

# Macroeconomics A: EI056

## Quizz

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### 1 Ramsey and Solow models

**Question:** What are the similarities and difference between the Ramsey model and the Solow growth model?

**Answer:** Both model assume that the economy has an aggregate production function with constant returns to scale in the two factors, labor and capital. The resource constraint that output is consumed or invested is thus identical in the two models.

The difference is in the choice of consumption. The Solow model abstract from this choice and instead assumes that a constant share of output is invested. The Ramsey model by contrast derives consumption from an explicit utility maximization. The consumption choice reflects a trade-off between consuming today, and getting the current marginal utility, or postponing consumption to a later date by investing, which yields the marginal return of investment times the future marginal utility of consumption, adjusted by the discount factor.

### 2 Elasticity of utility

**Question:** What is the interpretation of the parameter  $\theta$  in the utility function used in class?

**Answer:**  $\theta$  measures the degree of curvature of the utility. All utility functions have the features that marginal utility is positive, and that it is decreasing as consumption increases (i.e. the second derivative of the function is negative). The parameter  $\theta$  measures how sensitive the marginal utility is to the level of consumption. If  $\theta$  is high, even a small decrease in consumption leads to a large increase in the marginal utility, so the consumer is very affected by a reduction in consumption.

### 3 Euler condition

**Question:** A central relation of the setting is the Euler condition. What is it used for, and what is its intuitive interpretation?

**Answer:** The Euler condition determines the optimal dynamic path of consumption, and is computed by combining the optimality conditions with respect to consumption and the optimality condition with respect to capital.

There are two uses for a marginal unit of revenue today. It can be consumed, giving the marginal utility of consumption today. It can instead be saved and invested. The return is the real interest rate, which needs to be adjusted by the time discount as consumption is postponed. The utility of consuming the return tomorrow is the marginal utility of consumption.

A higher interest rate implies that postponing consumption is worth it. The interest rate is the intertemporal price of consumption. The sensitivity of consumption to that price is given by the intertemporal elasticity of substitution, which reflects the curvature of the utility function. If the function is nearly a straight line, the marginal utility of consumption does not vary much between a high and a low level of consumption. The consumer is then willing to substantially shift consumption through time to consume when consumption is cheapest. By contrast, if the utility is very concave, the consumer perceives a much lower marginal utility from a high consumption than from a low one. She is then little inclined to switch consumption through time in response to its relative price.

## 4 Control and state variables

**Question:** What is the difference between a state variable and a control (or jump) variable? Explain in intuitive terms the use of the “phase diagram”. What is the saddle path, and why can we be sure that the economy is on it?

**Answer:** A state variable is set at the time of the optimization by agent. The standard example is the capital stock. We can accumulate additional capital, but this becomes productive only tomorrow. There is no way to boost the level of the current capital stock (time travel to the past is not allowed).

A control variable by contrast can be set freely. The standard example is consumption. The agent can set it at any level she wants, provided she does not consume more than the available resources of course. The control variable is set at the level from which the economy converges to its steady state. Setting it at any other level would imply that the economy would run out of resources, or only invest, which is not optimal. The agent perfectly foresees this and thus never puts herself on a divergent path.

The phase diagram shows the relation between the state and the control variables. It depicts the current combinations of state and control variables for which the state variable is constant, or the control variable is constant. The economy steady state is the point at which both variables are constant. In addition to the steady state, the phase diagram illustrates how the two variables evolve from any starting point. Not all paths converge towards the steady state. In fact, most do not and only one “saddle path” brings both variables to the steady state. While capital is preset, consumption can be freely adjusted, thus there is nothing preventing the economy from being on the saddle path.

## 5 Extra: capital adjustment

**Question:** Explain intuitively what is the appeal of adjustment costs to investment (presented in extra slides).

**Answer:** Introducing the adjustment cost slows the dynamics of the model and generates an asset price.

Without the adjustment cost, the economy can quickly build the capital stock and converge to the steady state (especially in the case of an open economy that can borrow abroad). This is not realistic. Introducing an adjustment cost makes it optimal to smooth the adjustment of capital. Building capital fast is not efficient as it entails a cost that gets more pronounced the faster we build capital (the marginal adjustment cost is increasing).

The adjustment cost also implies that one cannot freely exchange consumption for capital, as this entails a cost. The economy then effectively has two goods: a consumption good and a capital good, which we can think of as an asset. The Tobin's  $Q$  is the relative price of the capital good to the consumption good, and it can be interpreted as a real asset price. Without adjustment costs this price is always equal to one.