Advanced Macroeconomics 1, KU Leuven
Answer sheet for Assignment 2 (Fall 2024)
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1 Basic model - IRFs

In order to understand the following figures, below is the legend of the variables used:

- pi_p = Price Inflation.
- pi_w = Wage Inflation.
- y_tilde = Output Gap.
- w_tilde = Wage Gap.
- w_n= Natural Real Wage
- r_n = Natural Interest Rate.
- i = Nominal Interest Rate.
- a_t = Technology shock.
- nu_t = Monetary Policy shock.
- z_t = Preferences shock.

Now we turn to explain the IRFs figure for the different shocks, where we present the responses along with 20 periods.

1.1 Interpretation of a Technology Shock (Figure 1):

1. Price Inflation: Inflation falls sharply after the shock and gradually converges to its steady state. To explain this, we could notice that the technology shock reduces marginal costs for firms, leading the output gap to enter negative ground, thus adding a deflationary pressure, as firms lower prices.

2. Wage Inflation: Similar to price inflation, wage inflation also decreases but more slowly than price inflation. The reason behind is that sticky wages delay the adjustment of labor costs, causing wage inflation to lag price inflation.

3. Output Gap: The output gap enters negative ground before slowly converging to its steady state. The reason behind it is that the productivity shock boosts supply, temporarily exceeding demand, but as prices fall, activity return to its steady state, taking the output gap to its steady state (zero).

4. Wage Gap: The wage gap turns negative (although small) initially but narrows over time. The reason behind is that the natural wages rises due to higher productivity, but sticky wages

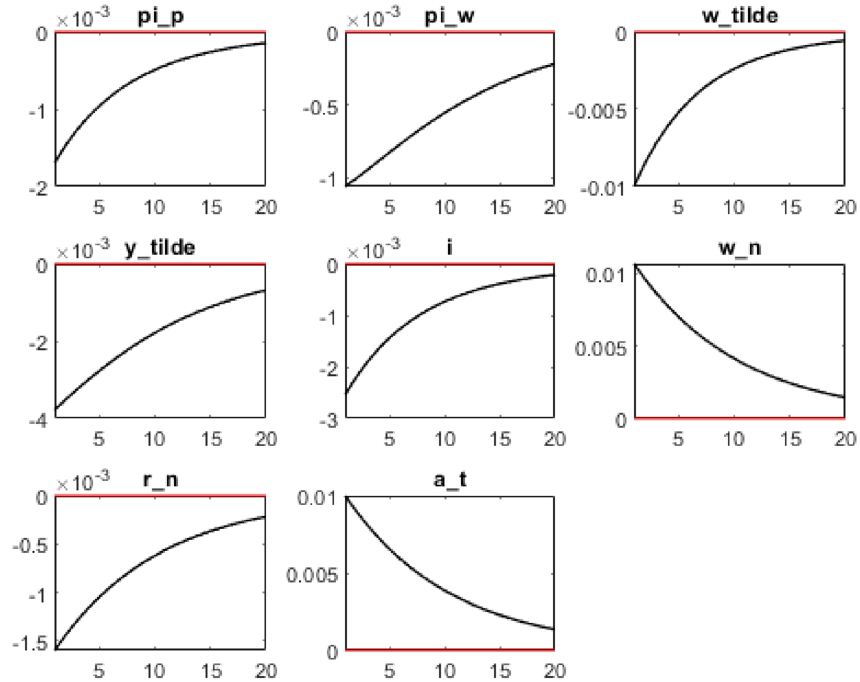

Figure 1: The effects of a Technology Shock

prevent actual wages from adjusting immediately.

5. Natural real Wage: Natural wages increases sharply but then continues to decline steadily after the shock. The reason behind is that the productivity shock shifts equilibrium conditions in the labor market, increasing the natural wage temporarily.

6. Natural Real Interest Rate: The natural interest rate decreases initially, as a result of a higher productivity and lower inflation. In addition, the productivity improvement lowers the baseline for real rates, aligning with lower demand-side pressures.

7. Nominal Interest Rate: Nominal interest rates decrease sharply and converge back to steady state value. This behavior can be explained by the Central Bank response stated in the Taylor rule equation of the model: The central bank responds to lower inflation and reduced natural interest rates by lowering nominal rates.

8. Productivity: The last graph shows how the productivity shock is simulated in the model, where we can see clearly that reflects a AR(1) process with $\rho_a < 1$.

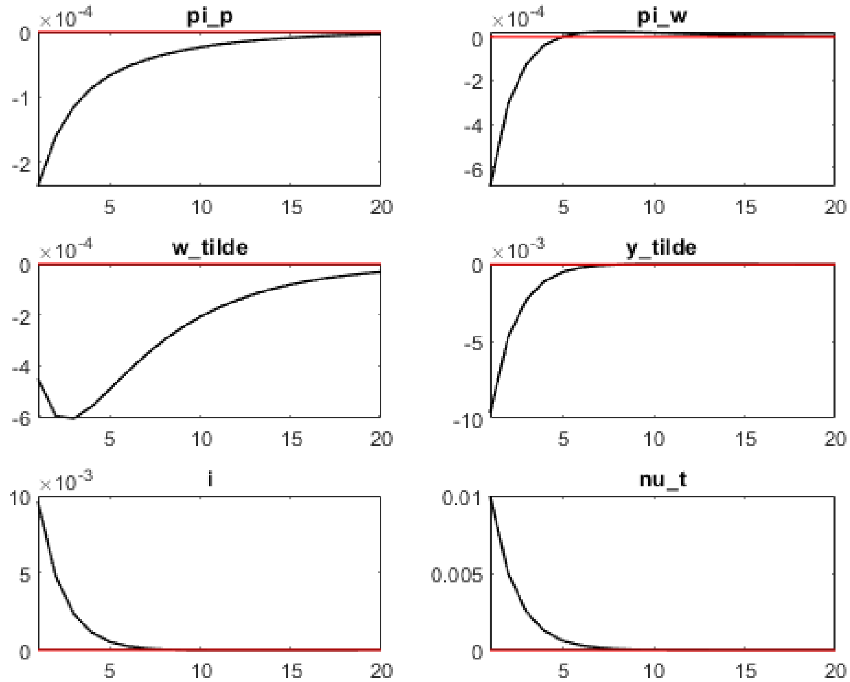

Figure 2: The effects of a Monetary Policy Shock

1.2 Interpretation of a Monetary Policy Shock (Figure 2):

1. Price Inflation: Inflation declines sharply following the shock and stabilizes gradually over time. This outcome is primarily attributed to the effects of a contractionary monetary policy shock, which raises nominal interest rates. The higher interest rates dampen aggregate demand, causing the output gap to turn negative, and this reduced demand, in turn, drives inflation lower.

2. Wage Inflation: Wage inflation also decreases but at a faster pace than price inflation after the shock. The reason behind is that sticky wages delay the response of labor costs to changes in economic conditions.

3. Wage Gap: The wage gap narrows initially, then stabilizes. The reason behind is that sticky wages adjust slowly, creating temporary misalignment between actual and natural wages.

4. Output Gap: The output gap decreases sharply and then converges to its steady state value. This happens because higher interest rates suppress activity (consumption and investment), leading the output gap to negative ground, and thus reducing inflationary pressures.

5. Nominal Interest Rate: The nominal interest rates increase sharply due to the shock and gradually return to steady state. This is due that the monetary policy shock directly increases nominal rates to curb inflation.

6. Monetary Shock: The last graph shows how the monetary policy shock is simulated in the model, where we can see clearly that reflects a AR(1) process with $\rho_\nu < 1$.

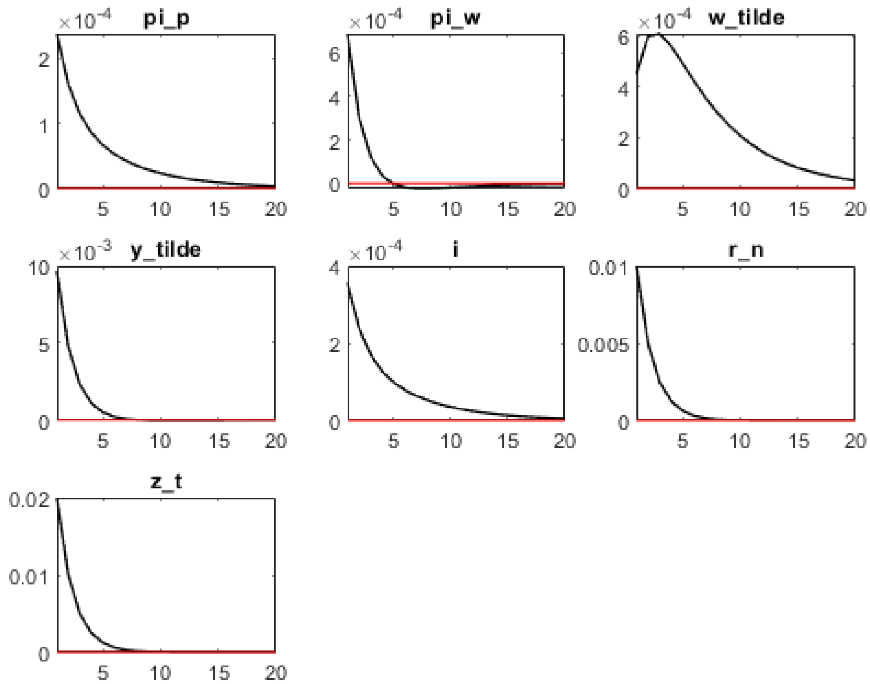

Figure 3: The effects of a Preference Shock

1.3 Interpretation of a Preference Shock (Figure 3):

1. Price Inflation: Inflation rises initially and then decays to its steady state. The reason behind it is that the preference shock shifts demand temporarily, creating inflationary pressures before stabilizing.

2. Wage Inflation: Wage inflation increases in response to increased demand pressure, and then, converges somewhat more quickly than price inflation. Again, sticky wages delay the response of labor costs to changes in economic conditions.

3. Wage Gap: The wage gap goes to positive ground, and then converges gradually. The reason behind is that wages reacts to the activity boost due to wage stickiness, creating the temporary misalignment.

4. Output Gap: The output gap increases initially and stabilizes over time. The reason behind is that the preference shock stimulates consumption, increasing demand above its natural level.

5. Nominal Interest Rate: The nominal interest rate rises sharply and stabilizes. This is because the Central Bank responds to inflationary pressure by raising nominal rates.

6. Natural Real Interest Rate: The natural interest rate rises temporarily and then stabilizes. The reason: higher demand increases the equilibrium real interest rate.

7. Preference Shock: The last graph shows how the preference shock is simulated in the model, where we can see clearly that reflects a AR(1) process with $\rho_z < 1$.

2 Simulated data

After simulating the model for $T = 10,000$ periods, below is the table with the calculated moments.

Table 1: Summary of Moments

Variable	**Standard Deviation**
Output Gap ($\tilde{y}$)	0.01791
Price Inflation (π_p)	0.00338
Wage Inflation (π_w)	0.00296

3 Role of nominal rigidities

To explore the sensitivity of the results to nominal rigidity parameters, we examine the model's response to three different sets of parameters for price and wage rigidity: $\{\theta_p, \theta_w\} = \{\{0.75, 0.75\}, \{0.25, 0.75\}, \{0.75, 0.25\}\}$. The results show how the output gap, price inflation, wage inflation, wage gap, and nominal interest rate respond to preference shocks under varying levels of price and wage flexibility.

Output Gap: In the subfigure (A) of Figure (4) we can see how the output gap responds positively to the the preference shock under all the different parametrizations. However, it is important to notice that the response is somewhat lower under the parametrization of more rigid wages, but more flexible prices ($\theta_p = 0.25, \theta_w = 0.75$ - red line), where in the scenario of more rigid prices and flexible wages ($\theta_p = 0.75, \theta_w = 0.25$ - blue line) the output gap increases more. In addition the return towards its steady state values are similar between the three scenarios.

Price Inflation: We can see in subfigure (B) that inflation reacts more under more flexible price setting ($\theta_p = 0.25, \theta_w = 0.75$ - red line). This can be explained by the absence of constraints on price adjustment, where price inflation increases considerably in response to the

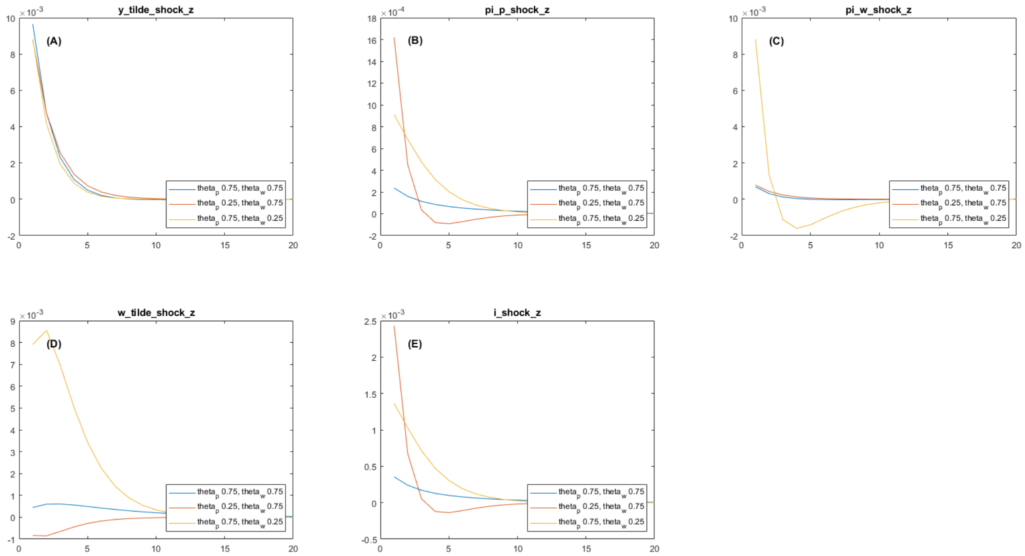

Figure 4: Sensitivity Analysis

activity boost. In addition, it is important to notice that under this parametrization, the response of inflation turns negative in the following periods before returning to its steady state. Regarding other parametrizations, the smallest deviation from the steady state occurs when prices and wages are more rigid. Finally, all parametrizations return to the steady state at approximately the same time.

Wage Inflation: As showed in subfigure (C) of Figure (4), under the case of more rigid prices but flexible wages ($\theta_p = 0.75, \theta_w = 0.25$- yellow line) wage inflation exhibits the greatest divergence (in comparison with the other parameter sets), indicating the highest deviation from the steady state. Again, this can be explained by the absence of constraints on wage adjustment in response to the activity boost. In other cases, the results are very similar, showing only small deviations. The convergence to the steady state occurs at the same time for all three cases.

Wage Gap: Subfigure (D) of Figure (4) shows the behavior of the wage gap under the three scenarios, where can we see important differences between them. In specific, under the scenario of flexible wages, after the preference shock, wages can readjust more rapidly to the new economic conditions, as expected for the defined parametrization. However, under the scenario of more rigid wages (red line), the wage gap turns negative before converging to its steady state. This result could be explained by the fact that wages are more rigid, and thus firms could not adjust wages as fast as they would want under the new economic conditions.

Nominal Interest rate: The response of the nominal interest rate can be seen in subfigure (E) of Figure (4), where we can see clearly how the level increases after the shock under all the scenarios. However, a larger response is notices under the scenario of more flexible prices (red line), where the inflationary response is larger. This result is in line with the response of the Central Bank due to the inflationary pressures caused by the new economic conditions.

4 In search of optimal rules (extended version B)

Table 2: Welfare Loss for Different Parameter Values of ϕ_p and ϕ_w

Welfare Loss	**Description**
0.00037659	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 1.4$
0.00037666	Welfare loss for $\phi_p = 1.4$ and $\phi_w = 1.5$
0.00038054	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 1.3$
0.00038089	Welfare loss for $\phi_p = 1.3$ and $\phi_w = 1.5$
0.00038449	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 1.2$
0.00038535	Welfare loss for $\phi_p = 1.2$ and $\phi_w = 1.5$
0.00038841	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 1.1$
0.00039006	Welfare loss for $\phi_p = 1.1$ and $\phi_w = 1.5$
0.00039231	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 1$
0.00039505	Welfare loss for $\phi_p = 1.0$ and $\phi_w = 1.5$
0.00039618	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.9$
0.00039999	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.8$
0.00040037	Welfare loss for $\phi_p = 0.9$ and $\phi_w = 1.5$
0.00040375	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.7$
0.00040606	Welfare loss for $\phi_p = 0.8$ and $\phi_w = 1.5$
0.00040744	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.6$
0.00041104	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.5$
0.00041218	Welfare loss for $\phi_p = 0.7$ and $\phi_w = 1.5$
0.00041455	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.4$
0.00041794	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.3$
0.0004188	Welfare loss for $\phi_p = 0.6$ and $\phi_w = 1.5$
0.00042121	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.2$
0.00042433	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0.1$
0.00042603	Welfare loss for $\phi_p = 0.5$ and $\phi_w = 1.5$
0.00042728	Welfare loss for $\phi_p = 1.5$ and $\phi_w = 0$
0.000434	Welfare loss for $\phi_p = 0.4$ and $\phi_w = 1.5$
0.00044286	Welfare loss for $\phi_p = 0.3$ and $\phi_w = 1.5$
0.00045287	Welfare loss for $\phi_p = 0.2$ and $\phi_w = 1.5$
0.00046438	Welfare loss for $\phi_p = 0.1$ and $\phi_w = 1.5$
0.00047792	Welfare loss for $\phi_p = 0$ and $\phi_w = 1.5$

Table 2 shows the 30 simulated rules and their welfare losses. **Which of the rules gives the best results?**

Based on the welfare losses obtained from simulating the model for various monetary policy rules, the best rules that minimize the welfare loss are as follows:

1. **Rule 1:** $\phi_p = 1.5$ and $\phi_w = 1.4$ with a welfare loss of 0.00037659.
2. **Rule 2:** $\phi_p = 1.4$ and $\phi_w = 1.5$ with a welfare loss of 0.00037666.

3. **Rule 3:** $\phi_w = 1.5$ and $\phi_p = 1.3$ with a welfare loss of 0.00038054.
4. **Rule 4:** $\phi_p = 1.3$ and $\phi_w = 1.5$ with a welfare loss of 0.00038089.

Thus, the best monetary policy rules is:

- $\phi_p = 1.5$ and $\phi_w = 1.4$ with a welfare loss of 0.00037659.

This rule yield the lowest welfare losses among the 30 simulated rules.