Computational Macroeconomics

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Final Assignment for:
Lecture Number 1810001257 - Computational Macroeconomics

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Final Assignment

Below are the verbal and graphical solutions for the final assignment. These solutions are also within the python code, either as comments or as graphs produced when the code is executed.

Task 9 - Figures

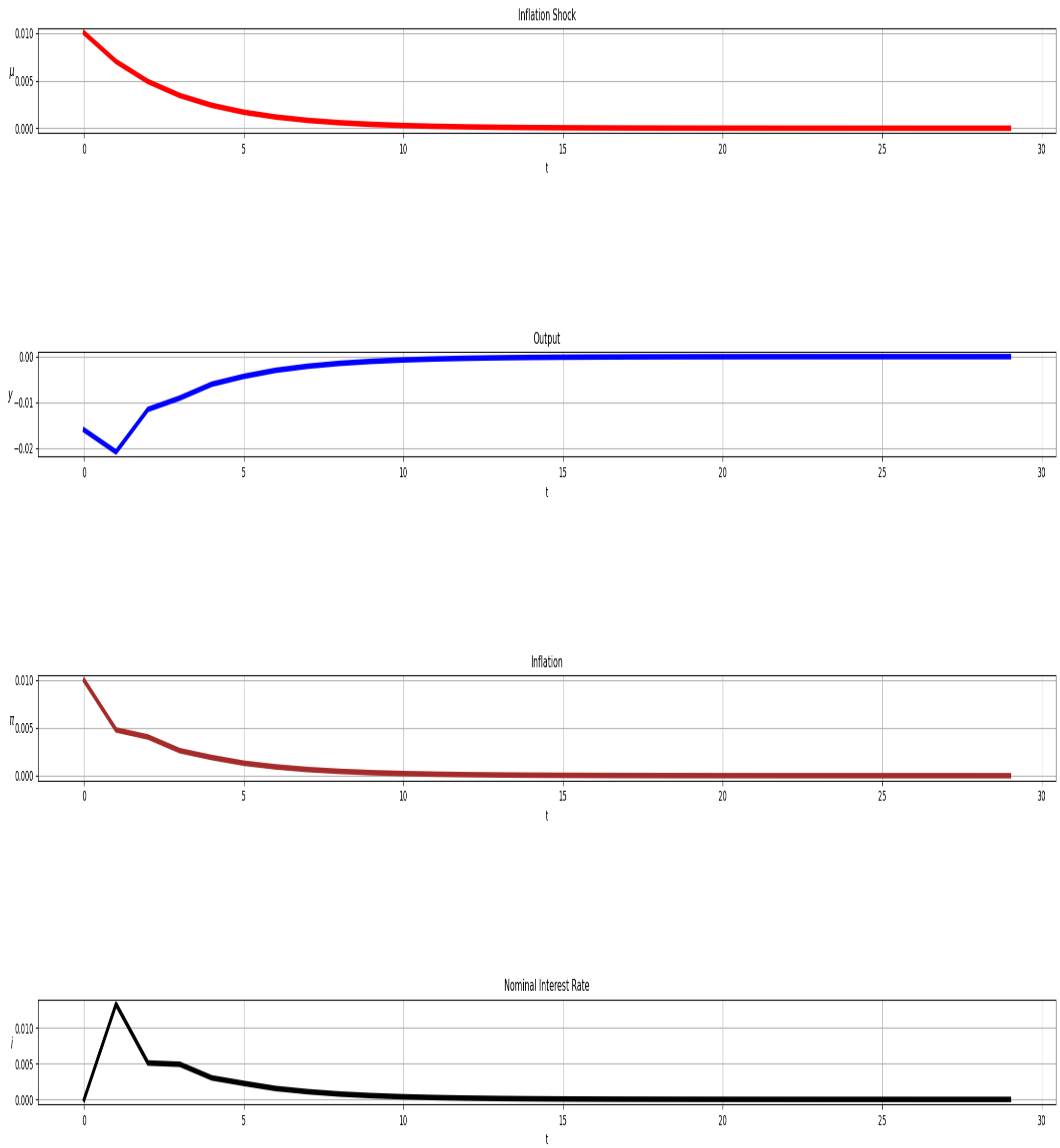

Figure 1: Impulse Response to a Shock to μ_t in t=0

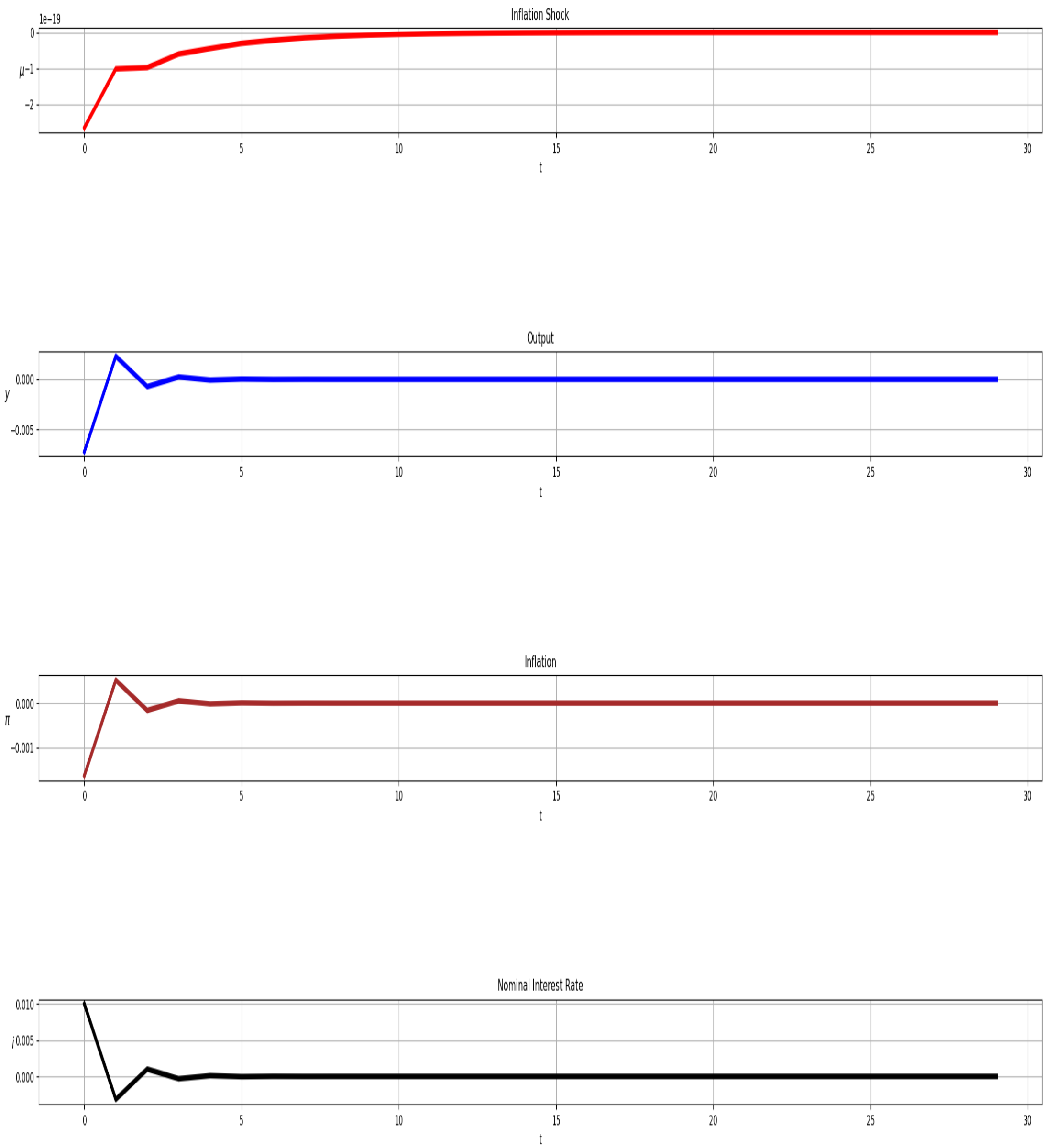

Figure 2: Impulse Response to a Shock to ϵ_t^i in t=0

Task 10 - Interpreting Impulse Response

Impulse Response to μ_t

After the one-time shock to μ_t via ϵ_t^i in figure 1, one can first observe μ_t increasing by the same value. Afterward, μ_t converges back to its steady-state (e.g., 0). The rate at which μ_t converges back to its SS depends on its AR(1) process which is determined by the parameter ρ. Note that μ_t can never the old SS, as any future value will be a fraction of the previous one. However, we can see that μ_t quickly retracts back to a value that, at least from an economic perspective, would be indistinguishable from zero. The shock we observe is a shock to (the error term of) inflation. This shock, could for example be due to an expressionistic monetary policy, which increases the money supply in our economy or a cost shock to firms, such that more labor is now required to produce the same amount of output. The latter would increase inflation, due to the Calvo pricing mechanic that leads to sticky prices, which won't allow all firms to adjust their prices and therefore leads them away from their SS-output. Regarding our two other state variables, we can see that output takes a less pronounced dip than the initial shock, while the nominal interest rate has a behavior similar to the inflation rate, however, with one period delay. On a glace, one can immediately spot the similarities between the behavior of inflation and its error term μ_t, indicating that the inflation rate is predominantly influenced by the shock itself. The Taylor rule in NKM's is designed such that an increase in inflation triggers an increase in the nominal interest rate. Therefore, the real interest rate also increases, and instead of heating up the economy further with high inflation and low interest rates, decreases the output gap and, therefore, inflation. While our Taylor rule only depends on past values (i.e. is backward-looking) and thus exhibits a one-period lag, it reacts much more sensitive to inflation (ϕ_π =1.5) than to output ($\phi_y = 0.1$). From this follows, that in period one, the nominal interest overshoots the initial shock to inflation and thus leading to a higher real interest rate than in the SS. As expectations matter for the NKM, the outlook on the nominal interest rate already leads to lower (i.e., negative) expectations about future output from which a negative output gap arises in period zero. The balancing effect of the Taylor rule then leads all of our state variables to converge back to their SS (or at least very near). In general, one could say that it takes around ten periods for the shock to wear of and all variables to retract to their pre-shock value.

Impulse Response to ϵ_t^i

The shock to the nominal interest rate in 2 could again be part of a central bank's monetary policy. By increasing the nominal interest rate, the real interest rate increases as defined by the Fischer equation, and therefore future consumption becomes more attractive. As HH have the option to invest in risk-less bonds, they will alter their consumption decision in this period and opt to save (a larger) part of their income to consume it with interest in the next period. As our version of the NKM implies market clearing, a reduction in consumption is followed by a reduction in production. We can see this in the output graph, where a negative output gap is observable in the first period. This gap then leads to a small degree of deflation, as seen in the inflation graph. Deflation reduces the price level in the first period, which makes current consumption more attractive, reducing the amount of income that is shifted to the next period. The output gap further leads to a reduction in labor demand and therefore reduces overall HH labor income shifting the HH budget constraint inwards. As the shock to the nominal interest rate is a one-time shock, it would normally move back to its SS-level in the following period. However, our backward looking Taylor rule, leads to a negative nominal interest rate in the following period. Further, the shifting of income from the previous period leads to an increase in demand in period t=1 which, due to our market-clearing condition, leads to an increase output as well. A positive output gap will now lead to inflation. Based on our backward-looking Taylor rule, this sets the basis for the following periods nominal interest rate, which exhibits a positive deviation from its SS to counter the positive inflation and output gap of this period. This again is the mechanism implemented in the Taylor rule, which prevents the nominal interest rate from returning to its pre-shock level immediately is supposed to prevent the economy from overheating. However, in this case, it prevents the economy from returning to its SS immediately after the shock as its delay affects future periods both due to expectations about future nominal interest rates and its actual realizations. Subsequently we can see a repetition of this up and down movement in the two subsequent periods, however, with much lower amplitudes.

In other words, the economy starts to balance itself out, moving around its SS until it reaches the pre-shock values again, somewhat around period 5. Lastly, it is worth mentioning that even though it looks like there is movement in μ_t, all values portrayed are 19 decimals behind the comma and can therefore be considered a computational zero.

Comparing both Impulse Responses

I would state that there are two main differences in how the auto-correlated and the non-auto-correlated shock differ. Firstly, the auto-correlated shock takes roughly twice as long to converge back to the SS. A result that due to the nature of auto-correlation was to be expected, as this shock smooths out over time instead of being a one time occurrence. More interestingly, I think one can see that an auto-correlated shock produces an asymptote for each state variable. This means that the values of the variables will always stay below/above the SS and converge back to their respective SS values over time without crossing the SS at any point in time. However, the non-auto-correlated shock produces a zigzag movement around the SS in which all variables (except μ_t) exhibit values above and below their respective SS values until they converge. Combining those two observations, one could say that an auto-correlated shock produces a longer but smoother convergence back to its SS compared to a non-auto-correlated one.

Task 14 - Interpreting Regression Results

Table 1: Results Task 14

	forecast error	
Intercept	0.4134***	(0.0469)
Inflation	-0.0060	(0.0344)
Obs	499	
R-squared	0.0001	

Robust SE in parentheses

Table 1 above depicts the results from the regression executed in task 14. Apart from resulting in an insignificant effect of inflation on the forecast error, it also shows a highly significant intercept. The latter could stem from our shocks' randomness, which leads to some degree of forecast error that is prevalent no matter the level of the inflation rate itself. The insignificance of the coefficient on inflation, i.e., β, is a direct result of our assumption on rational expectation. As all state variables, their distributions and codependency's are known to the agent, the perceived and the actual law of motion coincide. Therefore errors in predicting future inflation do not depend on the level of inflation itself as an agent knows the effect inflation has on its future self and should therefore independently of its level make predictions according to the actual law of motion.