Commodity Prices, Macroeconomic Volatility and Canada's Exchange Rate Regime

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VERY PRELIMINARY

July 11, 2006

Bank of Canada Workshop on Commodity Price Issues

Canada's Flexible Exchange Rate

- Canada has more experience with flexible exchange rate than almost any other country
- Canadian dollar has floated for all but 8 years since 1950
- Commodity prices played a role in both transitions to floating (1950 and 1970)

Benefits of a Fixed Nominal Exchange Rate

- Reduced transaction costs

- Improved efficiency due to:
  - Reduced uncertainty (possibly increased trade)
  - Better economic decision-making

- Eliminates movements in real exchage rate (RER) caused by speculation

Costs of a Fixed Nominal Exchange Rate

- Loss of monetary independence
- Price level must adjust to allow movements in RER
- If nominal prices/wages are sticky, output will move in short-run when RER adjustments are needed
- Potential for significantly increased macroeconomic volatility

Objectives

- Quantify impact on macro volatility of adopting a fixed exchange rate
- Assess role of various shocks and frictions in alternative regimes
- The analysis is conducted using a variant of ToTEM, the Bank of Canada's main projection model

What we don't do

- We *do not* attempt to quantify microeconomic benefits

- We *do not* perform a welfare analysis
  - Size of model makes it computationally challenging to perform second-order approximation

Canadian Block

- Small open economy
- Direct trade links only with US
- Produces and consumes two types of commodity: Energy and Non-Energy

US Block

- Large open economy
- Mostly symmetric to Canadian block
- Unaffected by Canadian variables, but affected by ROW variables
- Produces and consumes two types of commodity: Energy and Non-Energy

ROW Block

- Large open economy
- Simple forward-looking IS Curve/Phillips Curve structure (no capital)
- Net supplier of both types of commodities

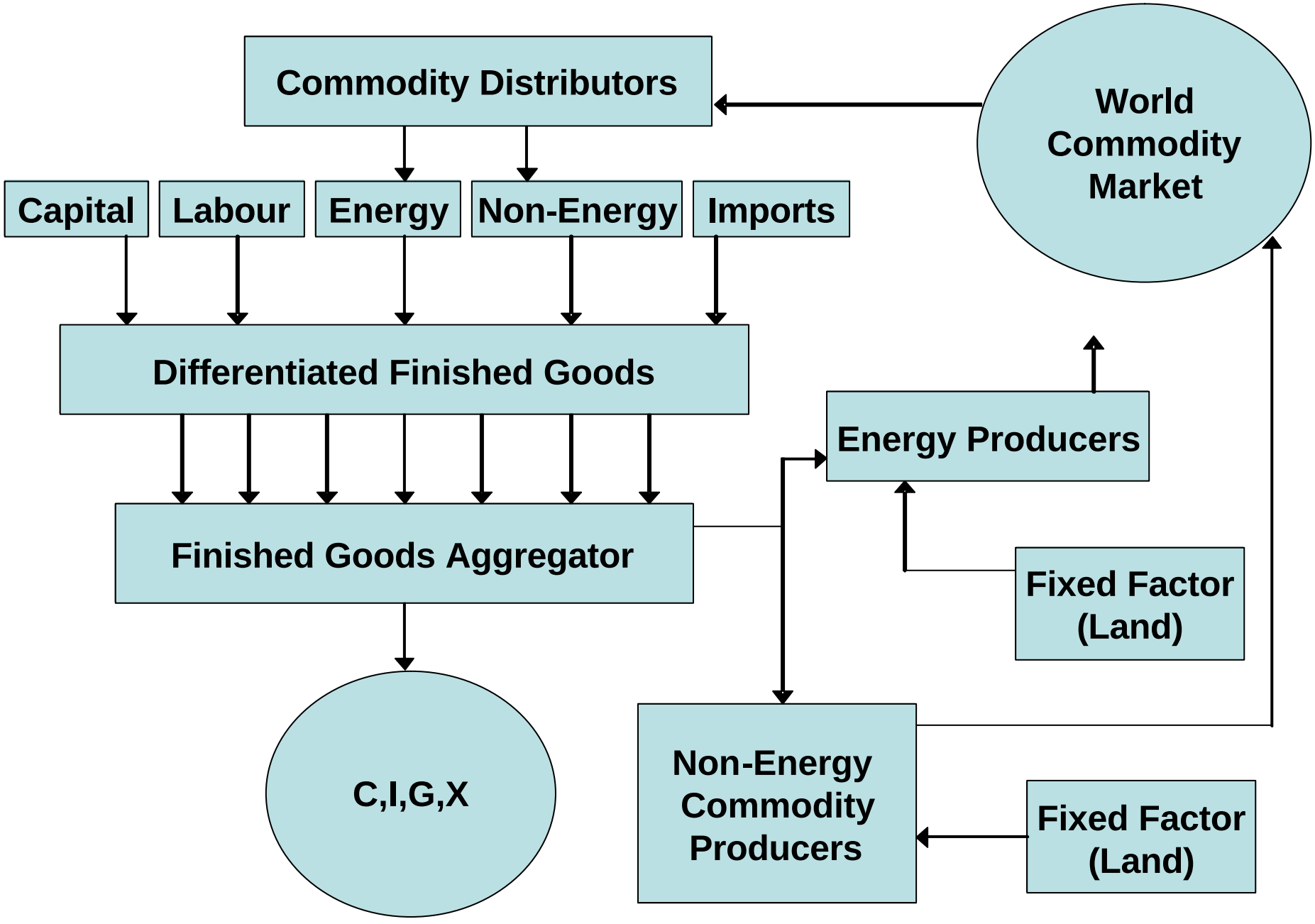
Model: Key Differences with ToTEM

1. Simplified production structure

2. Two types of commodities: Energy and Non-Energy

3. Symmetric US Block

Production Structure



Finished Goods Production

- Continuum of firms $i \in (0, 1)$ with production function:

$$Z_{it} = \left(\delta_1^{\frac{1}{\sigma}} (A_t L_{it})^{\frac{\sigma-1}{\sigma}} + \delta_2^{\frac{1}{\sigma}} K_{it}^{\frac{\sigma-1}{\sigma}} + \delta_3^{\frac{1}{\sigma}} ENER_{it}^{d\,\frac{\sigma-1}{\sigma}} + \delta_4^{\frac{1}{\sigma}} NE_{it}^{d\,\frac{\sigma-1}{\sigma}} + \delta_5^{\frac{1}{\sigma}} M_{it}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

- Each firm faces a downward sloping demand curve for its differentiated good

- A_t is an exogenous productivity shock:

$$\ln(A_t) = \ln(A_{t-1}) + \varepsilon_t^A$$

Price-Setting

- Price set according to a variant of the Calvo mechanism
- Each period firms face a constant probability, $1-\theta$, of being able to reoptimize their price
- If they cannot reoptimize then their price is set to $P_t(i) = \pi_{t-1}^{\gamma}\overline{\pi}_t^{\gamma}P_{t-1}(i)$
- We assume firm-specific capital following Altig, Christiano, Eichenbaum and Linde (2005)

Imports

- Imported goods prices are sticky in domestic currency terms

- Calvo mechanism

Commodity Production

- Two commodity sectors: Energy and Non-Energy
- Producers are perfectly competitive
- Production Technology: Combine Finished Goods and Fixed Factor (LAND)
- Quadratic cost of adjusting finished good input

Commodity Distributors

- Used to introduce stickiness in domestic prices of commodities
- Costlessly differentiate commodity
- Calvo price-setting

Households

- Households chooses C_{ht}^{tot}, L_{ht}, $B_{h,t+1}$ and $B_{h,t+1}^{*}$ to maximize

$$\mathbf{E}_t \sum_{s=t}^{\infty} \boldsymbol{\beta}_{t,s} \frac{\mu}{\mu - 1} (C_{ht}^{tot} - \xi C_{t-1}^{tot})^{\frac{\mu-1}{\mu}} \exp\left(\frac{\eta(1-\mu)}{\mu(1+\eta)} L_{ht}^{1+1/\eta} \right)$$

- subject to

$$P_{c,t} C_{ht}^{tot} + \frac{B_{h,t+1}}{R_t} + \frac{e_t B_{h,t+1}^{*}}{R_t^{*} \kappa_t} = e_t B_{h,t}^{*} + B_{h,t} + W_{ht} L_{ht} + \boldsymbol{\Delta}_t - T_t$$

- where

$$C_t^{tot} = \left(\rho_1^{\frac{1}{\varphi}} C_t^{\frac{\varphi-1}{\varphi}} + \rho_2^{\frac{1}{\varphi}} C_{ener,t}^{\frac{\varphi-1}{\varphi}} \right)^{\frac{\varphi}{\varphi-1}}$$

Wage-Setting

- Nominal wages set according to a variant of the Calvo mechanism
- Each period firms face a constant probability, $1 - \theta_w$, of being able to reoptimize their wage
- If they cannot reoptimize then their price is set to $W_t(h) = \pi_{t-1}^{\gamma_w} \bar{\pi}_t^{\gamma_w} W_{t-1}(h)$

Monetary Policy

- Policy Reaction Function:

$$R_t = R_{t-1}^{\Gamma_r} \left(\overline{r\pi}_t\right)^{1-\Gamma_r} \left[\left(\frac{\pi_t}{\overline{\pi}_t} \right)^{\Gamma_\pi} \left(\frac{Y_t}{\overline{Y}_t} \right)^{\Gamma_y} \left(\frac{Y_t}{gY_{t-1}} \right)^{\Gamma_{dy}} \right]^{(1-\Gamma_r)} \exp\left(\varepsilon_t^R\right)$$

ROW Commodity Supply

- Net supply function:

$$\frac{P_t^{j*}}{P_t^*} = \mu_t \left(\frac{COM_t^{j**}}{LAND_j^{**}} \right)^{\phi_j}$$

- μ_t is a shock to ROW net supply

Estimation (Briefly)

- Two steps: first US/ROW, then Canada

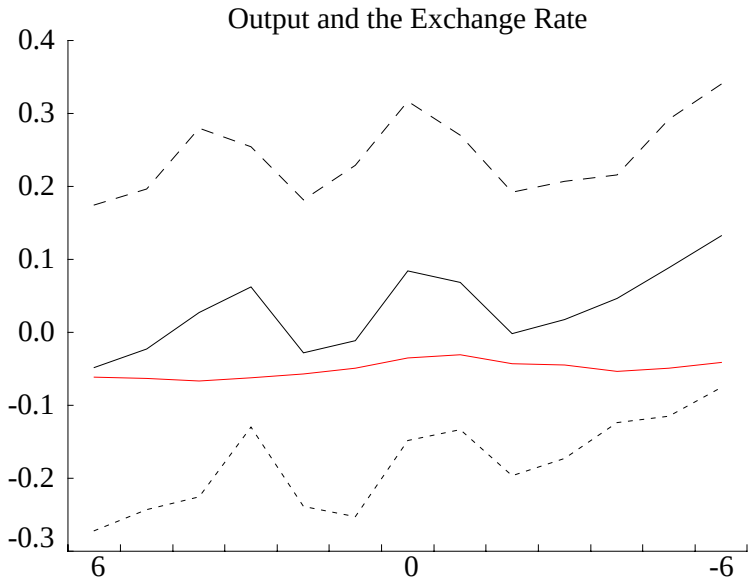
- Some Canadian shocks permitted to be correlated with US shocks as follows:

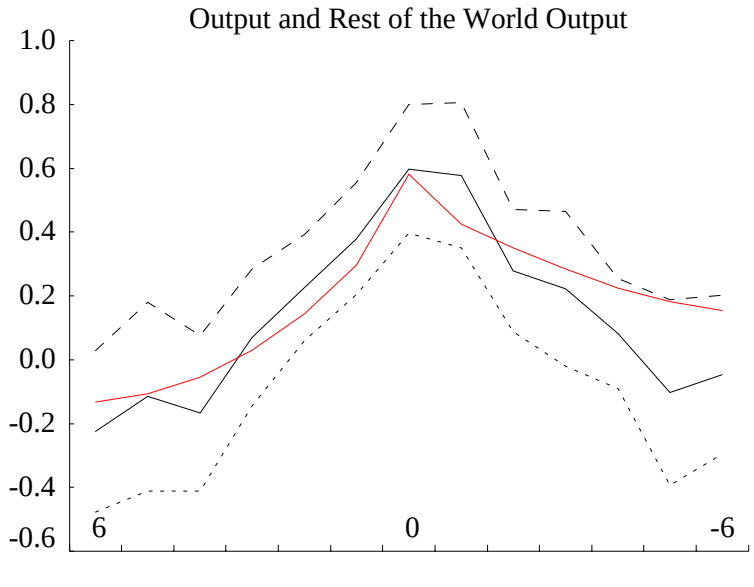
$$\varepsilon_t = \phi\widehat{\varepsilon}_t + (1-\phi)\varepsilon_t^*$$

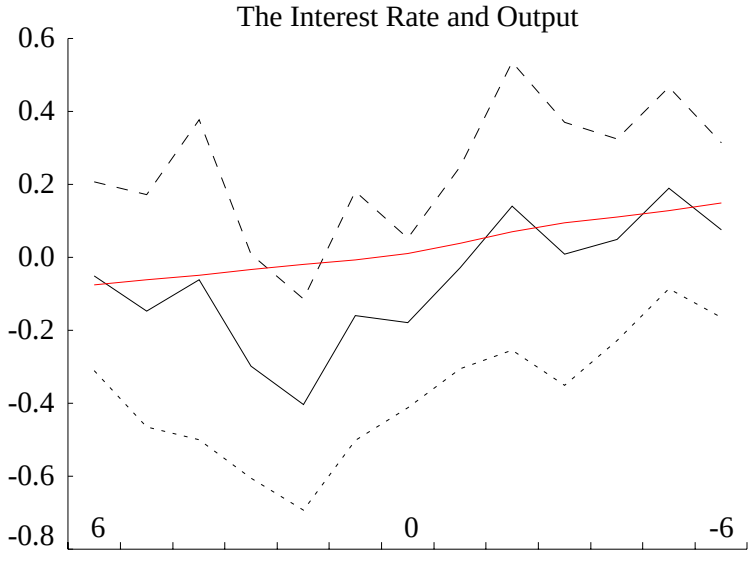
Estimation (Briefly)

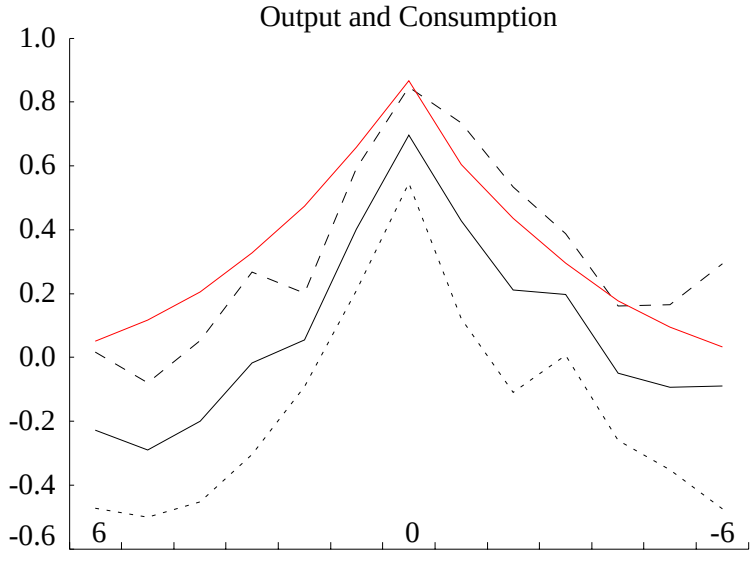
- Shocks that are allowed to be correlated: time preference, mark-up, monetary policy, wage, government spending

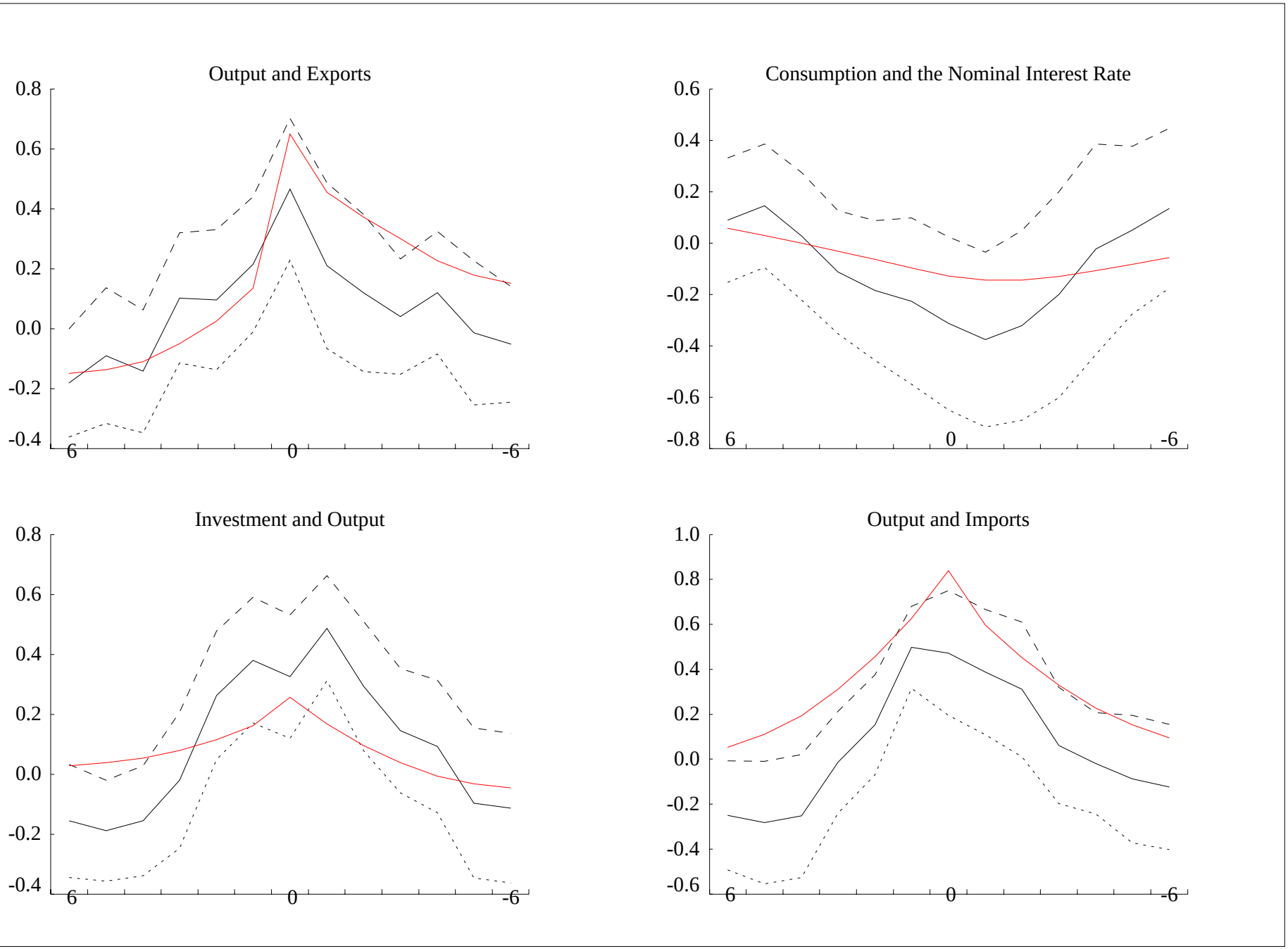
Weight on Canadian Component	**Prior Distribution**	**Prior Mean**	**Prior S.D.**	**Posterior Mean** (95% C.I.)
ϕ_β	beta	0.75	0.2	**0.64** (0.49,0.72)
ϕ_p	beta	0.75	0.2	**0.66** (0.55,0.69)
ϕ_R	beta	0.75	0.2	**0.80** (0.75,0.88)
ϕ_w	beta	0.75	0.2	**0.65** (0.62,0.77)
ϕ_g	beta	0.75	0.2	**0.91** (0.82,0.96)

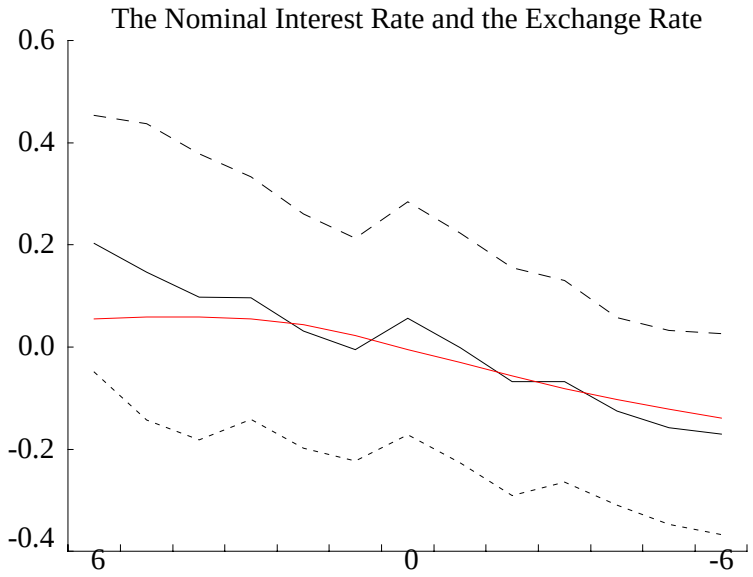

Output and the Exchange Rate
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
6
0
-6

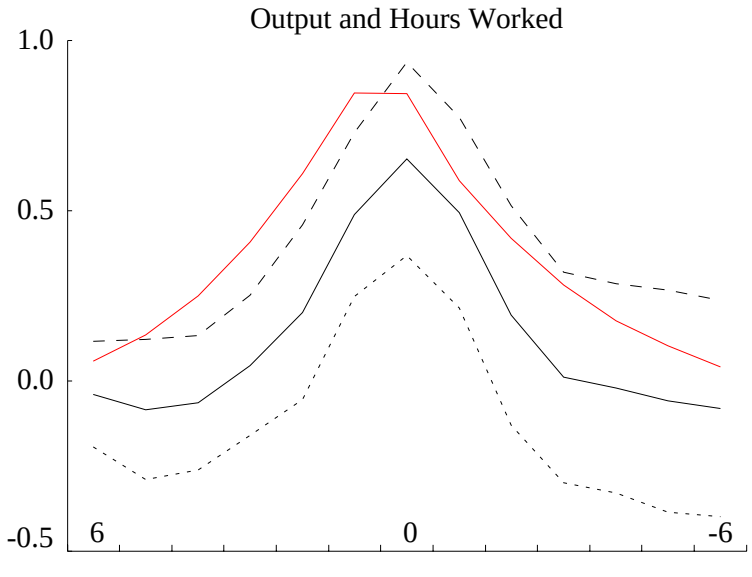

Output and Rest of the World Output
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
6
0
-6

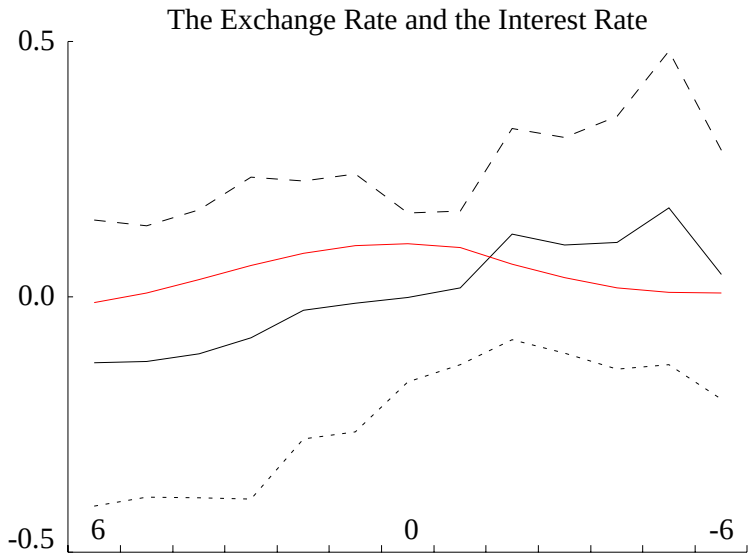

The Interest Rate and Output
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
6
0
-6


Output and Consumption
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
6
0
-6


Output and Exports
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
6
0
-6
Consumption and the Nominal Interest Rate
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
6
0
-6
Investment and Output
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
6
0
-6
Output and Imports
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
6
0
-6


The Nominal Interest Rate and the Exchange Rate
0.6
0.4
0.2
0.0
-0.2
-0.4
6
0
-6

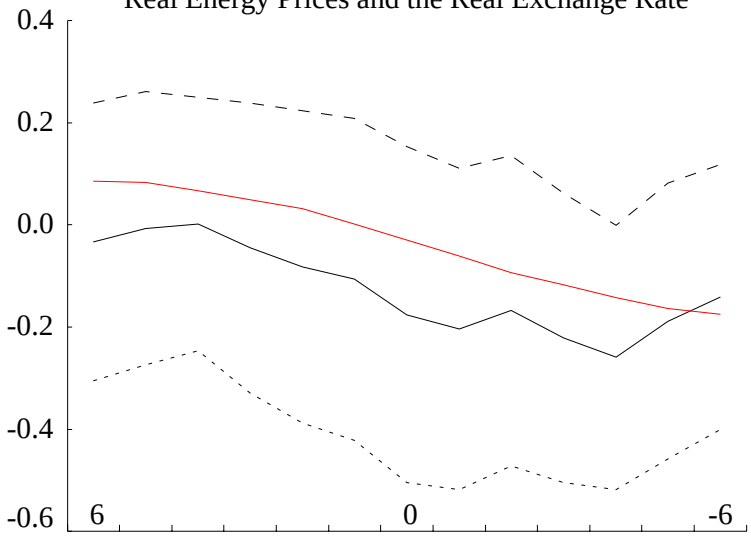

Output and Hours Worked
1.0
0.5
0.0
-0.5
6
0
-6


The Exchange Rate and the Interest Rate
0.5
0.0
-0.5
6
0
-6


Consumption and the Interest Rate
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
6
0
-6

Real Non-Energy Prices and the Real Exchange Rate

Real Energy Prices and the Real Exchange Rate



Fixing the Nominal Exchange Rate

- The nominal exchange rate is fixed by replacing the policy reaction function with:

$$e_t = \overline{e}$$

Fixed vs Flexible: Relative Standard Deviations

Variable	Relative SD
Output Growth	**1.52**
Consumption Growth	**1.26**
Investment Growth	**1.55**
Import Growth	**1.09**
Export Growth	**1.00**
Hours	**1.66**
CPIX Inflation	**1.30**
Wage Inflation	**1.38**
Change in RER	**0.18**
Real Exchange Rate	**0.49**

Variance Decomposition: Canada

Shock	**Output Flexible**	**Output Fixed**	Inflation Flexible	Inflation Fixed	RER Flexible	RER Fixed
Productivity	**38%**	**9%**	1%	6%	2%	3%
Energy	**6%**	**25%**	3%	13%	31%	13%
Non-Energy	**1%**	**8%**	1%	4%	14%	7%
Time Pref. (CA)	**18%**	**9%**	3%	0%	0%	0%
Time Pref. (US)	**19%**	**9%**	4%	2%	0%	2%
Mark-up (CA)	**1%**	**1%**	60%	32%	1%	11%
Mark-up (US)	**0%**	**0%**	20%	14%	0%	7%
Wage (US)	**0%**	**1%**	0%	11%	6%	54%
Mon. Pol. (US)	**2%**	**31%**	4%	17%	39%	1%

Variance Decomposition: Canada

Shock	Output Flexible	Output Fixed	**Inflation Flexible**	**Inflation Fixed**	RER Flexible	RER Fixed
Productivity	38%	9%	**1%**	**6%**	2%	3%
Energy	6%	25%	**3%**	**13%**	31%	13%
Non-Energy	1%	8%	**1%**	**4%**	14%	7%
Time Pref. (CA)	18%	9%	**3%**	**0%**	0%	0%
Time Pref. (US)	19%	9%	**4%**	**2%**	0%	2%
Mark-up (CA)	1%	1%	**60%**	**32%**	1%	11%
Mark-up (US)	0%	0%	**20%**	**14%**	0%	7%
Wage (US)	0%	1%	**0%**	**11%**	6%	54%
Mon. Pol. (US)	2%	31%	**4%**	**17%**	39%	1%

Variance Decomposition: Canada

Shock	Output Flexible	Output Fixed	Inflation Flexible	Inflation Fixed	**RER Flexible**	**RER Fixed**
Productivity	38%	9%	1%	6%	**2%**	**3%**
Energy	6%	25%	3%	13%	**31%**	**13%**
Non-Energy	1%	8%	1%	4%	**14%**	**7%**
Time Pref. (CA)	18%	9%	3%	0%	**0%**	**0%**
Time Pref. (US)	19%	9%	4%	2%	**0%**	**2%**
Mark-up (CA)	1%	1%	60%	32%	**1%**	**11%**
Mark-up (US)	0%	0%	20%	14%	**0%**	**7%**
Wage (US)	0%	1%	0%	11%	**6%**	**54%**
Mon. Pol. (US)	2%	31%	4%	17%	**39%**	**1%**

Relative Standard Deviations: The Role of Commodity Shocks

	Base Case	No NE Shocks	No ENER Shocks	No Commodity Shocks
Output Growth	1.52	1.48	1.35	1.31
Consumption Growth	1.26	1.23	1.24	1.20
Investment Growth	1.55	1.51	1.46	1.41
Import Growth	1.09	1.08	1.09	1.08
Export Growth	1.00	1.00	1.01	1.01
Hours	1.66	1.60	1.49	1.42
CPIX Inflation	1.30	1.28	1.24	1.20
Wage Inflation	1.38	1.34	1.26	1.22
Change in RER	0.18	0.19	0.20	0.21
Real Exchange Rate	0.49	0.51	0.55	0.59

Relative Standard Deviations: The Role of Nominal Stickiness

	Base Case	No Wage Stickiness	No Price Stickiness	No Nominal Frictions
Output Growth	1.52	1.27	1.13	0.98
Consumption Growth	1.26	1.14	1.21	0.79
Investment Growth	1.55	1.38	1.25	1.00
Import Growth	1.09	1.21	0.56	1.00
Export Growth	1.00	0.98	1.02	0.99
Hours	1.66	1.17	0.92	0.99
CPIX Inflation	1.30	1.40	0.77	0.07
Wage Inflation	1.38	1.22	0.94	0.09
Change in RER	0.18	0.19	0.35	0.83
Real Exchange Rate	0.49	0.53	0.64	0.99

Relative Standard Deviations: The Role of Real Frictions

	Base Case	No Com. Adj. Costs	No Inv. Adj. Costs	No Habits	No Real Frictions
Output Growth	1.52	2.70	2.09	2.05	6.09
Consumption Growth	1.26	4.38	1.64	2.45	5.89
Investment Growth	1.55	2.81	2.09	1.50	4.30
Import Growth	1.09	2.34	2.09	1.72	7.29
Export Growth	1.00	0.85	0.99	0.99	0.87
Hours	1.66	2.70	2.14	3.24	7.73
CPIX Inflation	1.30	2.27	1.19	1.33	1.45
Wage Inflation	1.38	2.89	1.27	1.38	2.42
Change in RER	0.18	0.15	0.19	0.18	0.12
Real Exchange Rate	0.49	0.49	0.51	0.49	0.34

Conclusion

- Fixing the nominal exchange rate substantially increases macro volatility
- Eliminating real frictions exacerbates this effect
- The asymmetric effect of commodity prices on Canada and the US explains a large part of the increased volatility
- But, even in the absence of commodity shocks, a flexible exchange rate still delivers much lower volatility

Future Work

- Understanding results conditional on individual shocks
- More careful modeling of production structure
- Welfare analysis