ECON 710 - Advanced Macroeconomics

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The Real Business Cycle Model

Contents

1 Major Stylized Facts (Revisited)

Figure 1 shows the percentage deviations from the trend for GDP and consumption. It highlights how consumption is procyclical and tends to be less volatile than GDP.

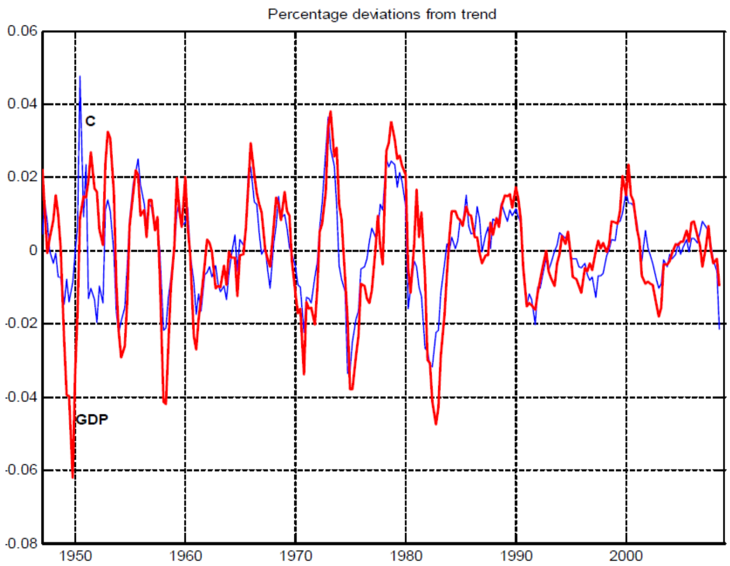

Figure 1: Percentage deviations from trend: GDP vs Consumption

Similarly, Figure 2 compares the percentage deviations from the trend for GDP and investment. Investment is procyclical but typically more volatile than GDP, reflecting the sensitivity of investment decisions to economic conditions and expectations about the future.

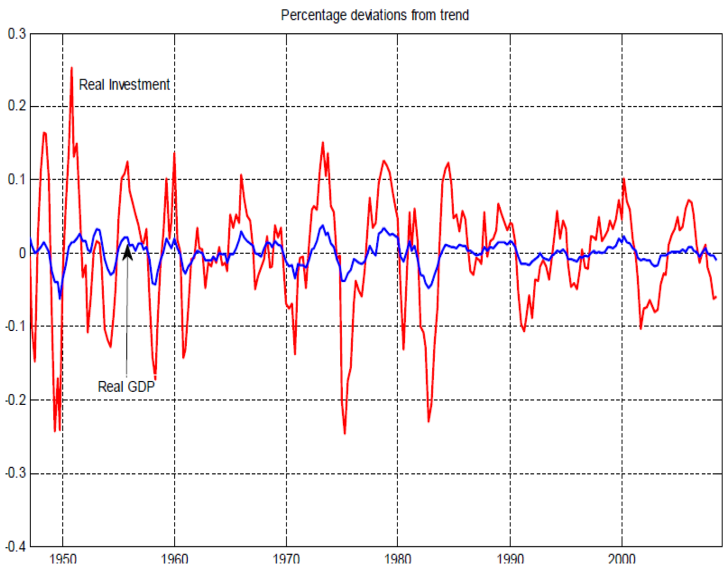

Figure 2: Percentage deviations from trend: GDP vs Investment

Figure 3 shows the relationship between GDP and the price index. The price index can be countercyclical, meaning it tends to move in the opposite direction of GDP, although this relationship can be complex and influenced by various factors.

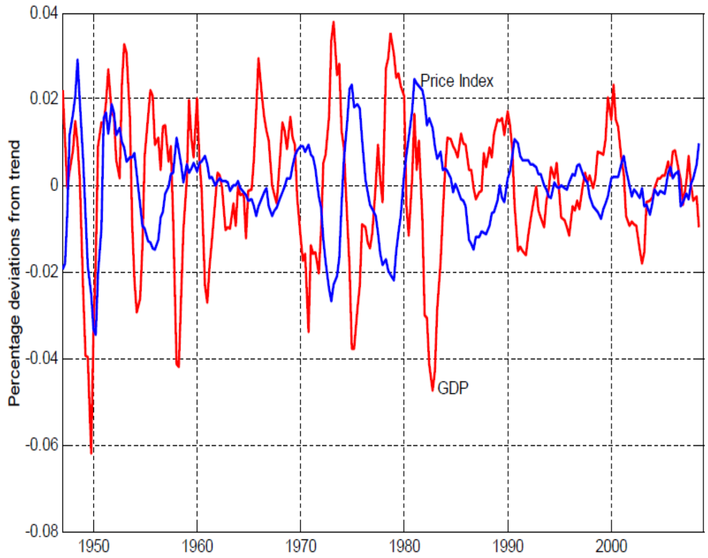

Figure 3: Percentage deviations from trend: GDP vs Price Index

Figure 4 illustrates the percentage deviations from the trend for GDP and money supply. The money supply can influence economic activity, but the relationship is not always straightforward due to factors like velocity of money and monetary policy. However, the graph shows that money supply is procyclical with smaller volatility.

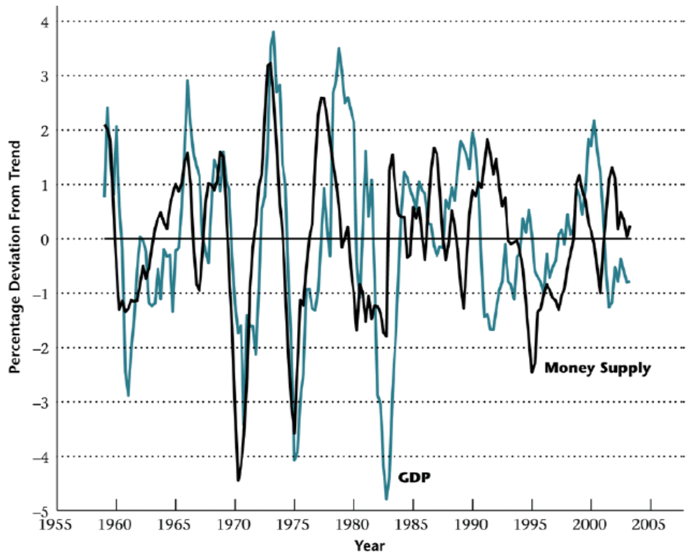

Figure 4: Percentage deviations from trend: GDP vs Money Supply

Figure 5 compares GDP and employment. Employment tends to be procyclical, moving in the same direction as GDP, as firms adjust their labor force in response to changes in economic activity.

Figure 6 shows the relationship between GDP and productivity. Productivity is a key driver of economic growth and tends to be procyclical, increasing during economic expansions and decreasing during recessions.

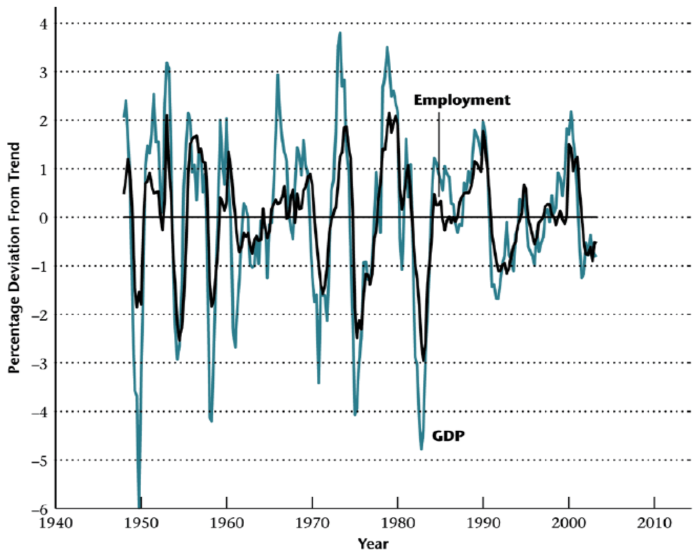

Figure 5: Percentage deviations from trend: GDP vs Employment

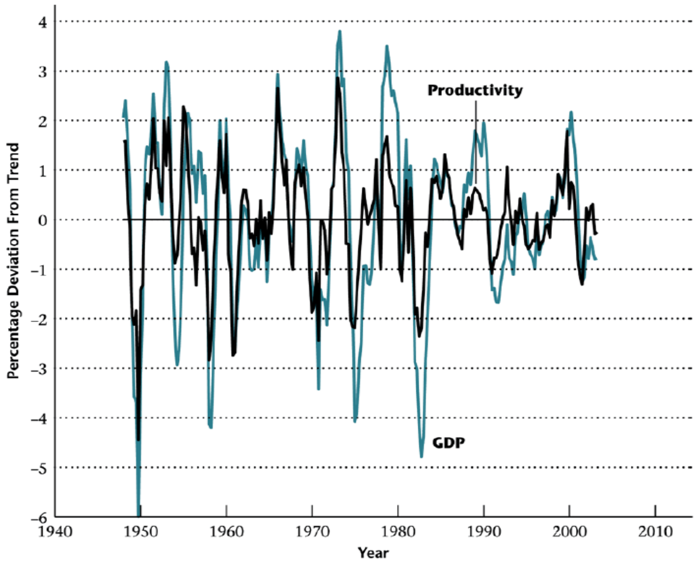

Figure 6: Percentage deviations from trend: GDP vs Productivity

Summary of Major Stylized Facts. Figure 7 highlights the key stylized facts of business cycles, including the volatility, comovements, and persistence of various economic variables.

1.1 How Modern Macro Explains Business Cycles

Economies naturally fluctuate over time, and modern macroeconomics seeks to explain these fluctuations by examining systematic facts. Key aspects that need to be explained include volatility, which refers to the degree of variation in economic variables; comovements, which describe how different economic variables move together; persistence, or autocorrelation, which measures how current economic conditions are related to past conditions; and how expectations about the future influence current economic decisions.

	Cyclicality	Lead/Lag	Variability Relative to GDP
Consumption	Procyclical	Coincident	Smaller
Investment	Procyclical	Coincident	Larger
Price Level	Countercyclical	Coincident	Smaller
Money Supply	Procyclical	Leading	Smaller
Employment	Procyclical	Lagging	Smaller
Real Wage	Procyclical	?	?
Average Labor Productivity	Procyclical	Coincident	Smaller

Note: From Stephen Williamson, Macroeconomics, Addison-Wesley, New York, 2005.

Figure 7: Stylized facts of business cycles

To address these aspects, dominant theoretical models have been developed. These models can be broadly categorized into market-clearing models, such as Real Business Cycles (RBC), and non-market-clearing models, such as the New Keynesian Model (NKM). RBC models assume that markets always clear, meaning supply equals demand, while NKM models incorporate elements like price stickiness and market imperfections.

1.2 RBC versus NKM

Both RBC and NKM models share a common framework that includes dynamic general equilibrium, stochastic shocks, quantitative (computational) methods, and forward-looking (rational) expectations. However, they diverge significantly in their assumptions about information and prices. RBC models assume that information is complete and prices are flexible, allowing markets to adjust quickly to changes. In contrast, NKM models assume that information is incomplete and prices are sticky, meaning they do not adjust immediately to changes, leading to short-term market imbalances.

2 The Real Business Cycle Model

The essence of the Real Business Cycle (RBC) model involves taking the Ramsey Optimal growth model and adding shocks to Total Factor Productivity (TFP). Additionally, leisure is incorporated to account for changes in hours of work. The competitive equilibrium in this model is determined by the preferences of households, the technology used by firms, and the policy decisions made by the government. These real factors—preferences, technology, and policy decisions—play a crucial role in shaping the economy.

In the RBC model, shocks to Total Factor Productivity (TFP) are the fundamental mechanism driving economic fluctuations. These shocks influence the intertemporal substitution of labor and saving decisions. A major result of the model is that fluctuations in economic activity can be seen as an equilibrium outcome. Specifically, individuals tend to work harder and save more when productivity is high.

The baseline version of the RBC model follows the work of Hansen (1985) and builds on the seminal paper by Kydland and Prescott (1982). This version provides a foundational framework for understanding how productivity shocks can lead to business cycle fluctuations.

2.1 Households

Households in the RBC model aim to maximize their utility over time. Utility depends on consumption (C) and hours worked (N), and intertemporal utility is discounted by a factor β. The utility function can be expressed as:

$$u() = \sum_{i=0}^{\infty} \beta^i u(C_{t+i}, N_{t+i}) \tag{1}$$

When introducing uncertainty, future values of consumption and hours worked are not known with certainty. The expectations operator is used to account for this uncertainty:

$$u() = E_t \left[\sum_{i=0}^{\infty} \beta^i u(C_{t+i}, N_{t+i}) \right] \tag{2}$$

A specific form of the utility function used in the RBC model is:

$$u(C,N) = \frac{C^{1-\sigma}}{1-\sigma} - \theta N \tag{3}$$

Households maximize then their expected utility, which can be written as:

$$\max E_t \left[\sum_{i=0}^{\infty} \beta^i \left(\frac{C_{t+i}^{1-\sigma}}{1-\sigma} - \theta N_{t+i} \right) \right] \tag{4}$$

2.2 Firms: Production

Firms produce goods and services using the following production function:

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha} \tag{5}$$

where Y_t is the output, A_t is the Total Factor Productivity (TFP), K_t is the capital, and N_t is the labor input. Capital accumulation is described by the equation:

$$K_t = (1-\delta)K_{t-1} + I_t \tag{6}$$

where δ is the depreciation rate and I_t is the investment. Total Factor Productivity (TFP) follows the process:

$$\ln A_t = (1-\rho)\ln \bar{A} + \rho \ln A_{t-1} + \varepsilon_t \tag{7}$$

where ρ is the persistence parameter, $\bar{A}$ is the steady-state level of TFP, and ε_t is a shock to TFP.

2.3 The Social Planner Solution

To solve for the equilibrium, both decentralized and central planner equilibria are considered. The social planner maximizes the objective function subject to a resource constraint:

$$Y_t = C_t + I_t = A_t K_t^{\alpha} N_t^{1-\alpha} \tag{8}$$

where C_t is consumption and I_t is investment. The Lagrangian for this problem is given by:

$$\mathscr{L} = E_t \sum_{i=0}^{\infty} \beta^i \left[\left(\frac{C_{t+i}^{1-\sigma}}{1-\sigma} - \theta N_{t+i} \right) + \lambda_{t+i} \left(A_{t+i} K_{t+i-1}^{\alpha} N_{t+i}^{1-\alpha} + (1-\delta) K_{t+i-1} - C_{t+i} - K_{t+i} \right) \right] \tag{9}$$

To simplify the exposition, we use $u(C_t, N_t)$ instead of $u = \frac{C_{t+i}^{1-\sigma}}{1-\sigma} + \theta N_{t+i}$. In certainty, the Lagrangian function for periods t and $t+1$ meanning $i = 0$ and $i = 1$:

$$\begin{aligned} \mathscr{L} = \ldots &+ \beta^0 \left[u(C_t, N_t) + \lambda_t \left(A_t K_{t-1}^{\alpha} N_t^{1-\alpha} + (1-\delta) K_{t-1} - C_t - K_t \right) \right] \\ &+ \beta^1 \left[u(C_{t+1}, N_{t+1}) + \lambda_{t+1} \left(A_{t+1} K_t^{\alpha} N_{t+1}^{1-\alpha} + (1-\delta) K_t - C_{t+1} - K_{t+1} \right) \right] \\ &+ \ldots \end{aligned} \tag{10}$$

Now, we derive the first-order conditions (FOCs):

$$\frac{\partial \mathscr{L}}{\partial C_t} = \beta^0 \left[u'_C(C_t) - \lambda_t \right] = 0 \tag{11}$$

$$\frac{\partial \mathscr{L}}{\partial K_t} = \beta^0 \lambda_t + \beta^1 \lambda_{t+1} \left[\alpha \frac{A_{t+1} K_t^{\alpha-1} N_{t+1}^{1-\alpha}}{K_t} + (1-\delta) \right] = 0 \tag{12}$$

$$\frac{\partial \mathscr{L}}{\partial N_t} = \beta^0 \left[u'_N(N_t) + \lambda_t (1-\alpha) \frac{A_t K_{t-1}^{\alpha} N_t^{\alpha}}{N_t} \right] = 0 \tag{13}$$

$$\frac{\partial \mathscr{L}}{\partial \lambda_t} = \beta^0 \left[A_t K_{t-1}^{\alpha} N_t^{1-\alpha} + (1-\delta) K_{t-1} - C_t - K_t \right] = 0 \tag{14}$$

The four FOCs can be written as:

$$\frac{\partial \mathscr{L}}{\partial C_t} = \beta^0 \left[u'_C(C_t) - \lambda_t \right] = 0 \quad (15)$$

$$\frac{\partial \mathscr{L}}{\partial K_t} = \beta^0 \lambda_t + \beta^1 \lambda_{t+1} \left[\alpha \frac{Y_{t+1}}{K_t} + (1-\delta) \right] = 0 \quad (16)$$

$$\frac{\partial \mathscr{L}}{\partial N_t} = \beta^0 \left[u'_N(N_t) + \lambda_t (1-\alpha) \frac{Y_t}{N_t} \right] = 0 \quad (17)$$

$$\frac{\partial \mathscr{L}}{\partial \lambda_t} = \beta^0 \left[A_t K_{t-1}^{\alpha} N_t^{1-\alpha} + (1-\delta) K_{t-1} - C_t - K_t \right] = 0 \quad (18)$$

By inserting $u'_C(C_t) = \lambda_t$ and $u'_C(C_{t+1}) = \lambda_{t+1}$ into the FOC $\frac{\partial \mathscr{L}}{\partial K_t}$, we get:

$$u'_C(C_t) = \beta \left[u'_C(C_{t+1}) R_{t+1} \right] \quad \text{(Euler equation)} \quad (19)$$

Bringing expectations back, the Euler equation with uncertainty is:

$$E_t \left[u'_C(C_t) \right] = E_t \left[\beta \left(u'_C(C_{t+1}) R_{t+1} \right) \right] \quad (20)$$

The specific utility function can now be applied:

$$u'_C(C_{t+i}) = \frac{\partial u}{\partial C_{t+i}} = C_{t+i}^{-\sigma} \quad (21)$$

The Euler equation appears as:

$$C_t^{-\sigma} = \beta E_t \left[C_{t+1}^{-\sigma} R_{t+1} \right] \quad (22)$$

Notice that from the FOCs $\frac{\partial \mathscr{L}}{\partial C_t} = 0$ and $\frac{\partial \mathscr{L}}{\partial N_t} = 0$, we can derive another result by canceling out λ_t:

$$\beta^t \left[u'_N(N_t) - \lambda_t (1-\alpha) \frac{Y_t}{N_t} \right] = 0 \quad (23)$$

As $\beta^t \neq 0$, therefore:

$$u'_N(N_t) - \lambda_t (1-\alpha) \frac{Y_t}{N_t} = 0 \quad (24)$$

Given that $u'_N(N_t) = \theta$ and $\lambda_t = u'_C(C_t)$, we get:

$$\frac{Y_t}{N_t} = \frac{\theta}{1-\alpha} C_t^{\sigma} \quad (25)$$

The first-order conditions (FOCs) give us three equations involving five variables (Y_{t+i}, N_{t+i}, C_{t+i}, R_{t+i}, K_{t+i}):

$$\frac{Y_t}{N_t} = \frac{\theta}{1-\alpha} C_t^{\sigma} \quad (26)$$

$$C_t^{-\sigma} = \beta E_t \left[C_{t+1}^{-\sigma} R_{t+1} \right] \quad (27)$$

$$R_{t+1} = \alpha \frac{Y_{t+1}}{K_t} + (1-\delta) \tag{28}$$

The system is indeterminate with these three equations. Two further equations are needed to determine the system:

- The production function
- The capital accumulation equation.

However, these two additional equations introduce two more variables into the system (A_t, I_t), which requires two further equations:

- The national accounting identity
- The TFP process

Now the system can be solved as we have a system of seven equations with seven unknowns (Y_{t+i}, N_{t+i}, C_{t+i}, R_{t+i}, K_{t+i}, A_{t+i}, I_{t+i}). Our seven equations are:

$$R_{t+1} = \alpha \left(\frac{Y_{t+1}}{K_t}\right) + (1-\delta) \tag{29}$$

$$C_t^{-\sigma} = \beta E_t \left[C_{t+1}^{-\sigma} R_{t+1}\right] \tag{30}$$

$$\frac{Y_t}{N_t} = \frac{\theta}{1-\alpha} C_t^{\sigma} \tag{31}$$

$$K_t = (1-\delta)K_{t-1} + I_t \tag{32}$$

$$Y_t = A_t K_{t-1}^{\alpha} N_t^{1-\alpha} \tag{33}$$

$$Y_t = C_t + I_t \tag{34}$$

$$\ln A_t = (1-\rho)\ln \bar{A} + \rho \ln A_{t-1} + \varepsilon_t \tag{35}$$

This forms a nonlinear system of stochastic difference equations, some of which are nonlinear. Solutions to these systems are extremely difficult, if not impossible, to obtain. A common approach is to linearize the system in the vicinity of the steady state, which is widely used and very useful in economics.

3 Log-Linearization

We shall recall a number of points regarding linearization. The system has seven endogenous variables (Y_{t+i}, N_{t+i}, C_{t+i}, R_{t+i}, K_{t+i}, A_{t+i}, I_{t+i}). In steady state, for any variable x_t, we get $x_t = x_{t+1} = \bar{x}$. The natural way to linearize an equation is to apply logarithms, or Δlog (first difference in logs). Remember that Δlog is approximately equal to a growth rate. We will apply Δlog to our system. Although linearization may look very complicated, it is actually quite simple. We only need to know how to transform the equations of the model into Δlog functions.

3.1 How to Transform Functions in Levels into Log Differences

Transforming functions into log-differences can be illustrated with several cases. First, consider a linear function: $Y_t = 2X_t$. Applying logs to two consecutive periods, we get:

$$\ln Y_t = \ln 2 + \ln X_t \tag{36}$$

$$\ln Y_{t+1} = \ln 2 + \ln X_{t+1} \tag{37}$$

Therefore, the first difference of logs is:

$$\ln Y_{t+1} - \ln Y_t = (\ln 2 + \ln X_{t+1}) - (\ln 2 + \ln X_t) = \ln X_{t+1} - \ln X_t \tag{38}$$

In this kind of function, the growth rate of Y, let's call it g_Y, is equal to the growth rate of g_X:

$$g_Y = g_X \tag{39}$$

Next, consider a linear function of two independent variables: $Y_t = 2X_tZ_t$. Applying logs to two consecutive periods, we get:

$$g_Y = g_X + g_Z \tag{40}$$

You can prove this result yourself from *Introduction Chapter*.

Finally, consider a power function: $Y_t = 2X_tZ_t^3$. Applying logs, we get:

$$\ln Y_t = \ln 2 + \ln X_t + 3\ln Z_t \tag{41}$$

$$\ln Y_{t+1} = \ln 2 + \ln X_{t+1} + 3\ln Z_{t+1} \tag{42}$$

Therefore, the first difference of logs is:

$$\ln Y_{t+1} - \ln Y_t = (\ln 2 + \ln X_{t+1} + 3\ln Z_{t+1}) - (\ln 2 + \ln X_t + 3\ln Z_t) = \ln X_{t+1} - \ln X_t + 3(\ln Z_{t+1} - \ln Z_t) \tag{43}$$

So this power function can be written in $\Delta\log$ as:

$$g_Y = g_X + 3g_Z \tag{44}$$

The last function we need to consider is an additive function like $Y_{t+1} = X_{t+1} + Z_{t+1}$. Here we can't apply logs directly. But there is another way:

$$\frac{Y_{t+1}}{Y_t} = \frac{X_{t+1}}{X_t}\frac{X_t}{Y_t} + \frac{Z_{t+1}}{Z_t}\frac{Z_t}{Y_t} \tag{45}$$

Now apply the following:

$$\frac{Y_{t+1}}{Y_t} = 1 + g_Y, \quad \frac{X_{t+1}}{X_t} = 1 + g_X, \quad \frac{Z_{t+1}}{Z_t} = 1 + g_Z \tag{46}$$

The previous equation can be written as:

$$(1+g_Y)Y_t = (1+g_X)X_t + (1+g_Z)Z_t \tag{47}$$

Divide through by Y_t and get:

$$1 + g_Y = (1+g_X)\frac{X_t}{Y_t} + (1+g_Z)\frac{Z_t}{Y_t} \tag{48}$$

Notice that the previous equation can be written as:

$$1 + g_Y = \left(\frac{X_t}{Y_t} + \frac{Z_t}{Y_t}\right) + g_X\frac{X_t}{Y_t} + g_Z\frac{Z_t}{Y_t} \tag{49}$$

Therefore, an additive function like $Y_{t+1} = X_{t+1} + Z_{t+1}$ can be expressed as:

$$g_Y = g_X\frac{X_t}{Y_t} + g_Z\frac{Z_t}{Y_t} \tag{50}$$

Notice that if $Z = 2$, its growth rate were $z = 0$, and we would get:

$$g_Y = g_X\frac{X_t}{Y_t} \tag{51}$$

Let's summarize our results:

Variables in levels	Variables in $\Delta \log$
$Y_t = 2X_t$	$g_Y = g_X$
$Y_t = 2X_tZ_t$	$g_Y = g_X + g_Z$
$Y_t = 2X_tZ_t^3$	$g_Y = g_X + 3g_Z$
$Y_{t+1} = X_{t+1} + Z_{t+1}$	$g_Y = g_X\frac{X_t}{Y_t} + g_Z\frac{Z_t}{Y_t}$
$Y_{t+1} = X_{t+1} + 2$	$g_Y = g_X\frac{X_t}{Y_t}$

3.2 Linearizing the Model in the Vicinity of the Steady State

Transforming our system into a linear one. Let's use small letters to express the growth rate of a variable, $x = G_X$ then:

$$C_t^{-\sigma} = \beta E_t\left[C_{t+1}^{-\sigma} R_{t+1}\right] \iff \quad c_t = E_t c_{t+1} - \frac{1}{\sigma} E_t r_{t+1} \tag{52}$$

$$\frac{Y_t}{N_t} = \frac{\theta}{1-\alpha} C_t^{\sigma} \iff \quad n_t = y_t - \sigma c_t \tag{53}$$

$$K_t = (1-\delta)K_{t-1} + I_t \iff \quad k_t = (1-\delta)k_{t-1} + i_t \tag{54}$$

$$Y_t = A_t K_{t-1}^{\alpha} N_t^{1-\alpha} \iff \quad y_t = a_t + \alpha k_{t-1} + (1-\alpha)n_t \tag{55}$$

$$C_t + I_t = Y_t \iff \quad y_t = c_t \frac{C_t}{Y_t} + i_t \frac{I_t}{Y_t} \tag{56}$$

$$R_t = \alpha\left(\frac{Y_t}{K_{t-1}}\right) + (1-\delta) \iff \quad r_t = \alpha\left(\frac{R_t Y_t}{K_{t-1}}\right)(y_t - k_{t-1}) \tag{57}$$

$$\ln A_t = (1-\rho)\ln \bar{A} + \rho \ln A_{t-1} + \varepsilon_t \iff \quad a_t = \rho a_{t-1} + \varepsilon_t \tag{58}$$

Notice that now our system is: 7 equations, 12 unknowns: (c, r, n, y, k, i, a) plus (K, C, Y, I, R).

One example. Let us solve the less simple equation of the whole set:

$$R_t = \alpha\left(\frac{Y_t}{K_{t-1}}\right) + (1-\delta) \tag{59}$$

Simplify the previous equation by assuming that $Z_t = \frac{Y_t}{K_{t-1}}$, and $\mu = 1-\delta$:

$$R_t = \alpha Z_t + \mu \tag{60}$$

Now apply the rule discussed above and get:

$$r_t = \alpha z_t \frac{Z_t}{R_t} \tag{61}$$

But as $z_t = y_t - k_{t-1}$:

$$r_t = \alpha\left(\frac{R_t Y_t}{K_{t-1}}\right)(y_t - k_{t-1}) \tag{62}$$

3.3 Determining the Steady State

We can determine the values of K, C, Y, I, R associated with the steady state. Remember that in the vicinity of the steady state, for any x_t, we get $x_t = x_{t+1} = \bar{x}$, then $\frac{x_t}{x_{t+1}} = 1$. Let's start with the Euler equation. As $C_t = C_{t+1} = \bar{C}$, then:

$$C_t^{-\sigma} = \beta E_t\left[C_{t+1}^{-\sigma} R_{t+1}\right] \tag{63}$$

If $\bar{R} = \beta^{-1}$, then from the production function:

$$\bar{R} = \alpha \left(\frac{\bar{Y}}{\bar{K}} \right) + (1 - \delta) \tag{64}$$

Therefore:

$$\frac{\bar{Y}}{\bar{K}} = \frac{\beta^{-1} - (1 - \delta)}{\alpha} \tag{65}$$

As we know that $\bar{R} = \beta^{-1}$ and $\frac{\bar{Y}}{\bar{K}} = \frac{\beta^{-1} - (1-\delta)}{\alpha}$, then:

$$\alpha \bar{R} \frac{\bar{Y}}{\bar{K}} = \frac{1}{\beta(1 - \delta)} \tag{66}$$

Next, from the capital accumulation equation:

$$\bar{K} = (1 - \delta)\bar{K} + \bar{I} \tag{67}$$

Therefore:

$$\frac{\bar{I}}{\bar{K}} = \delta \tag{68}$$

And:

$$\frac{\bar{I}}{\bar{Y}} = \frac{\bar{I}}{\bar{K}} \frac{\bar{K}}{\bar{Y}} = \phi, \quad \text{for simplicity with} \quad \phi = \frac{\alpha\delta}{\beta^{-1} - (1 - \delta)} \tag{69}$$

Finally:

$$\frac{\bar{C}}{\bar{Y}} = 1 - \frac{\bar{I}}{\bar{Y}} = 1 - \phi \tag{70}$$

Our system of stochastic linear difference equations with rational expectations looks like:

$$c_t = E_t c_{t+1} - \frac{1}{\sigma} E_t r_{t+1} \tag{71}$$

$$n_t = y_t - \sigma c_t \tag{72}$$

$$k_t = (1 - \delta)k_{t-1} + \delta i_t \tag{73}$$

$$y_t = a_t + \alpha k_{t-1} + (1 - \alpha)n_t \tag{74}$$

$$y_t = c_t(1 - \phi) + \phi i_t \tag{75}$$

$$r_t = \left[\frac{1}{\beta(1 - \delta)} \right] (y_t - k_{t-1}) \tag{76}$$

$$a_t = \rho a_{t-1} + \varepsilon_t \tag{77}$$

With $\phi = \frac{\alpha\delta}{\beta^{-1} - (1-\delta)}$.

3.4 Numerical Simulation of the Linearized Model

Now we can assign values to the parameters, take the model to the computer, and simulate the impact of shocks on the endogenous variables. We use a routine for Matlab developed by Harald Uhlig, now at the University of Chicago. For more variations on the RBC model taken to the computer, see the work by Jesus Fernandez-Villaverde (University of Pennsylvania) at https://avoumatsodo.github.io/pages/econ-710-details/.

We calibrate the model with the following parameters: $\alpha = 0.4$, $\delta = 0.012$, $\rho = 0.95$, $\beta = 0.987$, $\sigma_e = 0.07$, $\sigma = 1$, and $\bar{N} = 1/3$ (steady state employment is a third of total time endowment). See the following figures for the results. The RBC model reproduces relatively

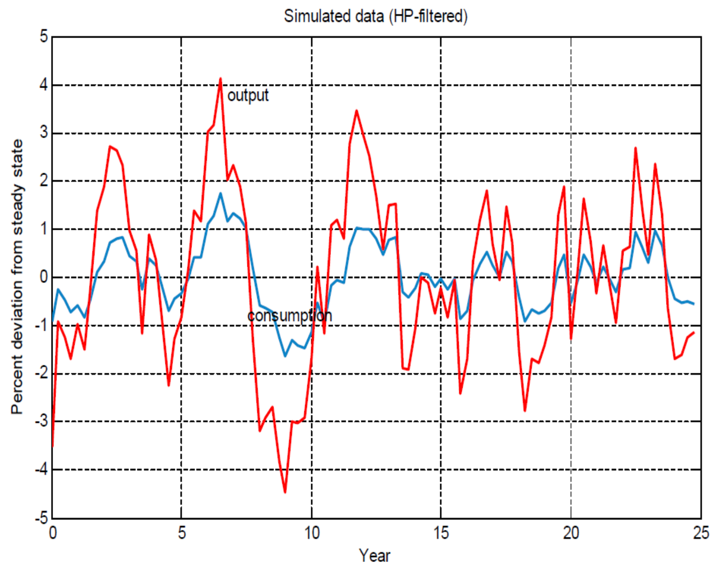

Figure 8: Simulated data (HP-filtered): Output vs Consumption

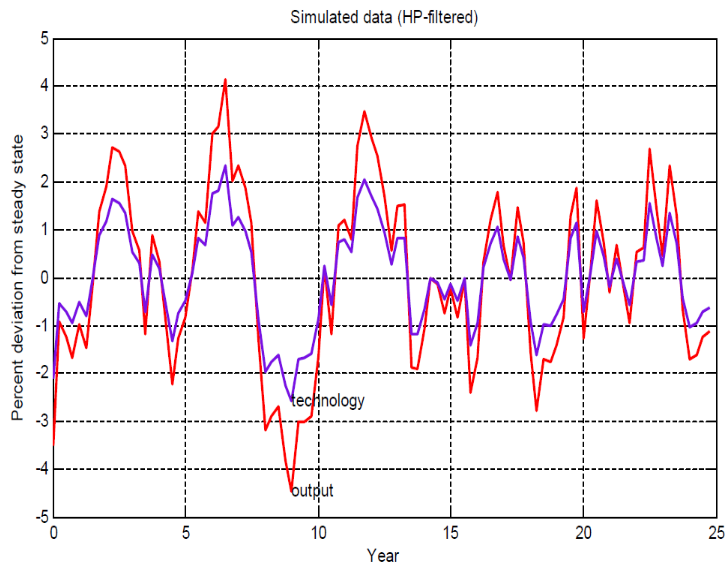

Figure 9: Simulated data (HP-filtered): Output vs TFP

well several stylized facts of business cycles. Output is nearly as volatile as in the data, while

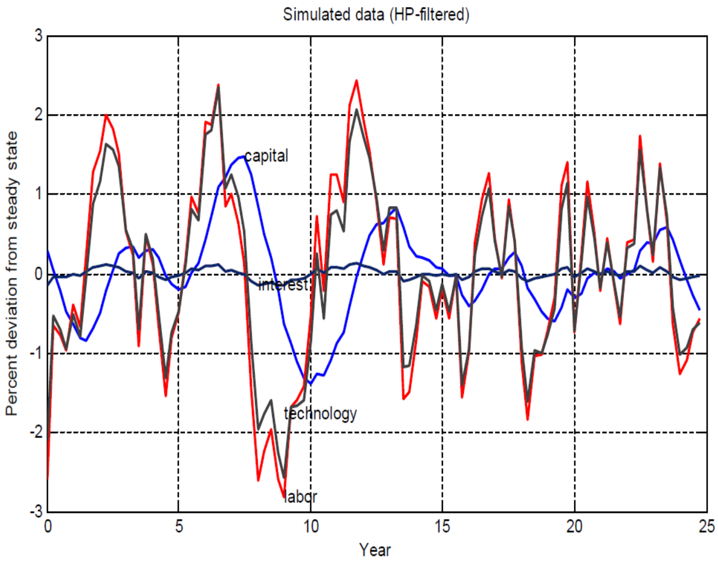

Figure 10: Simulated data (HP-filtered): Capital, Interest Rate, TFP and Labor

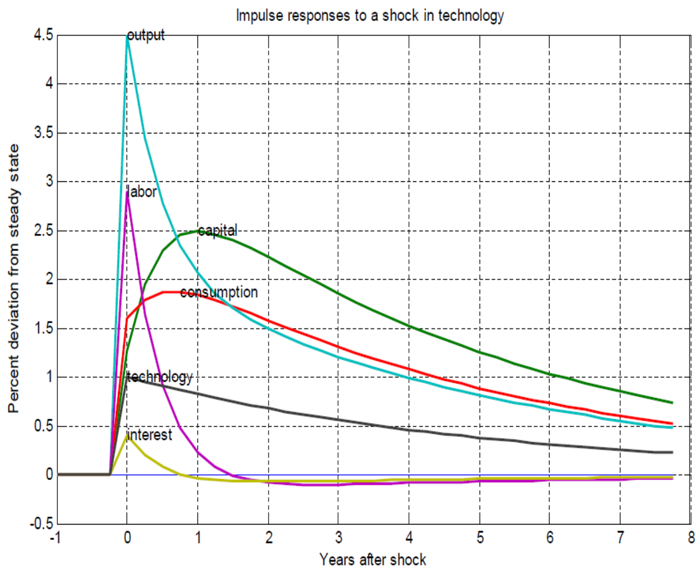

Figure 11: Impulse responses to a shock in technology

consumption is less volatile than output. Investment, on the other hand, is more volatile, and persistence is high. The model seems to align well with covariances.

However, there are serious problems with the RBC model. The variability of hours of work is understated, as well as consumption. Real wages and interest rates are highly procyclical, which is not consistent with the data. Additionally, the source of negative shocks is unclear. The model does not account for the role of monetary policy, and fiscal policy is of little help due to Ricardian equivalence.

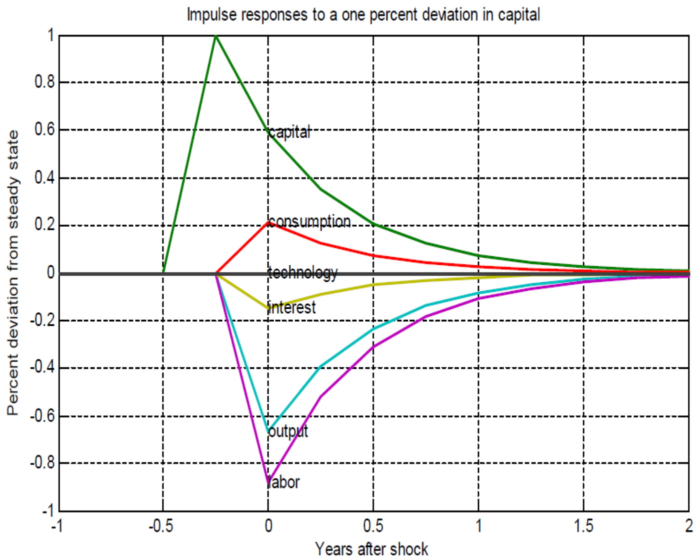

Figure 12: Impulse responses to a one percent deviation in capital

4 Readings

- Eric Sims (2017). Graduate Macro Theory II: The Real Business Cycle Model, University of Notre Dame, Spring 2017.
- Dirk Krueger (2007). "Quantitative Macroeconomics: An Introduction" Unpublished manuscript, Department of Economics, University of Pennsylvania.