

DYNAMIC POLITICAL EFFECTS
IN A NEOCLASSIC GROWTH
MODEL WITH HEALTHCARE
AND CREATIVE ACTIVITIES

LUIS GUIMARÃES ¹
ÓSCAR AFONSO ^{1 2 3}
PAULO B. VASCONCELOS ^{1 3 4}

¹ FACULDADE DE ECONOMIA, UNIVERSIDADE DO PORTO

² CEF.UP, NIFIP

³ OBEGEF,

⁴ CMUP

U. PORTO

FEP FACULDADE DE ECONOMIA
UNIVERSIDADE DO PORTO

Dynamic political effects in a neoclassic growth model with healthcare and creative activities

Luís Guimarães,^{*}Oscar Afonso,[†]and Paulo B. Vasconcelos[‡]
Faculdade de Economia da Universidade do Porto
Rua Roberto Frias 4200-464 Porto, Portugal

November 14, 2011

Abstract

This paper incorporates healthcare and creative activities in the Ramsey-Cass-Koopmans model in order to analyse the endogenous growth effects arising from governmental policies. An increase in lump-sum taxes and inefficient expenditures decrease the short, medium and the long-run economic growth.

Keywords: Neoclassical economic growth; Governmental policies; Healthcare and creative activities; Numerical analysis.

JEL classification Codes: O47, J20, C63.

^{*}Faculdade de Economia, Universidade do Porto.

[†]CEFUP, OBEGEF, NIFIP and Faculdade de Economia, Universidade do Porto. Please address correspondence to Oscar Afonso oafonso@fep.up.pt; +351225571100 (phone); +351225505050 (fax).

[‡]CMUP, OBEGEF and Faculdade de Economia, Universidade do Porto.

1 Introduction

By considering microeconomic foundations, the Ramsey-Cass-Koopmans (RCK) model has made a great impact in the economic growth literature; however, the long-term economic growth remains unexplained (e.g., Acemoglu 2009, chs. 2, 3 and 8).

In the original RCK model, agents maximize their lifetime utility, dependent on the consumption level, and their labour supply is assumed to be constant. These assumptions are restrictive; for example, the number of hours worked by each individual is not constant through time and leisure, in which healthcare and creative activities are included, affects positively the utility (e.g., Fogel 2000, Ramey and Francis 2009).

The paper extends the RCK model to cope with its weakness, allowing that a well-known and established model be used to analyse the economic growth effects arising from governmental policies (e.g., Irmen and Kuehnel, 2009). In line with Fogel (2000) and Ramey and Francis (2009), among others, the utility function is modified to consider the fraction of time each individual devotes to healthcare and creative activities.¹ In this context, governmental expenditures financed by lump-sum taxes and inefficient expenditures lead to a decrease in the short, medium and long-run economic growth.

After these introductory remarks, the paper proceeds to characterize the set-up of the model. Then, the dynamic general equilibrium is derived and, resorting to numerical computation, steady state and transitional dynamics are analyzed. Finally, the paper ends with some concluding remarks.

2 Set-up of the model

It is assumed that agents live infinitely and that the economy is populated by an invariant large set of identical households. Households divide their time between work to earn an income, and healthcare and creative activities. Additionally, they decide to spend part of their income directly on consumption and lend another part in return for future interest. The fraction of the output that is not consumed is used in investment. Also, the output of the economy is produced in perfect competition by using labour and physical capital.

¹In order to isolate the effect of healthcare and creative activities on agents decisions, endogenous human-capital accumulation is not considered.

2.1 Consumers

The aim of households is to maximize their lifetime utility given by

$$U(C(t), i(t)) = \int_{t=0}^{+\infty} e^{-\rho t} \left[\ln C(t) - \frac{(1-i(t))^{1+\varphi}}{1+\varphi} \right] dt, \quad (1)$$

where $\rho > 0$ is the discount rate, C is the consumption, i is the fraction of time used for healthcare and creative activities, and $\varphi > 0$ is a labour coefficient as a proxy for the temporal elasticity of substitution of labour. They have to make a decision on how to split their labour time between work, and healthcare and creative activities: by working they have a higher income, while through healthcare and creative activities they yield a higher utility. The intuition behind (1) is that households like to postpone the entrance in the labour market;² yet, as time passes, individuals do not value this postponement and thus they prefer to work once achieved a certain age.

Households accumulate assets, a , in the form of physical capital. Those assets earn returns at the interest rate $r(t)$. Households's assets stock is affected by net savings, given by the difference between income (interest and wages, w) and consumption. The flow budget constraint is

$$\dot{a}(t) = r(t)a(t) + w(t)[1-i(t)] - C(t) \quad (2)$$

where $\dot{a}(t)$ is the change in the assets stock, and $1-i$ is the fraction of time devoted to work.

Households maximize lifetime utility subject to the budget constraint and the “no Ponzi games” condition ($\lim_{t \rightarrow \infty} a(t)e^{-\rho t} = 0$). The solution for the consumption path, which is independent of the household, is the standard Euler equation

$$\frac{\dot{C}(t)}{C(t)} = r(t) - \rho, \quad (3)$$

where $\dot{C}(t)$ is the change in aggregate consumption. Moreover, the resulting expression for i is

$$i(t) = 1 - \left[\frac{w(t)}{C(t)} \right]^{\frac{1}{\varphi}}, \quad (4)$$

²Thus, the focus is on the particular channel related to the postponement of the entrance in the labour market. This channel also accommodates the possibility of agents to switch from working to healthcare and creative activities, and vice versa.

which implies that the fraction of time devoted to healthcare and creative activities depends positively on consumption but negatively on wages. Higher wages imply higher opportunity cost connected with healthcare and creative activities and thus more time is devoted to work.

2.2 Productive structure

Following the usual RCK approach, the production function has constant returns to scale in capital, K , and labour, $L(1 - i)$, the Inada conditions are satisfied and Harrod-neutral technological-knowledge progress is considered:

$$Y(t) = K(t)^\alpha [A(t)L(t)(1 - i(t))]^{1-\alpha}, \quad (5)$$

Representing the capital and output per unit of effective household, respectively, $k(t) = \frac{K(t)}{A(t)L(t)} = \frac{K(t)}{A(t)}$ and $y(t) = \frac{Y(t)}{A(t)L(t)} = \frac{y(t)}{A(t)}$, since, without loss of generality, the number of households, L , is normalised to 1. Function (5) can then be rewritten as

$$y(t) = \frac{k(t)^\alpha}{(1 - i(t))^{1-\alpha}}, \quad (6)$$

The change of technological-knowledge progress, \dot{A} , depends positively on i (healthcare and creative activities)

$$\dot{A}(t) = i(t)A(t), \quad (7)$$

What is implicit in (7) is that the increase in technological-knowledge progress is an externality from healthcare and creative activities, and since there is a very high number of agents, the impact of each of them on the technological-knowledge progress is almost null.

Under competitive markets each input earns its marginal product; thus,

$$w(t) = \frac{\partial y(t)}{\partial(1 - i(t))} = (1 - \alpha) \left[\frac{k(t)}{1 - i(t)} \right]^\alpha, \quad (8)$$

$$r(t) = \frac{\partial y(t)}{\partial k(t)} - \delta = \alpha \left[\frac{1 - i(t)}{k(t)} \right]^{1-\alpha} - \delta, \quad (9)$$

where δ is the discount rate of capital. It is important to note from (7) and (8), that the increase in technological-knowledge progress by the fraction of time i is not remunerated with wages: there is only an indirect impact on wages by the

increase in A . Intuitively, households engage in healthcare and creative activities to have higher utility and not because they are increasing others productivity.

The expression for i in (4) can be rewritten considering (8).

3 Laws of motion

Since physical capital in the economy is $K(t) = a(t)L = a(t)$, then the capital per unit of effective household is $k(t) = \frac{a(t)}{A(t)}$. Now, bearing also in mind (7), (8) and (9) in (2) yields the following path for k :

$$\dot{k}(t) = k(t)^\alpha [1 - i(t)]^{1-\alpha} - k(t) [\delta + i(t)] - c(t), \quad (10)$$

where $c(t) = \frac{C(t)}{A(t)L(t)} = \frac{C(t)}{A(t)}$ is the consumption per unit of effective household. This equation states that the change $k(t)$, $\dot{k}(t)$, is equal to the difference between savings, $k^\alpha(1 - i)^{1-\alpha} - c$, and break even investment, $k[\delta + i]$.

Considering the Euler equation (3) and (9), the path of $c(t)$ is

$$\dot{c}(t) = c(t) [\alpha k(t)^{\alpha-1} (1 - i(t))^{1-\alpha} - i(t) - \delta - \rho]. \quad (11)$$

4 General equilibrium

Once characterised the country's economic structure, we now proceed to analyse the implications of healthcare and creative activities, which play a crucial role in the dynamic general equilibrium. We start with the steady state and then we analyse the transitional dynamics, by solving numerically the model and using the following set of baseline parameter values: $\rho = 0.05$, $\varphi = 4$, $\delta = 0.05$ and $\alpha = 0.4$.

4.1 Steady-state and transitional dynamics

The steady state can be easily computed by solving the system of nonlinear equations (10) and (11) for $\dot{k} = \dot{c} = 0$. The phase-diagram is depicted by Figure 1 in which is also represented the stable saddle path (the eigenvalues of the Jacobian matrix evaluated at the steady state are -0.2443 and 0.1640).

The $\dot{c} = 0$ curve is different from the one in the original RCK model, which is a vertical line. In this model, as the capital per unit of effective household increases, initially the consumption per unit of effective household decreases

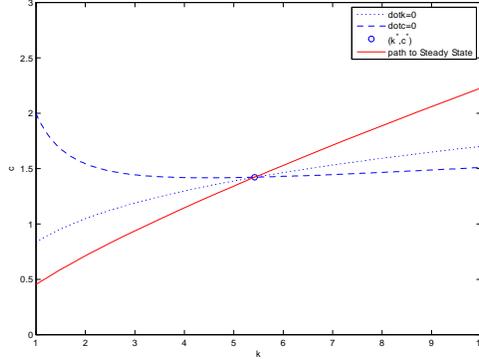


Figure 1: Phase diagram

until a certain level of k . Regarding the $\dot{k} = 0$ curve, to keep k constant, the higher is c the higher has to be k . In order to exist convergence to the steady-state, both c and k must evolve in the same direction.

4.2 Government intervention

Following Romer (2006), the government buys output at rate G per unit of effective household. Additionally, it is assumed that G does not affect utility directly, is only used as public consumption, and is financed with lump-sum taxes. In this case, equation (10) becomes:

$$\dot{k}(t) = k(t)^\alpha(1 - i(t))^{1-\alpha} - k(t)[\delta + i(t)] - c(t) - G. \quad (12)$$

A change of G from 0 to 0.1 is now considered.

The resulting effects in the phase diagram are plotted in Figure 2. In turn, Figure 3 depicts the immediate (short run), transitional dynamics (medium run) and the steady state levels (long run) of all relevant variables.³

Variable c jumps down due to the adjustment by households (immediate level effect), which does not occur in k . These two variables increase during the transitional phase towards their new steady state levels.

The immediate impact on wages results from the increase in the labour

³That is, c , k , wages per unit of effective labour, interest rate, fraction of leisure time and path of the total capital and total output growth rates (which, since the number of households is fixed, are equivalent to the growth rates of output and capital per capita).

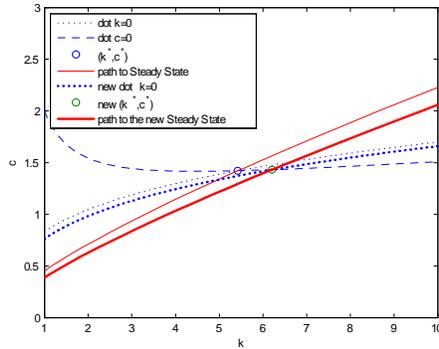


Figure 2: Phase diagram with and without government intervention

supply. As the fraction of time devoted to healthcare and creative activities jumps down, labour supply increases and thus wages decrease. Then, during the transitional phase, k increases and thus also the marginal productivity of labour; hence, the demand for labour and wages rise. In order to smooth the utility, households work less and the labour supply decreases, which also affects positively wages.

However, in the new steady-state the fraction of time households devote to healthcare and creative activities falls in comparison to the previous steady state. This results from the fact that wages are higher than before while consumption is more or less the same; households face a higher opportunity cost of healthcare and creative activities.

Bearing in mind the behaviour of c and i , in the new steady state households reach lower utility. This also means, that after an increase in the government inefficiency totally financed by lump-sum taxes yield a lower growth-rate of technological knowledge arising from healthcare and creative activities.

The path of the interest rate has the opposite explanation to the one for wages per unit of effective labour. Initially, due to the jump up in the labour supply, the marginal return of investing in capital increases. On the other hand, in transition dynamics, since k is increasing and labour supply is falling, capital becomes a relatively abundant input and its marginal return falls.

Initially, k does not change. However, the growth rate of technological knowledge falls at the time of this change leading to a fall in the growth rate of capital, K . Immediately after, k starts increasing and additionally technological knowl-

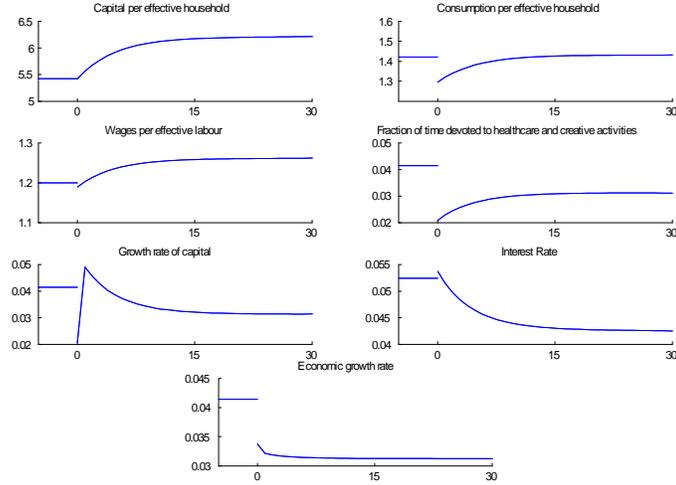


Figure 3: Impact of government intervention on the relevant variables over time

edge starts increasing at higher rates. These two facts together, lead to higher growth-rate of K than in the previous steady state. During the transition towards the new steady state, k is increasing at decreasing rates, which explains the fall in the growth rate of K . In the new steady-state, K grows at the rate of technological knowledge, which, in turn, is now lower than before.

As initially i decreases and k stays constant, there are two forces influencing the impact in the growth rate of output: the increment in the labour supply and the fall in the growth rate of technological knowledge, being, in this particular case, the latter stronger than the former. During the transitional phase, although capital and technological knowledge are increasing, the fall in the labour force lead to a fall in the growth rate of output. Hence, in the long run, an increase in the government inefficiency completely financed by lump-sum taxes lead to lower growth-rate of output.

5 Concluding remarks

This paper presents an endogenous version of the simpler Ramsey-Cass-Koopmans model, by introducing two new features: the decision of households regarding their healthcare and creative activities responsible for the technological knowl-

edge and an inefficient government, which expenditures are fully financed by lump-sum taxes.

In this context, a lower growth-rate of the economy can be observed. Households, concerned about the future, decrease consumption more than the increase in the government expenditures (in the original RCK model households fall consumption by the exact amount of the government expenditures). Therefore, they have a higher disposable income to invest in assets thus increasing future income. Moreover, they immediately dedicate less time to healthcare and creative activities. Then, towards the new steady state, they will increase at decreasing rates the time devoted to these activities. As a result, households expect to have a better life in the future than if they simply accommodated the increase in government expenditures with a fall in consumption.

However, to keep their level of assets in the new steady state, they have to work more even though they are consuming a bit more. Consequently, they devote less time to healthcare and creative activities and thus the growth-rate of technological knowledge falls.

6 References

Acemoglu, D. (2009). *Introduction to Modern Economic Growth*. Princeton University Press.

Fogel, R. (2000). *The Fourth Great Awakening and the Future of Egalitarianism*. Chicago and London: University of Chicago Press.

Irmen, A. and J. Kuehnel (2009). “Productive government expenditure and economic growth.” *Journal of Economic Surveys*, Vol. 23, pp. 692-733.

Ramey, V., Francis, N. (2009). A Century of work and leisure. *American Economic Journal: Macroeconomics*, 1(2), 189-224.

Romer, D. (2006). *Advanced Macroeconomics*. 3rd edition, McGraw-Hill.

Recent FEP Working Papers

Nº 440	João Pedro Nogueira and Aurora A.C. Teixeira, " <u>Determinantes do empreendedorismo académico na área das ciências da vida em Portugal</u> ", November 2011
Nº 439	Pedro Oliveira and Aurora A.C. Teixeira, " <u>The internationalization profiles of Portuguese SMEs</u> ", November 2011
Nº 438	Joana Filipa Lourenço Garcia, Francisco Vitorino da Silva Martins and Elísio Fernando Moreira Brandão, " <u>The Impact of Working Capital Management upon Companies' Profitability: Evidence from European Companies</u> ", November 2011
Nº 437	Marta Rodrigues Monteiro, Elísio Fernando Moreira Brandão and Francisco Vitorino da Silva Martins, " <u>A Panel Data Econometric Study of Corporate Tax Revenue in European Union: Structural, Cyclical Business and Institutional Determinants</u> ", November 2011
Nº 436	João Rebelo Barbosa and Rui Henrique Alves, " <u>Divergent competitiveness in the eurozone and the optimum currency area theory</u> ", November 2011
Nº 435	Álvaro Almeida and José Pedro Figue, " <u>Evaluating Hospital Efficiency Adjusting for Quality Indicators: an Application to Portuguese NHS Hospitals</u> ", November 2011
Nº 434	Octávio Figueiredo, Paulo Guimarães and Douglas Woodward, " <u>Firm-Worker Matching in Industrial Clusters</u> ", October 2011
Nº 433	Susana Assunção, Rosa Forte and Aurora A.C. Teixeira, " <u>Location Determinants of FDI: a Literature Review</u> ", October 2011
Nº 432	António Brandão, Luís Guimarães and Carlos Seixas, " <u>The Relationship between Trigger Price and Punishment Period in Green and Porter (1984) Game made Endogenous</u> ", October 2011
Nº 431	Argentino Pessoa, " <u>The Cluster Policy Paradox: Externalities vs. Comparative Advantages</u> ", October 2011
Nº 430	Susana Assunção, Aurora A.C. Teixeira and Rosa Forte, " <u>Do Countries' Endowments of Non-renewable Energy Resources Matter For FDI Attraction? A Cross-country Econometric Analysis</u> ", October 2011
Nº 429	Óscar Afonso and Armando Silva, " <u>Non-scale endogenous growth effects of subsidies for exporters</u> ", September 2011
Nº 428	Mariana Dias and Aurora A.C. Teixeira, " <u>Geopolítica e International Business: uma tentativa de síntese e proposta de enquadramento teórico para aplicação prática</u> ", September 2011
Nº 427	Carina Silva and Aurora A.C. Teixeira, " <u>Empreendedorismo político local em Portugal. Uma análise exploratória</u> ", September 2011
Nº 426	Marta Couto and Aurora A.C. Teixeira, " <u>Festivais de Música de Verão em Portugal: determinantes da participação e a identificação dos seus patrocinadores</u> ", September 2011
Nº 425	Luis Carvalho and Aurora A.C. Teixeira, " <u>Where are the poor in International Economics?</u> ", September 2011
Nº 424	Maria Inês Veloso Ferreira and Aurora A.C. Teixeira, " <u>Organizational Characteristics and Performance of Export Promotion Agencies: Portugal and Ireland compared</u> ", September 2011
Nº 423	Pedro Cosme Costa Vieira, " <u>Está na hora de Portugal sair da Zona Euro</u> ", September 2011
Nº 422	Márcia Daniela Barbosa Oliveira and João Gama, " <u>How we got Here? A Methodology to Study the Evolution of Economies</u> ", July 2011
Nº 421	Vitor M. Carvalho and Manuel M. F. Martins, " <u>Macroeconomic effects of fiscal consolidations in a DSGE model for the Euro Area: does composition matter?</u> ", July 2011
Nº 420	Duarte Leite, Pedro Campos and Isabel Mota, " <u>Computational Results on Membership in R&D Cooperation Networks: To Be or Not To Be in a Research Joint Venture</u> ", July 2011
Nº 419	Sandra T. Silva, Isabel Mota and Filipe Grilo, " <u>The Use of Game Theory in Regional Economics: a quantitative retrospective</u> ", June 2011
Nº 418	Marisa R. Ferreira, Teresa Proença and João F. Proença, " <u>An Empirical Analysis about Motivations among Hospital Volunteers</u> ", June 2011
Nº 417	Marlene Grande and Aurora A.C. Teixeira, " <u>Corruption and Multinational Companies' Entry Modes. Do Linguistic and Historical Ties Matter?</u> ", June 2011

Nº 416	Aurora A.C. Teixeira, " Mapping the (In)visible College(s) in the Field of Entrepreneurship ", June 2011
Nº 415	Liliana Fernandes, Américo Mendes and Aurora A.C. Teixeira, " A weighted multidimensional index of child well-being which incorporates children's individual perceptions ", June 2011
Nº 414	Gonçalo Faria and João Correia-da-Silva, " A Closed-Form Solution for Options with Ambiguity about Stochastic Volatility ", May 2011
Nº 413	Abel L. Costa Fernandes and Paulo R. Mota, " The Roots of the Eurozone Sovereign Debt Crisis: PIGS vs Non-PIGS ", May 2011
Nº 412	Goretti Nunes, Isabel Mota and Pedro Campos, " Policentrismo Funcional em Portugal: Uma avaliação ", May 2011
Nº 411	Ricardo Biscaia and Isabel Mota, " Models of Spatial Competition: a Critical Review ", May 2011
Nº 410	Paula Sarmiento, " The Effects of Vertical Separation and Access Price Regulation on Investment Incentives ", April 2011
Nº 409	Ester Gomes da Silva, " Portugal and Spain: catching up and falling behind. A comparative analysis of productivity trends and their causes, 1980-2007 ", April 2011
Nº 408	José Pedro Figue, " Endogenous Response to the 'Network Tax' ", March 2011
Nº 407	Susana Silva, Isabel Soares and Carlos Pinho, " The impact of renewable energy sources on economic growth and CO2 emissions - a SVAR approach ", March 2011
Nº 406	Elena Sochirca and Sandra Tavares Silva, " Efficient redistribution policy: an analysis focused on the quality of institutions and public education ", March 2011
Nº 405	Pedro Campos, Pavel Brazdil and Isabel Mota, " Comparing Strategies of Collaborative Networks for R&D: an agent-based study ", March 2011
Nº 404	Adelaide Figueiredo, Fernanda Figueiredo, Natália P. Monteiro and Odd Rune Straume, " Restructuring in privatised firms: a Statis approach ", February 2011
Nº 403	Cláudia M. F. Pereira Lopes, António Cerqueira and Elísio Brandão, " The financial reporting quality effect on European firm performance ", February 2011
Nº 402	Armando Silva, " Financial constraints and exports: evidence from Portuguese manufacturing firms ", February 2011
Nº 401	Elena Sochirca, Óscar Afonso and Pedro Mazedra Gil, " Directed technological change with costly investment and complementarities, and the skill premium ", January 2011
Nº 400	Joana Afonso, Isabel Mota and Sandra Tavares Silva, " Micro credit and Territory - Portugal as a case study ", January 2011
Nº 399	Gonçalo Faria and João Correia-da-Silva, " The Price of Risk and Ambiguity in an Intertemporal General Equilibrium Model of Asset Prices ", January 2011
Nº 398	Mário Alexandre Patrício Martins da Silva, " A Model of Innovation and Learning with Involuntary Spillovers and absorptive capacity ", January 2011
Nº 397	Fernando Governo and Aurora A.C. Teixeira, " Marketing and technology sophistication as hidden weapons for fostering the demand for 'art house' cinema films: a cross country analysis ", January 2011
Nº 396	Liliana Fernandes, Américo Mendes and Aurora A.C. Teixeira, " A review essay on child well-being measurement: uncovering the paths for future research ", December 2010
Nº 395	David Nascimento and Aurora A.C. Teixeira, " Recent trends in the economics of innovation literature through the lens of Industrial and Corporate Change ", December 2010
Nº 394	António Brandão, João Correia-da-Silva and Joana Pinho, " Spatial competition between shopping centers ", December 2010
Nº 393	Susana Silva, Isabel Soares and Óscar Afonso, " E3 Models Revisited ", December 2010

Editor: Sandra Silva (sandras@fep.up.pt)

Download available at:

<http://www.fep.up.pt/investigacao/workingpapers/>

also in <http://ideas.repec.org/PaperSeries.html>

www.fep.up.pt

FACULDADE DE ECONOMIA DA UNIVERSIDADE DO PORTO

Rua Dr. Roberto Frias, 4200-464 Porto | Tel. 225 571 100

Tel. 225571100 | www.fep.up.pt