradables - -



## *A Temporary Increase in the Probability of Corporate Bankruptcy*

- In any given period, there is a probability of bankruptcy for each firm, which results in an average percentage of firms going bankrupt each quarter.
- We assume a temporary but persistent increase in the rate of bankruptcies (or, in other words, borrower riskiness).

## *United States - Financial Sector*

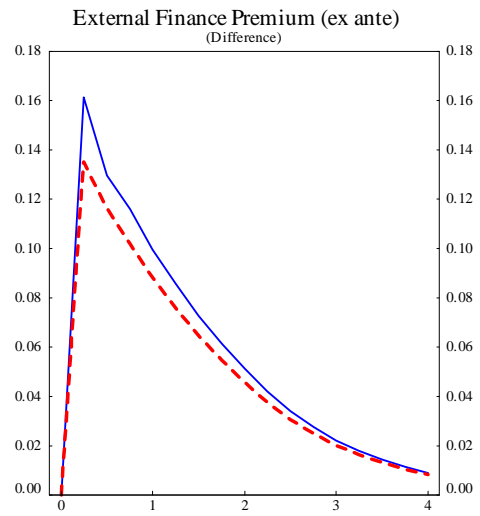
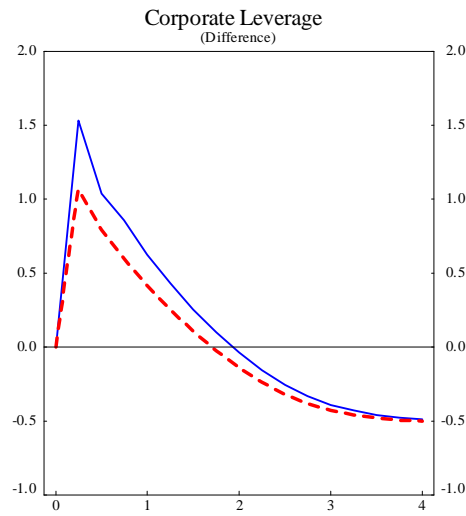
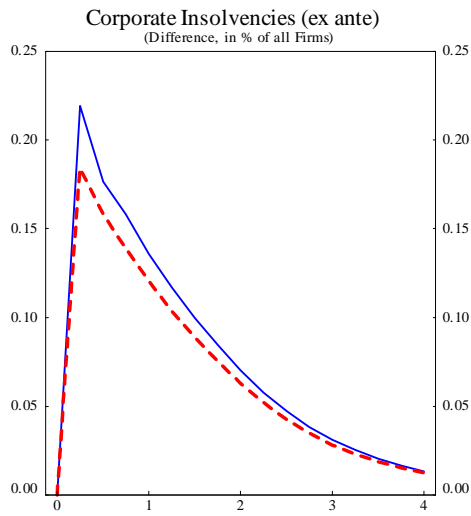
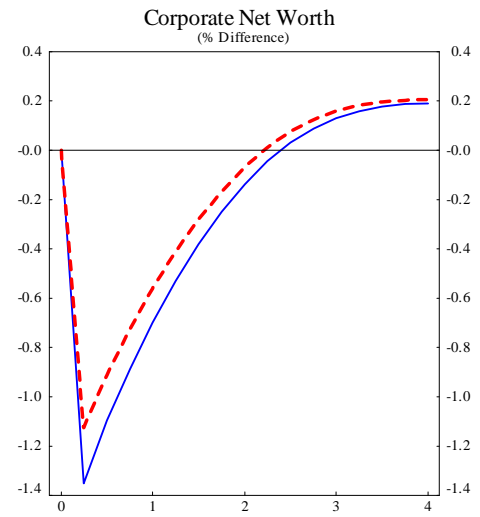
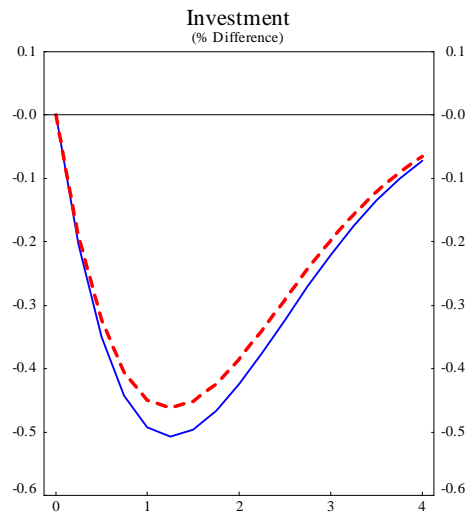
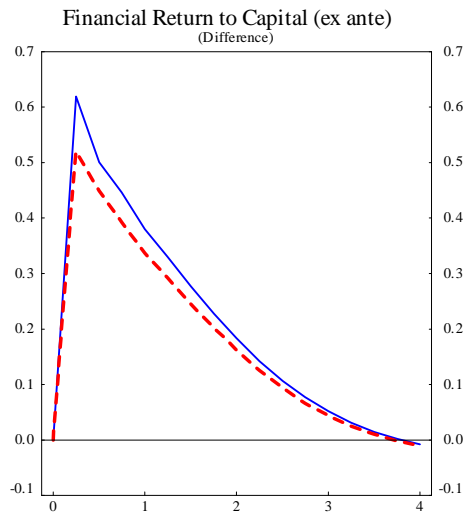
- As probability of bankruptcy increases by 0.2%age pts, financial intermediaries need to better monitor the risky firms, so they charge a higher external finance premium – drives down net worth, increases leverage.
- Also drives down investment by roughly 0.5% – reinforces fall in net worth.
- So leverage increases from by roughly 1.2% (economy wide).

= overall, an increase of the external finance premium of around 15 bp.



# United States: Temporary But Persistent Increase in Borrower Riskiness in the United States

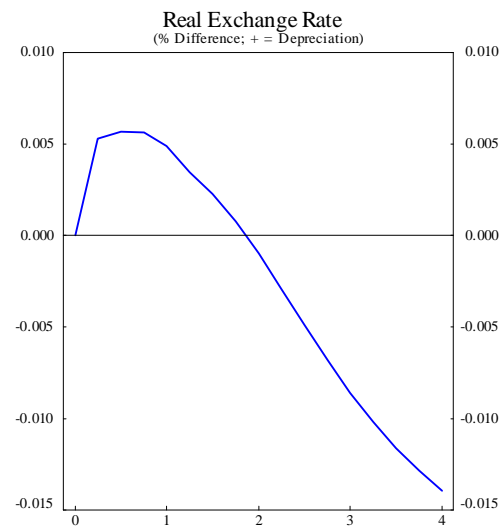
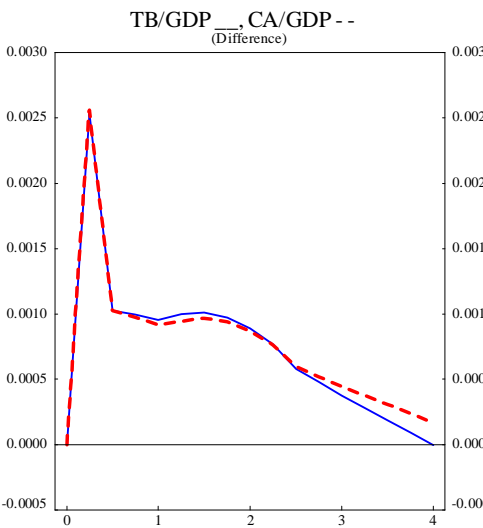
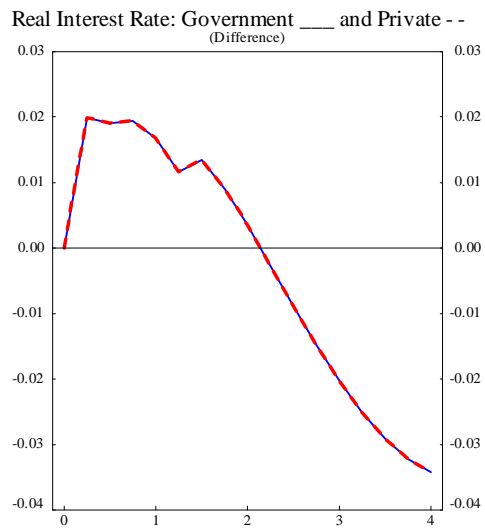
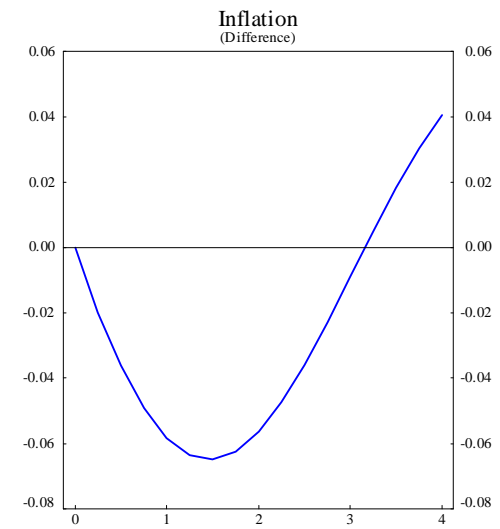
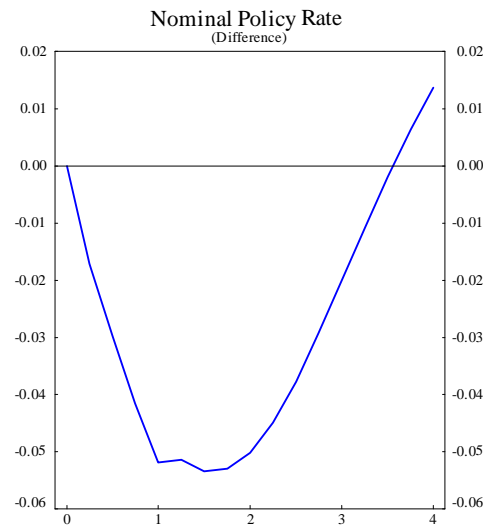
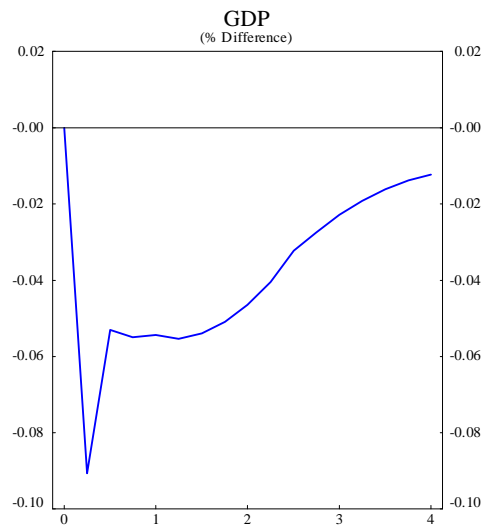
Tradables \_\_ and Nontradables - -



## *United States - Overall*

- GDP falls overall by 0.05% – weaker investment, lower consumer wealth as firms deteriorate.
- Monetary policy can try to offset this – fall in policy rate of 25bp by year 2; but still cannot prevent financial difficulties.
- Mild depreciation leads to very small improvement in current account.

## United States: Temporary But Persistent Increase in Borrower Riskiness in the United States



## *A Temporary Loss of Net Worth - Destruction of Firm Value*

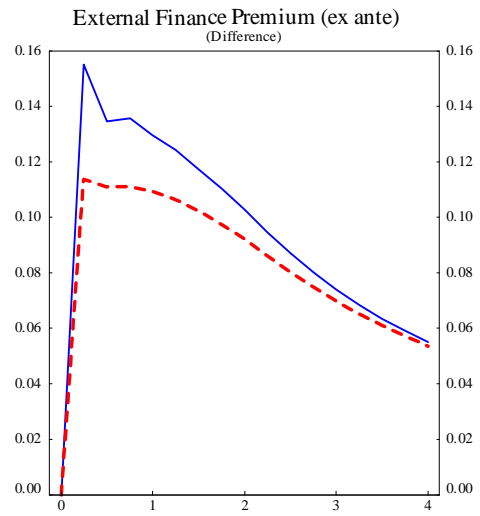
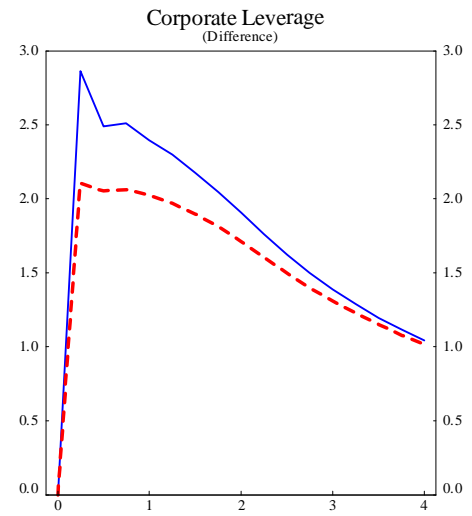
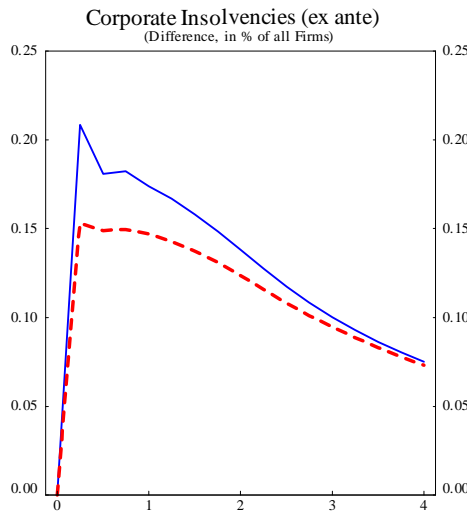
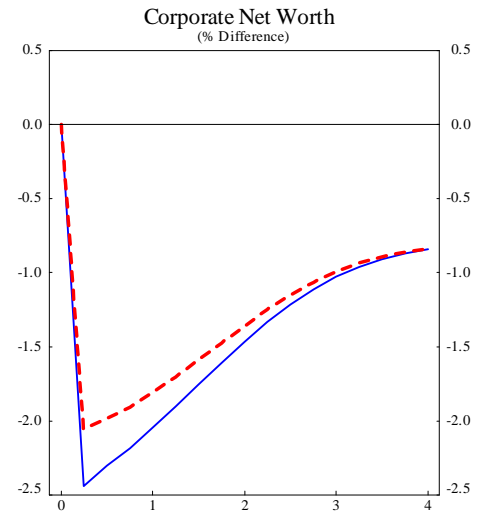
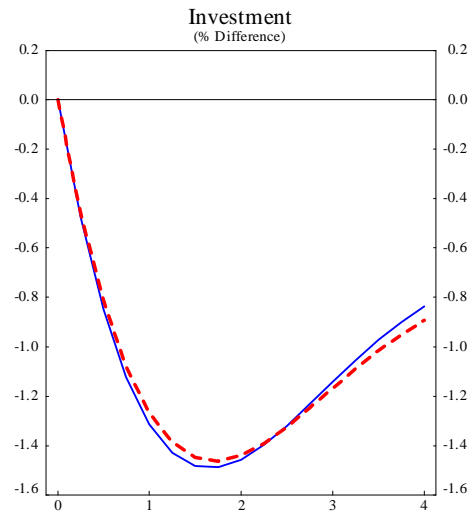
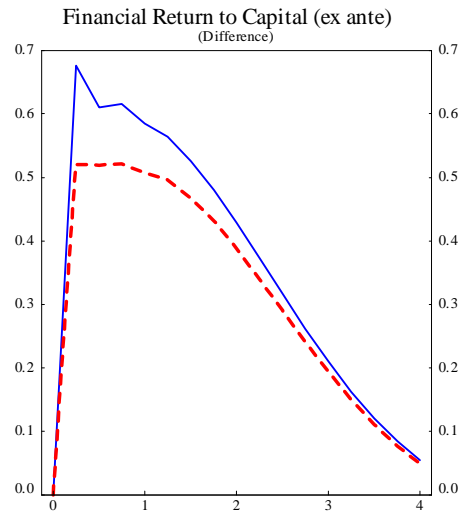
- Firms temporarily (but persistently) distribute a dividend to their shareholders (consumers) that is higher than the steady-state level.
- The higher level of dividend gradually reduces the firm's net worth, increasing its reliance on borrowing.

## *United States - Financial Sector*

- Increased distribution of dividends lowers firms' net worth by 2.5%, leading to higher leverage of 2.5 %age pts.  
  
⇒ higher external finance premium (reinforced by lower investment ⇒ lower net worth) of roughly 13bp.
- Probability of bankruptcies increase by almost 0.2%age pts.

## United States: Temporary Decrease in Net Worth - Dividend Distribution in the United States

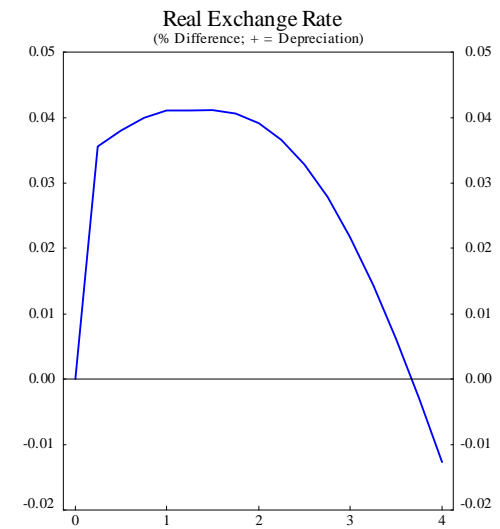
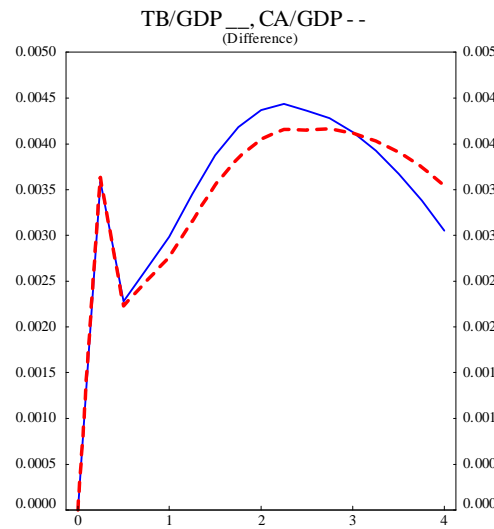
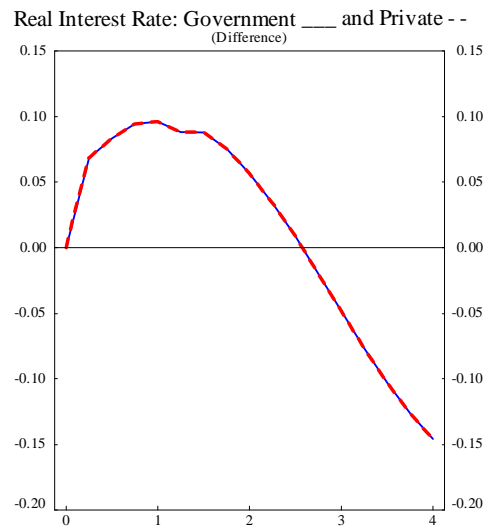
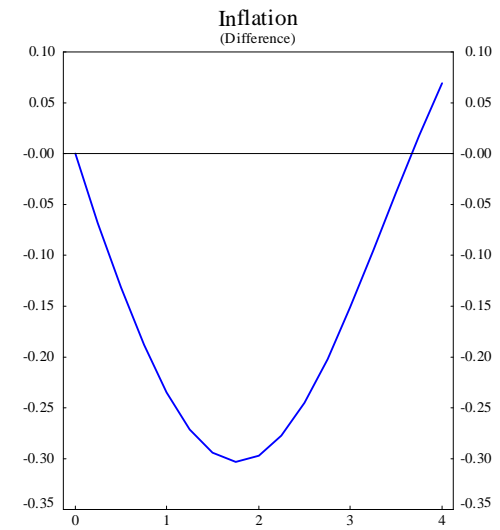
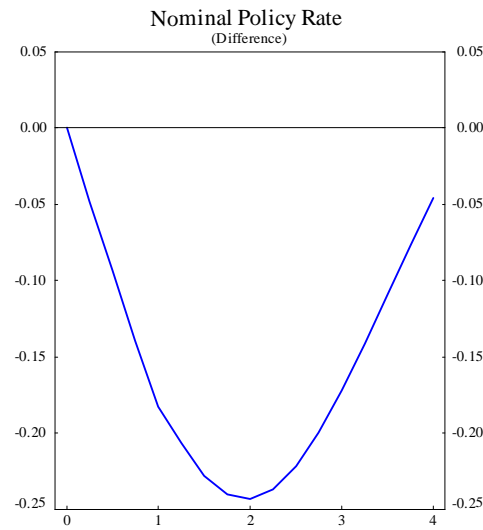
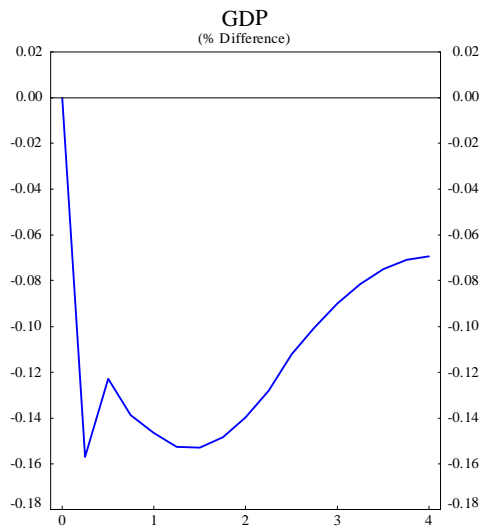
Tradables \_\_ and Nontradables - -



## *United States - Overall*

- GDP falls overall by 0.15% – weaker investment, lower consumer wealth as firms deteriorate.
- Monetary policy can try to offset this – fall in policy rate of 25bp by year 2; but still cannot prevent financial difficulties.
- Mild depreciation leads to very small improvement in current account.

## United States: Temporary Decrease in Net Worth - Dividend Distribution in the United States





## *A Temporary Loss of Net Worth - Capital Destruction*

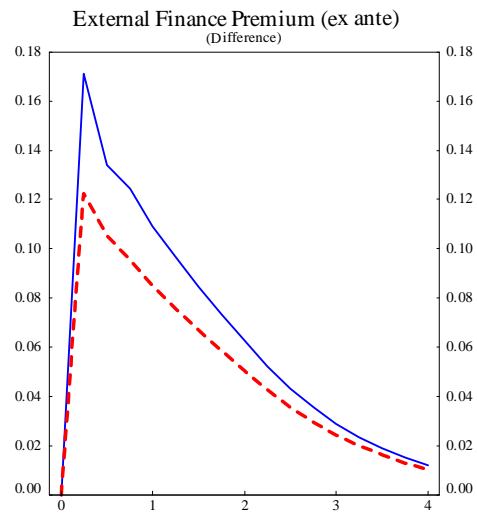
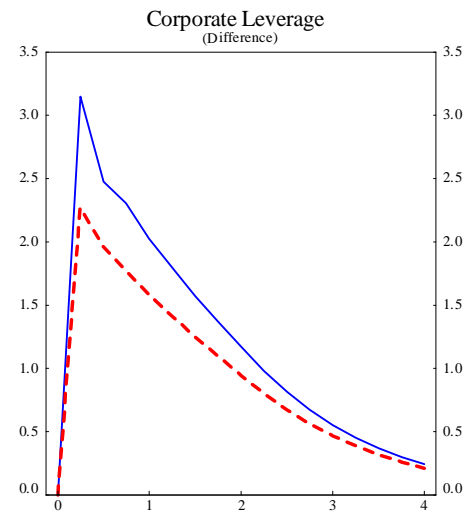
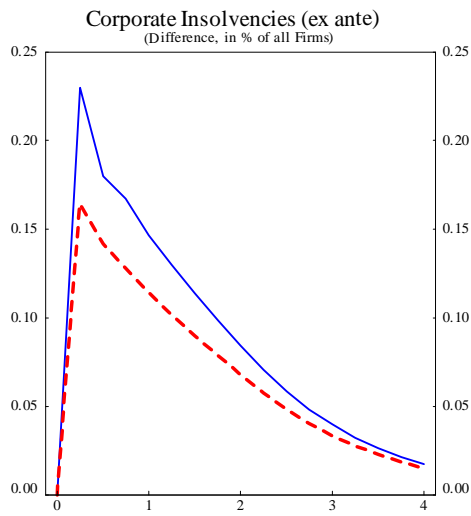
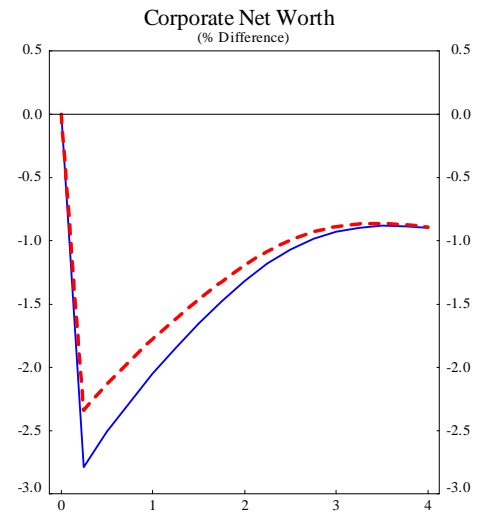
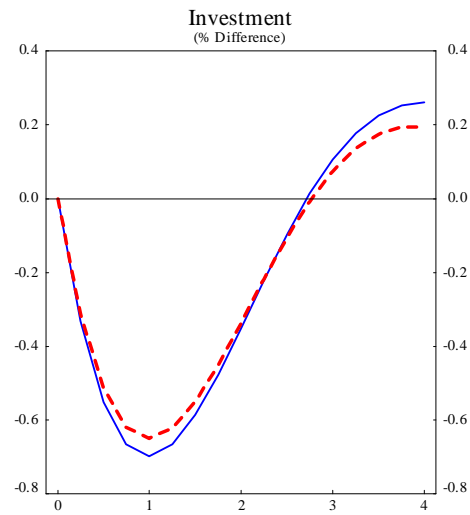
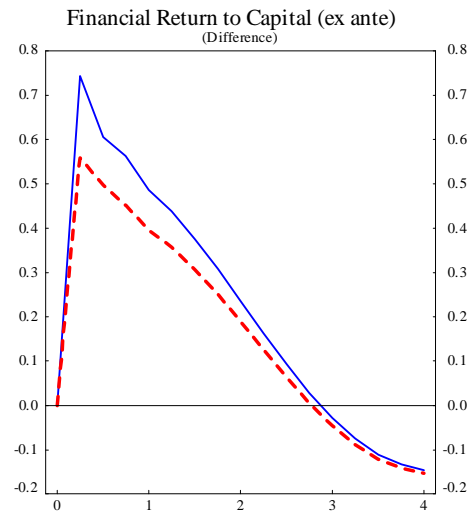
- In this case, net worth of the firms decline, because of a temporary but persistent increase in the rate of depreciation of capital by 0.8 percentage pts on an annual basis.
- This can be thought of as a sudden obsolescence of capital stock.
  - example: the over-investment of the "high-tech bubble" of 1998-2000.

## *United States - Financial Sector*

- As the capital stock falls rapidly, net worth falls with it, driving up corporate leverage nearly 2.5 %age pts.  
  
⇒ Increase in the external finance premium of around 14 bp.
- Investment is actually falling in the short run, by 0.6%.
  - It begins rebounding in year 4, as there is a need to rebuild the capital stock to maintain the steady-state capital-output ratio.
- The probability of bankruptcies by firms increase by almost 0.2%age pts.

## United States: Temporary Decrease in Net Worth - Capital Destruction in the United States

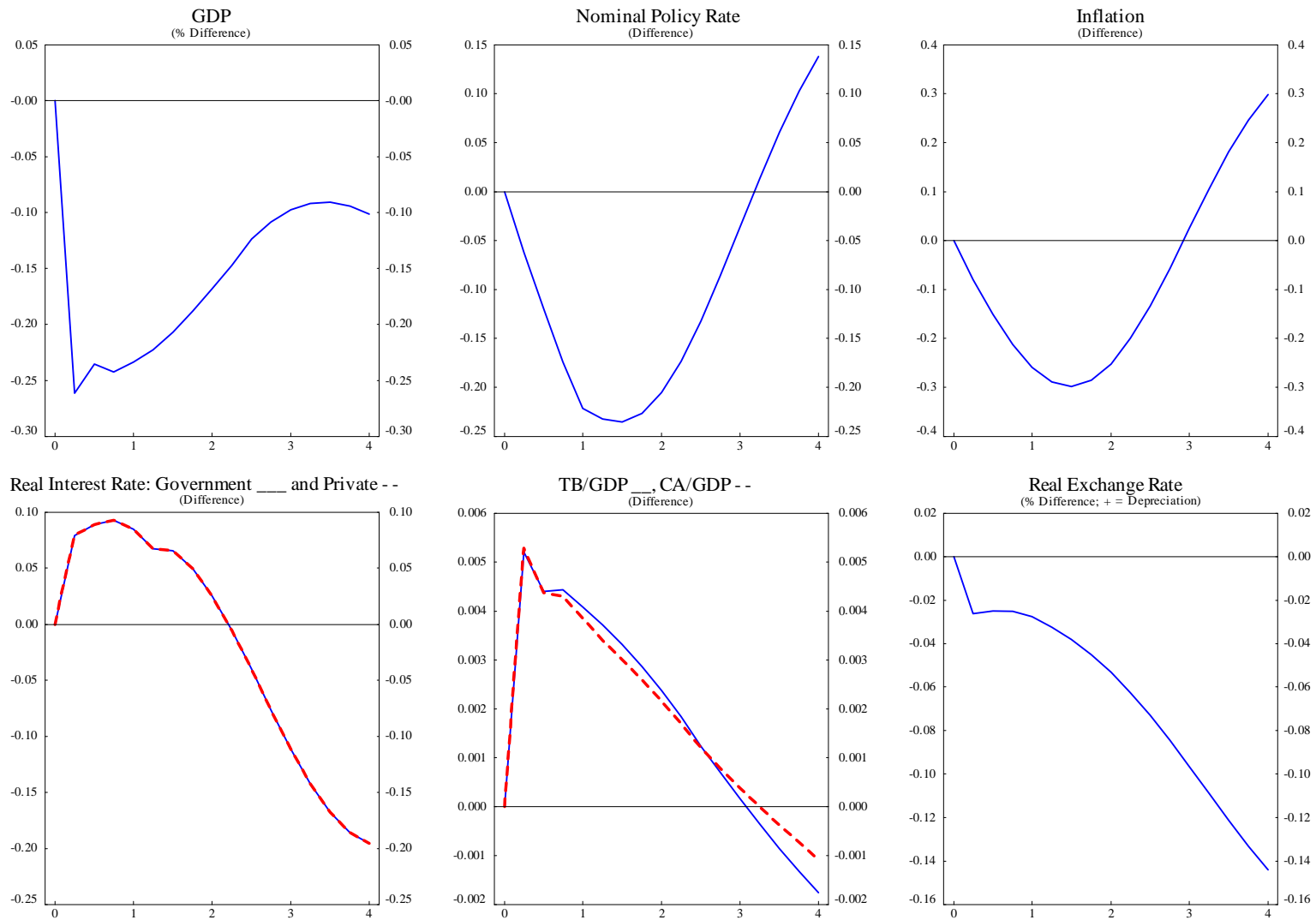
Tradables \_\_ and Nontradables - -



## *United States - Overall*

- GDP falls overall by 0.25% – weaker investment, lower consumer wealth as firms deteriorate.
- Monetary policy can try to offset this – fall in policy rate of 25bp during the second year; but still cannot prevent financial difficulties.
  - inflation falling more rapidly in the short-run, leading to an increase in the real interest rate  $\therefore$  real exchange rate is appreciating
  - nonetheless, current account improves as investment falls more than savings.

## United States: Temporary Decrease in Net Worth - Capital Destruction in the United States



## Conclusions

- GIMF has a new financial sector, based on the BGG financial accelerator model.
- It has richer features than in models hitherto published – potential to exploit the full nonlinearity of the BGG formulation.
- Still work to be done on simulating the nonlinear model, without numeric linearization.
  - even if we depend on numeric linearization, we still have a richer framework for storytelling than the standard BGG implementation.