Exercícios práticos Macroeconomia II

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Contents

Aula prática 1: Portuguese economic data and computation of growth rates

1.1 (Excel-based) Download the file "MA2 - 2024-2025 - AP1" from Fenix and perform the following exercises:

1.1.1 Perform the necessary calculations and fill in the columns:

1.1.1.1 Population (1991-2021)
1.1.1.2 GDP per capita (1960-1990)
1.1.1.3 Annual GDP growth rate
1.1.1.4 Annual population growth rate
1.1.1.5 Annual GDP per capita growth rate

1.1.2. Plot the evolution over time of GDP per capita in a graph and discuss economically the trend over time, and whether you can identify distinct periods and important fluctuations in the data series. What could the causes of these fluctuations have been?

1.1.3. Plot the evolution over time of the GDP per capita growth rate in a graph and continue the discussion from 1.1.2. Are there any interesting/relevant additional facts/patterns which you can identify?

1.1.4. Compute the discrete and continuous annual average growth rates of Portugal's GDP per capita between 1960 and 2021. Compare the two figures.

1.1.5. Compute the continuous average growth rates of GDP per capita for the periods 1960-1970; 1970-1980; 1980-1990; 1990-2000; 2000-2010; and 2010-2020. Discuss your findings in a comparative economic perspective.

1.1.6 1.1.6 At the average annual growth rate for 1960-2021, how many years from 2021 will it take for GDP per capita to reach 25,000 Euros? What about if the growth rate is the same as the average for 2000-2021?

1.1.7 At the average annual growth rate (discrete) for 1960-2021, how many years from 2021 will it take for GDP per capita to double? What about if the growth rate is the same as the average for 2000-2021?

Aula prática 2: Growth rates (2): computation and analysis of convergence.

2.1 (Excel-based) Download the file "MA2 – 2024-2025 – AP2" from Fenix and perform the following exercises:

2.1.1 Plot the evolution of GDP per capita over time in these ten economies/regional groupings in a graph.

2.1.2 Discuss, from an economic perspective, what you see in the table and in the graph. Which countries seem to have grown the fastest over these three decades? Are there cases of economic decline? In general, did the countries that started out poorer grow faster or slower than the countries that started out richer. What factors could explain and account for all these phenomena?

2.1.3 Compute the (continuous and discrete) average annual growth rates for these ten countries in the period 1989-2019.

2.1.4 Based on your answer to 2.3, which countries did Portugal experience real convergence towards in the period 1989-2019, and which countries did it experience real divergence from?

2.1.5 Plot in a scatterplot graph the initial GDPpc and the (continuous) average annual growth rate of these ten countries/groups of countries except for the World. Discuss whether the data and the graph are suggestive of economic convergence or divergence among this group of countries.

2.1.6 At the average annual growth rate for 2009-2019, how many years will it take for China's GDP per capita to be the same as the Portuguese GDP per capita of 2019?

2.1.7 Assuming that both Portugal and China continue to grow at their average annual growth rates for 2009-2019, how many years will it take for China's GDP per capita to catch up to Portugal's GDP per capita? And how many years will China take to reach the United States' GDP per capita if both economies continue to grow at their 2009-2019 average rates? Discuss, economically, whether this seems likely or unlikely, and why in your view that is the case.

Aula prática 3: Apresentação e discussão de textos. Tema 1 – crescimento económico moderno e sua explicação

Aula prática 4: Growth accounting and the Harrod-Domar model

4.1 - Growth Accounting:

4.1.1 Consider an economy whose production function is given by: $Y = A.K^{0.7}.L^{0.3}$. If, in 2022, this economy's GDP (Y) grew by 1.2%, the physical capital stock (K) grew by 0.8% and the labour force (L) grew by 0.5%, calculate by how much Total Factor Productivity (A) grew in 2022.

4.1.2 Consider an economy whose production function is as follows: $Y = A.K^{0.6}.(h.L)^{0.4}$, and whose GDP in 2022 amounted to 50 Billion monetary units. Assuming that, in the period 2022-2042, the average annual growth rates of TFP (A), the physical capital stock (K), the average stock of human capital per worker (h) and the labour force (L) will respectively be 2%, 1.5%, 1% and 0.5%, calculate the level of GDP of this economy in 2042.

4.1.3 Suppose that output, Y, in an economy is produced by combining physical capital, K, with skilled labour, h.L, according to a constant-returns *Cobb-Douglas* production function with disembodied technical progress:

$$Y(t) = A(t).K(t)^{0.4}.[h(t).L(t)]^{0.6}$$

where K is the stock of physical capital, L is the labour force and h is the average human capital per worker. In the last 20 years the labour force grew at an annual rate of 0.6%, the average human capital per worker grew at an annual rate of 1% and the stock of physical capital grew at an annual rate of 2.5%. Assume that the annual growth rate of GDP was 3% in the last 20 years. Calculate the average annual growth rate of the total factor productivity, r(A), in this period.

4.1.4 Suppose an economy with a Cobb-Douglas aggregate production function with disembodied technical progress, with elasticities of output relative to physical capital equal to 0.3 and to the human capital equal to 0.7. Calculate the average annual growth rate of the labour productivity, assuming that the total factor productivity (TFP) has grown at an annual average rate of 1%, the average human capital per worker has grown at an annual average rate of 0.5% and the stock of physical capital per worker has grown at an annual average rate of 2%.

4.2 - The Harod Domar Model:

4.2.1 In light of the Harrod-Domar model, discuss the main measures that governments should take to promote economic growth.

4.2.2 Consider the following data for three economies which behave in accordance with the hypotheses of the Harrod-Domar model:

	Investment rate	Depreciation rate	Physical capital productivity	Warranted growth rate
Economy A	35%	4%	0.2	
Economy B	28%		0.25	2%
Economy C	30%	2.5%		5%

Fill in the blank cells in the table.

4.2.3 The government of country A set as its goal, for the period 2023-2027, for the average annual growth rate of labour productivity to be 2.5%. The Statistics Office forecast an average annual growth rate of the labour force of 1.5% for this period, and estimated, also for this period, a capital-output ratio equal to 3 and a depreciation rate of 4%. Assuming the hypotheses of the Harrod-Domar model, make use of it to say what should be, in such conditions, the savings rate of this economy.

4.2.4 Suppose an economy which functions in accordance with the hypotheses of the Harrod-Domar model, growing at its warranted growth rate, and in which total income (Y) increased from 128 billion euros in 2005 to 180 billion euros in 2020. Over the same period, the savings rate was 20% and the depreciation rate was 4%.

a) Estimate the value of the capital stock in 2020.
b) If the capital-output ratio had been larger, with all else constant, would the economy have grown faster or slower? Explain why that is the case.

4.2.5 With regard to an economy which behaves in accordance with the hypotheses of the Harrod-Domar model and which has been growing at its warranted growth rate, the following information is known for the period 2017-2022:

- The value of the physical capital stock increased from 600 million monetary units to 730 million monetary units
- The savings rate, which remained constant throughout the period, was 32%
- The capital-output ratio, which also remained constant throughout the period, was equal to 4.

Based on the information provided, indicate:

a) the output of this economy in 2017 and in 2022;

b) the depreciation rate (assuming that this rate also remained constant throughout the period 2013-2018).

4.2.6 Comment on the following statement and correct it if necessary: “Capital accumulation is the engine of economic growth in the Harrod-Domar model because in this model physical capital is characterised by increasing marginal productivity".

Aula prática 5: The Solow model

Solow Model Part 1

5.1 Suppose an economy which functions in accordance with the hypotheses of the Solow model and which is currently *below* its steady-state in terms of capital per worker and output per worker.
a) Draw the Solow diagram and represent the current situation of this economy.
b) According to the model, what will tend to happen to this economy in the short-run and the long-run? Explain the economic mechanisms that will bring about these outcomes.

5.2 Suppose an economy which functions in accordance with the hypotheses of the Solow model and which is currently in its steady state.
a) Draw the Solow diagram and represent the current situation of this economy.
b) Suppose the following changes occur in this economy (each one in its turn, i.e. not all at once, and ceteris paribus). Represent the corresponding graphical shifts and describe the consequences to the economy in the short-run and the long-run:

i. a decrease in the savings rate;
ii. a positive change in the available technologies;
iii. an increase in the depreciation rate;
iv. a decrease in the population growth rate;
v. a sudden reduction in the available stock of physical capital per worker, e.g. due to a natural disaster;
vi. a one-off increase in the population, e.g. due to a sudden inflow of refugees.

5.3 Suppose an economy which functions in accordance with the hypotheses of the Solow model and is adequately described by the following Cobb-Douglas production function:

$$Y = 0{,}2.K^{\alpha}.L^{1-\alpha}$$

Further assume that the population is growing at an annual rate of 0.5%, the depreciation rate of physical capital is 4%, the investment rate is 25% and the partial elasticity of GDP with respect to physical capital is 0.6. For simplification, assume also that the total population, labour force and employed population are identical.

a) Formalize the model which represents the functioning of this economy and find the steady state level of physical capital per worker. Represent this graphically.

b) Find the steady state levels of GDP per worker, consumption per worker and investment per worker. Represent these values graphically.

c) With everything else constant, what will be the effect upon the steady state of an increase in the population growth rate to 1%? Represent this change graphically.

d) With everything else constant, what will be the effect upon the steady state of an increase in the investment rate to 30%? Represent this change graphically.

5.4. Consider an economy which functions in accordance with the Solow model and which is adequately described by the production function $Y = 0{,}4.K^{\alpha}.L^{1-\alpha}$. Assume that the partial elasticity of GDP with respect to physical capital is 0.4, the population growth rate is 1% and capital depreciates at 5% per annum.

a) Find what the investment rate must be if the steady state level of physical capital per worker is $k^* = 2.5$?

b) If k is indeed at $k^* = 2.5$, what is the growth rate of GDP?

Solow Model Part 2

5.5 Suppose an economy which functions in accordance with the hypotheses of the Solow model, with the following Cobb-Douglas production function:

$$Y = 0{,}4.K^{\alpha}.L^{1-\alpha}$$

We also know that the partial elasticity of GDP with respect to physical capital is 0.6, the depreciation rate is 4%, the labour force growth rate is 0.5% and the steady state level of physical capital per worker is 7.36 monetary units.

a) Find the steady state value of GDP assuming that the labour force consists of 10 million people.

b) Find the level of the investment rate which is consistent with this steady state level of physical capital per worker.

c) Provide an economic explanation for the mechanism which leads the stock of physical capital per worker to return to its steady state level if at any time it increases above 7.36. What does this imply in relation to the ability of capital accumulation to bring about sustained productivity increases in the Solow model?

5.6 Suppose an Economy A which functions in accordance with the hypotheses of the Solow model, with the following Cobb-Douglas production function:

$$Y = 0{,}3.K^{0,4}.L^{0,6}$$

The investment rate is 20%, the labour force growth rate is 1% and the depreciation rate is 4%. We also know the initial values of K and L, which are as follows: K_0 = 11 million monetary units; and L_0 = 10 million people.

a) What is the future trend of the capital-output ratio in this economy? And what is the future trend of labour productivity?

b) Assume that this economy takes 20 years to reach the steady state. Characterize this equilibrium state in terms of the level and growth rates of the following variables: labour force, stock of physical capital, GDP, investment.

c) Consider that this economy is in the steady state and the government of this country decides to create a special income tax, which consists of a tax of 5% on GDP. What are the consequences upon the level and growth rate of GDP per worker?

d) What are the effects, both in the short term and the long term, of a one-off increase in the labour force to 11 million people (for example due to the massive return of refugees in a given year)?

5.7 Consider an economy which behaves in accordance with the hypotheses of the Solow model and about which it is known that the investment rate equals 25%, the depreciation rate equals 4% and the labour force is constant. The production function of this economy is as follows:

$$Y_t = K_t^{0.4}.L_t^{0.6}$$

a) Find the steady state level of physical capital per worker of this economy. In addition, find the level of labour productivity which corresponds to that steady state.

b) Suppose that, starting from the steady state, the government of this country is considering two alternative immigration policies. The first one consists of the immigration of a number of migrants corresponding to 10% of the population in one go, albeit without any effect upon the population growth rate thereafter (which continues to be zero). The second one consists of the immigration every year of a number of migrants such that the population growth rate undergoes a permanent increase from 0% to 2%. Explain the consequences of these two alternatives in terms of the Solow model and depict the two situations in a graph.

5.8 Consider an economy which behaves according to the Solow model and has the following aggregate production function:

$$Y = A.K^{\alpha}.(h.L)^{(1-\alpha)}$$

The variables Y, K, h and L stand for the level of output, physical capital, human capital per worker and the labour force. The variable A, which represents the level of technology, is constant and equal to 1, while the elasticity of GDP with respect to physical capital is equal to 0.8.

Assuming that human capital per worker remains constant and equal to 1, that the depreciation rate is 3.5% per year, and that the labour force grows at 0.5% per year, compute the investment rate which is compatible with a steady state capital-output ratio equal to 4.

Aula prática 6: Apresentação e discussão de textos. Tema 2 – Climate change

Aula prática 7: Representing and interpreting inequality.

7.1 Consider the following alternative distributions of the same total income:

Individuals	Distribution A	Distribution B	Distribution C
1	240	836	0
2	780	836	0
3	849	836	0
4	1007	836	0
5	1304	836	4180
Total	4180	4180	4180

a) Represent on the same graph the Lorenz curves that correspond to the three distributions.

b) Without making any calculations, indicate the Gini coefficients of Distributions B and C.

c) Indicate the Lorenz dominance relationships between Distributions A, B and C and discuss them in light of the Gini coefficients computed in (b) above.

7.2 Discuss the following statement and correct it if necessary: “If economy A has a lower Gini coefficient than economy B, we may conclude that the Lorenz curve of economy A dominates the Lorenz curve of economy B”.

Aula prática 8: Apresentação e discussão de textos. Tema 3 – Inequality

Aula prática 9: Social Security

10.1 For a given economy with a pay-as-you-go system, it is expected that the employed population will grow by 0.3% per year over the next 20 years and that, due to the ageing of the population, the number of pensioners will grow at an average annual rate of 1.6%. The government wants the average pension to grow at 2% per year.

a) Suppose the social security system is currently financially balanced. What should the annual GDP growth rate be in order to maintain this balance, without increasing the rate of contributions to the system and assuming that the functional distribution of income does not change during this period?

b) Consider now that while the functional income distribution remains unchanged, average labour productivity grows at 1% per annum and the employed population grows at 0.2% per annum. As before, the annual growth in the number of retired persons is 1.6% (as before) and the government wants the average pension to grow at 2% per annum. Compute the implication in terms of the contributions rate and discuss it.

10.2 Consider an economy whose social security system is based on a pay-as-you-go system. Its Office of Studies and Planning has the following projections for the next 20 years: the working-age population in 2019 (all employed) is estimated at 5 million people and is expected to grow to 5.526 million by 2039; the number of pensioners will grow at the annual average rate of 4% in the period; it is also predicted that GDP, at constant prices, will grow at the annual average rate of 4% and that there will be no change in the functional distribution of income. Based on these elements, the Government has set the objective of increasing the average retirement pension by 1% per annum without raising the rate of contributions but maintaining the balance of the system.

a) Check whether the objective set by the Government is attainable under the projections indicated above.

b) If it is not feasible, what change can be made to the contribution rate to help achieve this objective?

c) 600,000 migrant workers enter the labour force, evenly distributed throughout the 20 years. Assuming that all other variables (except from GPD growth) remain unchanged from (a) and labour productivity growth remains unchanged from (a), what should be the change in the rate of contribution to achieve the government's goal? Discuss.

10.3 Consider an economy whose Social Security is based on a pay-as-you-go system, where for the next twenty years (2023 to 2043) the following information is projected: GDP will grow at an average annual rate of 2%; the labour force (all employed), at the end of the period, will be 20% higher than in 2023; the

number of pensioners in proportion to the working population will be 30% higher in 2043; and real wages are expected to grow in line with average labour productivity. Suppose, furthermore, that the Government's objective is to increase the average retirement pension by 1% per annum without increasing the rate of social security contributions.

a) Check whether this Government objective is feasible.

b) Indicate and explain adequately an example of an additional measure that the Government could take to make possible the objective considered above.

c) If the Government chooses to attain this objective through faster economic growth, what should GDP growth be to ensure the desired real growth of the average retirement pension?

10.4 In economy X, GDP per capita (Y/N) grew by 3% per year between 2014 and 2022, while, due to demographic ageing, the share of the working-age population in the total population (P*/N) decreased by 2% per year in the same period.

a) If average labour productivity (Y/L) grew by 2% per year in this period, compute by how much the employment rate (L/P*) grew in this period.

b) Consider the data from (a) and assume further that the working-age population remained constant throughout the same period; that the average wage decreased by 5% per year; that the retired population increased by 2%; and that the both the rate of social security contribution and the contribution from the government budget to the social security remained unchanged. Under these assumptions, what was the annual rate of change in the average pension?

10.5 Discuss the following statement: “Population ageing in advanced economies can only be adequately addressed through a combination of delaying the retirement age and reducing the average pension.”

10.6 If, in country A, GDP per capita grew in 2022 by 3.4%, average labour productivity grew by 1.6% but the ratio of employed persons to old-age pensioners has remained constant, what conclusion can you draw regarding the share of old-age pensioners in this population?

10.7 Discuss the main risks posed by a private fully-funded social security system compared to a publicly-funded pay-as-you-go system.

Aula prática 10: Apresentação e discussão de textos. Tema 4 – Política industrial

Aula prática 11: Apresentação e discussão de textos. Tema 5 – Dilemas do crescimento económico português

Aula prática 12: Exercícios de revisão