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POLITICAL RIVALRY EFFECTS ON HUMAN CAPITAL ACCUMULATION AND INEQUALITY: A NEW POLITICAL ECONOMY APPROACH

Elena Sochirca, Oscar Afonso and Sandra T. Silva*
NIPE and CEFUP, Portugal, Universidade do Porto, Faculdade de Economia, Portugal and Universidade do Porto, Faculdade de Economia, CEFUP, Portugal

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ABSTRACT

We propose an endogenous growth model with new political economy elements in order to (1) examine how political incentives affect economic allocations and (2) study the effects of political rivalry on human capital accumulation and income inequality. Focusing on two important policies affecting economic performance—fiscal policy and public investments in human capital accumulation—we find that different political incentives have distinct effects on policies and economic allocations. We also find that political rivalry increases income inequality and reduces economic growth and human capital accumulation through its negative impact on public investments in education, wages and individual learning choice.

1. INTRODUCTION

Understanding how political institutions influence and determine economic outcomes has become one of the most challenging questions of modern economic theory. Related economic analysis of political institutions attributes considerable importance to their role in defining aggregate economic performance both from a theoretical and a practical, policy-making perspective. For example, studies of political incentives and political institutions argue that policy cannot be viewed as an exogenous process, playing a central role in explaining differences in growth rates across countries (e.g. Persson and Tabellini, 1992; Acemoglu and Robinson, 2000; Acemoglu,

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2006). In many contexts of new political economy, the need to jointly model political and economic mechanisms and their interaction is emphasized (see e.g., Sayer, 2000). Existing empirical evidence also indicates that political processes have a crucial impact on resulting economic policies and outcomes (e.g. Alesina and Rodrik, 1992; Perotti, 1996).

We propose an overlapping generations model with elements of new political economy to examine how different political incentives and policies may affect the resulting economic allocations and study the effects of political rivalry on human capital accumulation and income inequality. With this objective, we combine elements of endogenous growth theory and new political economy by considering human capital accumulation as the engine of endogenous growth and accounting for the crucial role of institutions in securing undistorted economic outcomes. In analysing the impact of political institutions, we focus on two important policies affecting economic performance: fiscal policy and provision of public goods in the form of investments in human capital accumulation via publicly provided education. This choice is motivated by the similarity in the targeted effects of both human capital accumulation and efficient redistribution, such as decreasing inequality, correcting possible institutional or economic failures, stimulating investments, improving economic performance and increasing growth. Our research framework relies on the idea that, being the basis for long-term economic development and one of the key factors influencing aggregate productivity and individual income, human capital accumulation is a fundamental macroeconomic policy, the significance of which cannot be neglected and for which political effects have a critical role. We also consider that understanding the determinants of income and income inequality is particularly important in what regards vertical and intergenerational social mobility.

The present work relates to the increasing literature on: (1) the relationship between income redistribution, inequality and growth; (2) the political economy of growth. In particular, as regards the possible effects of redistribution on income inequality and growth, our model accommodates some of the important conclusions of existent theoretical and empirical research. Considering the negative effects, in consistency with the hypothesis advanced by the theories, early cross-country analyses have established a negative association between the level of inequality and economic growth through the distortionary nature of taxation, emphasizing that anticipated distortionary redistribution will lower the incentives to accumulate and thus may hamper growth (e.g. Alesina and Rodrik, 1992; Perotti, 1996; Drazen, 2001). As for the positive effects, Perotti (1992) shows how in economic structures with public investments in education the effect of taxes on

growth is positive, a conclusion also supported in the relationship between Alesina and Rodrik (1992) and Persson and Tabellini (1992). In a later study, Perotti (1996) also shows that higher inequality is indeed associated with a lower level of human capital accumulation, and lower human capital accumulation is associated with lower levels of economic growth. Recently, the cross-country analysis of Easterly (2007) reaffirmed that human capital accumulation and economic development are adversely affected by inequality, which is a barrier to schooling and economic growth. An inverse relationship is modeled in Chatterjee and Turnovsky (2010), who view public investments in education both as the growth engine and an important determinant of inequality. Finally, there are some studies that integrate both positive and negative effects, by considering that, at different levels of economic development, inequality may have a dual impact on growth (e.g. Saint Paul and Verdier, 1996; Perotti, 1996; Galor and Moav, 2004).

Regarding the political economy of growth, directed research that combines economic analysis with political economy elements refers to political rivalry as a key element affecting economic performance (e.g. Dixit *et al.*, 2000; Acemoglu, 2006; Bar-El, 2009). The effects of political rivalry are generally associated with breaking the balance between political power and economic opportunities, thus negatively affecting the relation between political institutions, redistribution and economic outcomes. For example, Rodrik (1999) suggests that disagreements between political groups may inflict an extra cost on the economy, as well as Acemoglu and Robinson (2001) and Dixit and Londregan (1995), who suggest that contesting political power (resulting in inefficient redistribution) may induce economic costs due to its growth retarding effects. Success or failure of implemented economic policies then depends on how prevailing institutions manage political rivalry. As regards the specific approach adopted in this work, we follow Acemoglu (2006, 2009), who considers a (negative) political competition arising when enrichment by other social groups poses a threat to the elite's ability to benefit from their political power in the future. Thus, we regard political rivalry as the interparty political competition for power of both economic and political nature, aimed at keeping the political elite in the office and in control for as long as possible. As such, political rivalry may arise in both democratic and nondemocratic regimes and thus its existence is independent of the political system, varying only in degrees of intensity and forms of manifestation (see e.g. Acemoglu, 2006). Given that in the presence of political rivalry goals pursued by the political elite, instead of economic efficiency considerations, determine the policy choice, it reflects how political constraints may explain the choice of policies, and thus economic outcomes. As in Acemoglu (2006), in our model political rivalry

arises in the form of political competition against replacement and political incentives in public policy, and we then consider that excessive taxes are beneficial for the elite as a way of impoverishing their political competitors. Political rivalry then becomes a key distorting factor in our model.

Our goal to model the economic and social consequences of political decisions in a framework of knowledge-driven economic growth is also motivated by some historical examples and recent empirical evidence. For example, today's prosperity level of many rich countries can be traced to the British Industrial Revolution opening path to major technological change and resulting in remarkable social improvements, higher incomes and economic growth. Even so, initially the political elite was strongly opposed to it because allowing for institutions that create conditions favouring industrialization implied, at the same time, allowing the possibility of new income and power redistribution and a loss of welfare for the ones already holding political power. Thus, the elite's fear of losing political and economic power created, at first, strong incentives to resist technological and economic progress.[1] Gradually, the industrialization process raised the importance of human capital in the production process, reflecting its complementarity with physical capital and technology. And, although in the beginning of industrialization the demand for skilled workers was low due to the very simple initial requirements in industrial work, a higher and broader level of education was subsequently required as industrialization grew apace and industrial work became more and more demanding. Thus, in the UK, political reforms were effective in promoting education among children,[2] and rents derived from the industrial sector's spillovers contributed to increase the elite's economic incentives to support education (surpassing the respective costs). Human capital accumulation then contributed decisively to the transition from stagnation to growth.[3] More recently, the empirical work by Sochirca *et al*. (2016) specifically examines political rivalry effects on several macroeconomic variables. Their results showed that higher degrees of political rivalry are associated with lower *per capita* income, and that political rivalry has a strong adverse effect both on public investments in education and income inequality, especially in lower income countries and countries with higher inequality levels, respectively.

In line with our research objective, we will analyse how (1) redistribution through public education influences income levels and human capital

[1] Extensive historical evidence of the Industrial Revolution's economic and social consequences can be found, for example, in the synthetic analysis by Acemoglu and Robinson (2012).
[2] See, for example, Flora *et al*. (1983), Green (1990) and Mokyr (1990).
[3] See for example, Voigtländer and Voth (2006), Galor and Weil (2000) and Galor (2011).

accumulation in the economy; (2) political rivalry may affect policy efficiency. Our analytical framework combines elements from the study of Glomm and Ravikumar (2003) examining the evolution of inequality in an overlapping generations model with human capital accumulation, extended by: (1) the introduction of a final-goods production sector and (2) endogenous new political economy elements as suggested by Acemoglu (2006). Introducing a production sector in the economy allows us to specifically derive the equilibrium income and its growth rate. Considering endogenous fiscal and public investment policies allows for a richer analysis of economic results, accounting for the effects of the inherent political mechanisms and political rivalry and enabling us to show how political processes may distort the efficiency of economic interactions. Our analysis also suggests distinct perspectives as regards public policies targeting investments in education and inequality.

We find that increasing the tax rate will increase public investments in education only when taxes are chosen without political rivalry considerations. When taxes are excessively increased due to political rivalry, the result will be lower educational investments, reduced individual learning incentives and limited human capital accumulation, which will lower production, wages and consequently may deepen or prolong income inequality. This implies that only in the absence of political rivalry public investments in education can be used as an efficient social mobility promoter, enabling income convergence and overcoming inequality. Thus, our findings confirm that political rivalry produces negative outcomes in all dimensions. We also find that the elasticities of human capital accumulation with respect to public and private investments have crucial implications for the role of political institutions and require particular attention to the political rivalry effects.

The structure of this paper is the following. In section 2, we outline our model's specifications and derive equilibrium values for our main variables regarding productive activities, human capital accumulation, optimal policy choice and income inequality. Section 3 includes the comparative statics analysis focusing on the effects of public investments policy and political rivalry. In section 4, conclusions and references for possible future research are presented. Mathematical detail for the comparative statics analysis of section 3 is provided in the Appendix.

2. MODEL SPECIFICATIONS

We consider an overlapping generations economy with constant population. The economy consists of a continuum of risk-neutral agents

$1+S^e+S^m$, each with a discount factor equal to $\beta \in (0,1)$. We assume there is a total of S^e elite agents, S^m middle-class agents and a continuum of workers,[4] with a measure normalized to 1.[5] In this model, the elite, denoted by *e*, represents the social group of agents that hold the political power in the society, decide on policies and do not take part in productive activities. We make this assumption in order to emphasize the effects of political economy and show how a decoupling between political and economic power can lead to political rivalry, higher degrees of distortions in policy and poor economic outcomes. The middle class, denoted by *m*, are the entrepreneurs in the economy with access to the final good production technology. We emphasize that in our model, belonging to either the elite or the middle-class does not refer to social group membership over time, but reflects the difference in an agent's behaviour when in power or not. For example, an agent who is not in power today behaves as middle-class, but the same agent will behave as the elite if coming into power tomorrow.[6]

Finally, the workers, who supply their labour inelastically, are employed by the middle-class entrepreneurs for producing the final good. We also assume that in each period workers are differentiated by the amount of parental income invested in their education and by the human capital stock they accumulate depending (among other things) on their individual learning choice and on fiscal and public education policies adopted by the elite.

[4] We divide our model's agents into these three social groups following the terminology frequently used in the new political economy literature.

[5] Please note that, although the (implicit) fertility rate is considered exogenous in our model's specific framework, it is also possible to endogenously relate population growth to quality-quantity trade-offs (see e.g. Barro and Becker 1989; Galor and Moav 2004), which, on their turn, could result from an increase in human capital used in production, and consequently an increase in wages and learning incentives on the one hand, and the elite's decisions on public spending on the other hand. In this context, a possible decline in the fertility rate due to a higher cost of raising more skilled children could be (partly) restrained by the elite's investments in public education. For now, we leave this extension to our model as a possible venue for future research. Alternatively, Fanati and Manfredi (2003) argue that representative scenarios of a modern economy should consider unemployment rates/employment status as one of the key economic determinants of individual fertility choices.

[6] In order to keep the model tractable in the light of its main research objectives, we do not consider the election cycles and voting procedures explicitly. However, we note that these issues are very interesting research topics on their own, in particular in the light of the ongoing debate regarding the impact of institutions on growth. For example, their explicit consideration would allow analysing the very important hold-up and commitment problems, particularly relevant as regards the long-term impact factors (such as human capital accumulation and efficient institutions) on sustained economic growth and development. For some additional information on these topics, the reader may find interesting the works by, for example, Chari and Kehoe (1990) on strategic political decisions, and Singer and Carlin (2013) and Mikesell (1978) on election cycles.

2.1 Middle-class entrepreneurs and productive activities

For producing the final good, each middle-class entrepreneur has access to the following Cobb-Douglas Harrod-neutral production function:

$$Y_t \equiv F(K_t, G_t) = (K_t)^{\alpha}(A_t \cdot G_t)^{(1-\alpha)} \tag{1}$$

where Y_t is the final-good output produced in t by each entrepreneur, K_t is capital used, A_t is the aggregate labour-augmenting productivity term, and G_t is the total contribution of workers to final good production, such that $G_t = L_t \cdot H_t$, with L_t being the total amount of labour used in t and H_t the total amount of human capital that each worker is endowed with in period t. The use of a Cobb-Douglas production technology allows us solving for the political equilibrium analytically and, as it will be seen further, also links equilibrium taxes and public investments in education to the elasticity of output with respect to capital.

In order to derive the steady-state capital stock per unit of human capital and final output, we assume that, at each t, the economy starts with two predetermined variables: the output tax rate, τ_t, and the capital stocks of the middle-class entrepreneurs, K_t. We assume that the linear tax on output, τ_t, is applied by the elite to middle-class production for raising state revenues. As it will be shown in section 2.3, τ_t is endogenously determined in our model depending on political rivalry considerations of the politically powerful social group, i.e. the elite. As in Acemoglu (2006), we also assume that taxes are set before the entrepreneurs make their investment decisions, namely, that their capital and labour stocks for the next date are chosen after observing the tax rate previously announced by the elite. Then, final output is produced, and a fraction τ_t of the output is collected as tax revenue.

Denoting by $k \equiv \frac{K}{G}$ the capital stock per unit of human capital, we can rewrite equation (1) as $f(k) = A^{(1-\alpha)} \cdot k^{\alpha}$, where $f \equiv \frac{F}{G}$. Then, assuming that a fraction δ of capital depreciates, we can write the utility of an entrepreneur with a capital stock per unit of human capital k at time t as a function of the announced fiscal policy.[7] In particular, given a predetermined tax rate on output, τ_t, the utility of a middle-class entrepreneur can be written as:[8]

[7] In defining the middle-class entrepreneurs' utility we assume that preferences are linear, as in Acemoglu (2009), and thus the value function can be written as a discounted sum of gross production levels (i.e. before subtracting labour costs).

[8] We call equation (2) a 'utility function' in the sense that, given a specific fiscal policy, it will define the entrepreneurs' welfare level in equilibrium.

$$U^m(k_t, \tau_t, \delta) = \sum_{s=t}^{\infty} \beta^{s-t}((1-\tau_s)f(k_s) + (1-\delta)k_s - k_{s+1}) \tag{2}$$

Maximizing (2) with respect to each entrepreneur's choice of the next period capital stock per unit of human capital, k_{t+1}, yields the capital stock per unit of human capital that must satisfy:

$$\beta[(1-\tau)f'(k_{t+1}) + 1 - \delta] = 1 \tag{3}$$

Because of linear preferences, expression (3) applies for all t and using the above defined production function, $f(k_i)$, implies:

$$k^* = A_t \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)}\right)^{\frac{1}{\alpha-1}} \tag{4}$$

$$F(K^*, G) = A_t \cdot G_t \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}} \tag{5}$$

Expressions (4) and (5) illustrate the standard result that output will be reduced (in advance, given the announced fiscal policy) by a fraction τ and the steady-state output and capital stock per unit of human capital will be strictly lower than they would be in an economy without taxation. In our model's political economy context, this implies that economic incentives for production activities will be reduced even more due to the presence of political rivalry,[9] which, as we will further see in section 2.3, translates into an additional increase in the tax rate.

2.2 Human capital accumulation and wages

By our model's assumptions, workers are the only economic agents who receive wages and accumulate human capital individually. Assuming that workers are paid their marginal product for the labour they supply to middle-class entrepreneurs, and accounting for the above derived capital stock per unit of human capital (4), the wage at time t is given by:

$$w_t(K^*) = (1-\alpha) \cdot A_t \cdot H_t \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}} \tag{6}$$

Next, we derive the human capital accumulation function, H_{t+1}, which is endogenous in our model. Following Lucas (1988) and Glomm and

[9] As in, e.g. Alesina and Perotti (1994), Dixit and Londregan (1995), Acemoglu and Robinson (2001).

Ravikumar (2003), we assume that each worker's human capital stock at time $t+1$ (when he or she is an adult) results from a combination of factors devoted to its accumulation in t (when he or she is young),[10] as follows:

$$H_{t+1}=E_t^{\varsigma}w_t^{\gamma}(1-l_t) \tag{7}$$

where E_t is a compound variable that denotes public investments in education designed to improve its quality, expand infrastructure and provide equality of access and opportunity; w_t denotes parental income (i.e. wages of individuals old enough to work in t) invested in children's education; and $1-l_t$ denotes time devoted to learning.

The three variables that enter the human capital accumulation function are endogenously determined in our model. As it will be shown in the next section, E_t is determined by a (weighed) proportion of tax revenues collected by the elite from the middle-class entrepreneurial activity. Parental income is given by equation (6) and time devoted to learning is given by the time allocation between leisure and learning, in equation (9) below. Parameters γ and ς, which represent the sensitivity of human capital accumulation to parental income and public investments in education, respectively, are assumed exogenous. Following Glomm and Ravikumar (2003), γ and ς take values between 0 and 1, such that $\gamma+\varsigma<1$, which guarantees that the economy has a steady state. When parameter ς (γ) is close to 1 and parameter γ (ς) is close to 0, human capital accumulation is highly sensitive to public investments in education (parental income). In other words, depending on the values assumed by γ and ς, either parental income or public investments in education will exert significant influence on human capital accumulation decisions.

Moving now to the derivation of the optimal time allocation between leisure and learning, we recall that workers accumulate human capital while young and are employed and remunerated for producing the final good while old. Thus, time devoted to learning, $1-l_t$, is determined by each worker's individual preferences over leisure when young and consumption when old given by the standard constant-relative-risk-aversion utility function:

$$\frac{l_t^{1-\sigma}+c_{t+1}^{1-\sigma}}{1-\sigma}, \quad 0<\sigma<1 \tag{8}$$

where l_t is leisure at time t, c_{t+1} is consumption at time $t+1$, which we assume to be given by w_{t+1}, and σ is the usual coefficient of relative risk aversion, which we refer to throughout the model as the individual

[10] For empirical evidence supporting this specification for the human capital accumulation function see Coleman (1966), Heyneman (1984), Lucas (1988), Meghir and Palme (2005).

preferences parameter.[11] Regarding the specific form of the utility function used in this model, our choice is mainly due to the analytical part of our work. In particular, should we have adopted a more 'traditional' Cobb-Douglas type utility function, i.e. assuming complementarity between leisure in the first period and consumption in the next period, the model would only be able to yield a corner solution (implying that in the first period all agents should optimally devote zero time to leisure). While analytically this would turn the model extremely simple eliminating the larger part of the model's mathematical body, it would not be of great interest in generic terms since it would consider only one specific case scenario. Assuming, on the other hand, a utility function in which leisure and consumption are substitutes allows us to build a generic model, enriching the analysis and increasing the relevance of the obtained results and conclusions.

The young agent's problem at time t is to choose the optimal time allocation between leisure, l_t, and learning, $1-l_t$. This choice (along with public investments in education and parental income) will determine the worker's human capital accumulation and corresponding wage (and consumption) in $t+1$. Formally, we maximize (8) subject to $c_{t+1}=w_{t+1}$, where w_{t+1} is given by (6) in $t+1$ together with (7).[12] Then, for a standard constant-relative-risk-aversion utility function and assuming an interior solution to workers' maximization problem, the optimal learning choice, $(1-l_t)^*$, is given by:

$$(1-l_t)^* = \frac{\left((1-\alpha)\cdot A_{t+1}\cdot E_t^{\zeta} w_t^{\gamma}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{1-\sigma}{\sigma}}}{1+\left((1-\alpha)\cdot A_{t+1}\cdot E_t^{\zeta} w_t^{\gamma}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{1-\sigma}{\sigma}}} \tag{9}$$

Given E_t, the choice of $1-l_t$ allows us to (recursively) fully derive H_{t+1}, w_{t+1} and c_{t+1}.

[11] We impose the restriction $0<\sigma<1$ to guarantee that a worker's lifetime utility is increasing in $l_{j,t}^{1-\sigma}$ and $c_{j,t+1}^{1-\sigma}$ and is globally positive.

[12] Some alternative works on individual schooling chocies, for example by Oshio and Yasuoka (2009) on the individual's choice between staying and leaving education in a mixed (public and private) education system, particularly focusing on questions of efficiency and equity, and by Fischer and Keuschnigg (2002) on the aggregate human capital accumulation efficiency gains from dividing schooling time allocation between home study and school attendance could present interesting complementary reading on specific schooling choices and resulting aggregate human capital accumulation.

Again, note that, the young worker's optimal learning choice depends on τ, the magnitude of which, as previously mentioned, will be determined by the presence or absence of political rivalry. Thus, the optimal time allocation between leisure and learning is also affected by political rivalry. We will show in more detail the mechanisms of this relationship in the comparative statics analysis in section 3.

2.3 Elite utility and optimal policy choice

In this section, we characterize the 'policy' block of our model by looking at the fiscal and public investment policy choices of the elite. Recall that, in our paper, we have assumed that the elite does not take part in productive activities, its only role in the economy being purely political. This assumption is crucial for separating economic and political power, thus allowing for political rivalry effects. First, we consider the specific fiscal and public policies and the incentives of the elite. Then, we derive the optimal tax rate for each t under different scenarios, namely with and without political rivalry.

2.3.1 Fiscal and public policy and the incentives of the elite

Given our research objectives and the specific elements included in our model, we focus on two types of policies: fiscal policy and public investments in education. As regards fiscal policy, we consider available two instruments: a linear tax on output, $\tau_t \in (0, 1)$, and lump-sum transfers to the elite, T_t^e.[13] As regards public investments policy, we assume that the elite devotes part of the collected tax revenues to public investments in education, through which human capital accumulation is done. We consider that the elite's incentive for implementing this policy is supported (as for any type of public investments) by its expectations to reap the benefits of these investments in the future. Being closely related to economic development through its inherent features of increasing competencies, knowledge and other qualitative attributes, when incorporated in workers' performance, human capital accumulation produces increased economic value and

[13] Because the elite initially holds the political power in our model, we can restrict our analysis to the sequence of policies that imply no direct redistribution either to the middle-class entrepreneurs or workers. Additionally, as in Acemoglu (2006), the existence of lump-sum taxes allows us to link redistribution and efficiency, which is of particular interest in our political economy model's settings interrelating issues of inequality and growth.

leads to both quantitative and qualitative progress, from which the elite benefits directly. In particular, we consider that the elite's motivation for making public investments in education is twofold. On the one hand, besides increasing wages paid to workers, accumulated human capital also makes them more productive and increases the final output produced by middle-class entrepreneurs, thus enabling the elite to collect higher tax revenues. This part refers to the revenue extraction motive (Acemoglu, 2006). On the other hand, the political group in power has exclusive access to additional revenues generated by human capital accumulation, resulting from innovations, property rights and patents (note that additional exclusive revenues may also come from other sources, such as natural resources rents). In our political economy context, this refers to the political replacement effect (Acemoglu, 2006) and strengthens the elite's intention to secure its politically dominating position so as to continue benefiting from such revenues in the future.

Thus, there are two opposing forces that determine the elite's optimal policy choice. On the one hand, there is an elementary revenue extraction motive, so it is in the elite's interest to have a highly productive middle-class and growing human capital accumulation, as this would enable higher output-tax and additional elite exclusive revenues. This determines the elite to choose fiscal policies that promote human capital accumulation and economic growth.[14] On the other hand, because in the next period the elite do not want to lose power and all the benefits it entails, they will recur to political rivalry mechanisms. In the political economy context, political rivalry may arise in the form of competition against replacement and political incentives in public policy. In particular, in order to reduce the threat of being removed from power, the elite will use excessive taxation impeding the middle-class from becoming richer and consequently more powerful. Such policy will lower production and investments and reduce human capital accumulation, thereby negatively affecting economic performance. Thus, political rivalry generates significant distortions that have a negative impact on the resulting economic outcomes, as all economic allocations in the presence of political rivalry become highly inefficient. Below, we analytically show that, in fact, the optimal tax rate chosen by the elite is higher under political rivalry than in the absence of political rivalry.

[14] Throughout this paper, we use the terms 'economic growth' and 'final output growth' as synonymous, since both imply positive variations in $F(K, G)$.

2.3.2 Maximization problem of the elite

Following Acemoglu (2006) and with the above considerations in mind, we can derive the utility of the elite (the net present discounted utility of a representative elite agent). We start by calculating the elite transfer $T_t^e \geq 0$ subject to the government budget constraint as:

$$T_t^e \leq \frac{\omega}{S^e}\tau_t \int F(K_{i,t}, G_{i,t})di \tag{10}$$

where the left-hand side denotes government expenditures in transfers per one elite agent and the right-hand side are the revenues raised through taxing the middle-class output.[15]As in Acemoglu (2006), we also include the parameter $\omega \in [0,1]$ as a measure of state capacity to raise and redistribute revenues, such that it captures how much of the tax revenue can be redistributed, with the remaining $1-\omega$ being wasted.[16] Then, the elite choose the tax rate for the period t, τ_t, so as to maximize their current value accounting for the transfer amount, public investments in education, exclusive elite revenues and the probability of loosing power in the next period.

We can write the maximization problem of an elite agent when choosing the tax rate τ_t at $t-1$ recursively as:

$$V^e(E) = \max_{\tau_t} \left\{ T_t^e - E_t + \pi_t^e(H,N) + \beta[(1-\theta(\tau))V^e(E) + \theta(\tau)V^e(M)] \right\} \tag{11}$$

[15] Please note that equation (10) together with recalling equation (1) implies that in addition to the elements of Acemoglu (2006) our analysis of the elite's optimal policy choice also considers human capital accumulation. And given our model's particular specifications, there exists an interdependency between the two elements, as it will become clear from our subsequent analysis.

[16] As referred by Acemoglu (2009, Chapter 22), the fundamental concern of political economy growth models—whether governments perform the roles they are supposed to—is directly linked to issues of state capacity, i.e. weak versus strong states. In fact, in models where political considerations can influence economic outcomes, the interest of the political group in power to implement growth-promoting public policies (in our model this is related to public education investments, partly responsible for human capital accumulation and thus higher growth and lower inequality) should be considered. In particular, when the state is very weak, the political elite are unable to raise taxes and reap the future benefits of their investments, which basically discourages them from investing in public policies. On the other hand, when the state is too strong, there is very little or no control on the ability of the elite to tax productive activities, which will eventually suppress private investment (representing an important part of human capital accumulation in our model). From this perspective, states with intermediate levels of strength, i.e. intermediate values of ω, can be viewed as most capable (and most interested) to reap the benefits of public policies.

where $T_t^e = \omega\tau_t \cdot A_t G_t \cdot \left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}} \frac{S^m}{S^e}$ (from equations (5) and (10)) is the transfer to one elite agent given the output produced by S^m middle-class entrepreneurs, $E_t = \left(\frac{1-\alpha}{\alpha} \cdot \frac{\varsigma}{\gamma}\right) \cdot T_t^e$ is the fraction of state tax revenues destined for financing public education,[17] and $\pi_t^e(H, N)$ denotes rents from human capital and natural resources, available to the party in power exclusively. Note that, for a given level of tax-collected revenues, T_t^e, the elite's choice of the public investment amount in education is further adjusted by the ratio between output elasticities with respect to human and physical capital, $\frac{1-\alpha}{\alpha}$, on the one hand, and the relative sensitivity of human capital accumulation to public education, $\frac{\varsigma}{\gamma}$, on the other hand.[18] Finally, the component $\beta[(1-\theta(\tau))V^e(E)+\theta(\tau)V^e(M)]$ relates to the likelihood of political replacement and generates the political rivalry effects in the model. In particular, $\theta(\tau)$ denotes the probability that in period t political power will shift from the elite to the middle-class social group, and $V^e(E)$ and $V^e(M)$ denote the utility of the elite when they and the middle-class are in control of politics, respectively. Note that exclusive access to rents from human capital accumulation and natural resources, $\pi_t^e(H, N)$, ensures that the utility of the politically powerful social group is higher than the utility of any other social group, implying that $V^e(E) > V^e(M)$.

The probability of the elite loosing political power in the next period is modeled as a function of the magnitude of the middle-class social group, S^m, and the net income level (i.e. revenues from productive activities deducted of labour costs) of a representative middle-class entrepreneur, C^m:

$$\theta(\tau) = S^m \cdot C^m(\tau) \in [0, 1] \tag{12}$$

which captures the potential political power of the middle-class and where S^m is exogenous and $C^m(\tau) = \alpha A_t \cdot G_t \cdot \left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}$, with $\frac{\partial\theta(\cdot)}{\partial S^m} > 0$ and $\frac{\partial\theta(\cdot)}{\partial C^m} > 0$, implying that when the middle-class entrepreneurs are more numerous and richer they are more likely to gain power.[19] Given that $C^m(\tau)$ is decreasing in τ, we have that $\frac{\partial\theta}{\partial\tau} < 0$.

[17] That is, part of the tax revenue collected by the elite is reversed for public consumption, as in e.g. Greiner (1999).
[18] In our model, any possible variation in these ratios is assumed exogenous.
[19] With greater resources the middle-class may be more successful in attaining their collective interests (see Acemoglu, 2006).

2.3.3 Optimal policy choice

The first order condition for an interior solution for the tax rate, τ_t, is $\frac{\partial V^e(\cdot)}{\partial \tau}=0$. We can solve the elite's maximization problem first, for an equilibrium policy without political economy considerations, and then accounting for the effects of political rivalry on optimal policy choice.

(1) without political rivalry, the elite does not use economic policy instruments to remain in power in the next period, and therefore the tax rate is not manipulated to impoverish the middle-class. In this case, the probability that the elite will lose power in the next period is exogenous, i.e. $\theta'(\cdot)=0$. Consequently, the elite's maximization problem specified in (11) is given by:

$$\frac{\partial T^e}{\partial \tau}-\frac{\partial E}{\partial \tau}=0$$

Solving this for an interior solution, in period $t-1$ the elite will choose for period t the optimal output tax given by:

$$\tau^*=1-\alpha \tag{13}$$

(2) With political rivalry, the elite have political incentives to use the tax rate as an instrument in the competition against replacement, the probability that they will lose power in the next period is endogenous, and new political economy effects are more significant. In this case, the elite's maximization problem (11) becomes $\frac{\partial T^e}{\partial \tau}-\frac{\partial E}{\partial \tau}-\beta\frac{\partial \theta}{\partial \tau}[V^e(E)-V^e(M)]=0$, with $\frac{\partial \theta}{\partial \tau}=-S^m\cdot\frac{\alpha^2}{1-\alpha}\cdot A_t G_t\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\cdot[1-\tau]^{-1}$ given (12). This yields an optimal output tax of:

$$\tau^*_{PR}=1-\alpha+\Theta \tag{14}$$

Comparing the two optimal solutions, (13) and (14), it can be seen that τ^*_{PR} is strictly higher than τ^* by the factor $\Theta\equiv\frac{\alpha^2 S^e\beta[V^e(E)-V^e(M)]}{\left(1-\frac{\varepsilon 1-\alpha}{\gamma\ \alpha}\right)\omega}$.[20] Thus, as referred above, in a political economy context the elite will still choose to set higher taxes as this would weaken its potential political rivals—the middle-class,[21] thereby increasing the probability of the elite to remain in

[20] Note that, the value of $[V^e(E)-V^e(M)]$ in each t is sufficiently small, so that the condition $\tau^*_{PR}<1$ is satisfied.

[21] Recall that, in our model, potential political power of middle-class is captured by (12), which is decreasing in τ.

power for the next period and continue taking profit from all the benefits implied. However, as we will show in the comparative statics analysis, a higher tax rate does not bring more tax revenues for the elite.

2.4 Income inequality

This section is devoted to the analysis of income inequality in our model based on two endogenously defined key variables—the income growth rate (derived based on equilibrium wages and human capital accumulation calculated in section 2.2) and the critical level of income (derived following the approach in Glomm and Ravikumar (2003)).

2.4.1 Income growth rate and critical level of income

Considering the wages of two workers from the same generation, it can be easily seen, from expression (6), that differences in the level of incomes of workers in t can only arise from different levels of accumulated human capital. Despite being in line with endogenous economic theory and our model's assumptions, such an analysis of inequality is rather incomplete. It is also insightful to analyse income inequality between generations, namely by comparing the income growth rate of families with different initial income levels. In particular, recalling expression (6), we can use the human capital accumulation function (7) together with the optimal learning choice (9) to define individual income at $t+1$, w_{t+1} and, consequently, the income growth rate of a workers' family, W, as a function of w_t, as follows[22]:

$$W \equiv \frac{w_{t+1}}{w_t} - 1 = \frac{\left[(1-\alpha)\cdot E_t^{\zeta}\cdot A_{t+1}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right]^{\frac{1}{\sigma}}}{w_t^{1-\frac{\gamma}{\sigma}}+\left[(1-\alpha)\cdot E_t^{\zeta}\cdot A_{t+1}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right]^{\frac{1-\sigma}{\sigma}}\cdot w_t^{1-\gamma}} - 1 \quad (15)$$

Inspection of expression (15) shows that the relation between preferences and parental income parameters, σ and γ, is crucial for defining the behaviour of W as a function of w_t. In this respect, as in Glomm and Ravikumar (2003), we need to consider two distinct situations: (1) $\gamma < \sigma$, and (2) $\sigma < \gamma$.

[22] Note that the analytical expression obtained for the income growth rate is similar to that in Glomm and Ravikumar (2003), although the economic mechanisms considered for its derivation are distinct.

In the first case, when $\gamma < \sigma$, we have that expression (15) is strictly decreasing in w_t. Then, comparing the income growth rate for a poor and a rich working family, we can see that income will grow at superior rates for families with lower incomes than for those with higher incomes. Consequently, over time, incomes will converge and income inequality will decline. The intuition behind this result is simple. Recalling that the parameter γ is the sensitivity of a worker's human capital accumulation to his or her parents' income, with a small γ, parental income does not have a strong influence on their children's accumulation of human capital. This means that, for a worker, parental heritage is less important than his or her own individual preferences regarding education, and there is a high potential for social mobility even for workers coming from a less favourable background.

In the second case, when $\sigma < \gamma$, parental income has a greater role and affects more strongly the next generation's human capital accumulation than when $\gamma < \sigma$. Because parents with higher income can devote more resources to their childrens' education and their contribution weighs more, human capital accumulation for families with lower parental incomes is more limited. Such conditions on initial income distribution are more propense to deepening income inequality over time. When $\sigma < \gamma$, the behaviour of W is not monotonic in w_t, which now has a dual (positive and negative) effect on the income growth rate. More specifically, as it can be derived from expression (15), there is an inflection point below which W is increasing in w_t and above which W is decreasing in w_t. This is the critical income level, w^{CT}, given by:

$$w^{CT} = \left(\frac{\gamma-\sigma}{\sigma(1-\gamma)}\right)^{\frac{\sigma}{\gamma(1-\sigma)}} \cdot \left[(1-\alpha)\cdot E_t^{\zeta}\cdot A_{t+1}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right]^{-\frac{1}{\gamma}} \tag{16}$$

Comparing the income growth rate for a poor and a rich working family, their actual income relative to the critical income level in the economy will now define the behaviour of W. In particular, in an economy where both poor and rich working families' incomes are below the level of w^{CT}, W is increasing with w_t, and thus income will grow at inferior rates for workers with lower incomes than for those with higher incomes. Consequently, incomes will continue diverging and income inequality will increase. However, this pattern is inverted in an economy where both working families' incomes exceed w^{CT} and thus W is decreasing in w_t. Once the critical income level is overcome, the behaviour of the income growth rate induces income convergence (as in the case when $\gamma < \sigma$), the gap between higher and lower incomes narrows and income inequality starts to decrease.

In the context of our research, critical income effects are considered accounting for the endogenous fiscal and public investments in education policies, in a political rivalry environment. Moreover, the lower (higher) is the critical income level, the easier (more difficult) it is to attain income convergence, and, in this sense, w^{CT} can be treated as an income inequality indicator. Naturally, from a public policy perspective, the time necessary to achieve and overcome a given critical income level by both poor and rich families is rather important for inequality concerns. For example, when w^{CT} in the economy is high relative to actual wages paid to (poorer) workers and economic conditions are unfavourable and do not improve, inequality may persist indefinitely. We develop a more detailed analysis of these issues below.

In sum, when $\sigma < \gamma$, the income growth rate W is a strictly decreasing function of w_t only if $w_t > w^{CT}$. Consequently, it is easier to achieve income convergence over time for lower values of w^{CT} or for more rapidly increasing values of w_t. This dynamic analysis is similar to that in Glomm and Ravikumar (2003). However, our model's extended analytical framework enables a richer analysis and a detailed consideration of political implications, as regards income inequality and public policy in a political rivalry context.[23]

2.4.2 The role of public policy for the critical income level

Because in this paper, we adopt a political economy perspective to study income inequality, the above discussed elements have important institutional implications to be considered. In particular, in order to illustrate the importance of public policy in the framework of our model, we can compare two countries with different characteristics as regards individual preferences for learning and the importance of parental heritage. More specifically, we consider country A with $\gamma < \sigma$ and country B with $\sigma < \gamma$.

As referred above, the relation $\gamma < \sigma$ implies that individual preferences on learning have a dominating role relative to parental income in a worker's human capital accumulation. In this light, in country A where parental heritage is less important (either for cultural, economic or other reasons), the role of public policies implemented by the political elite is crucial, since individual learning choice is directly affected by the adopted fiscal and

[23] For an alternative, 'non-political' explanation of the importance of income distribution for economic growth see, for example, the empirical study by Falkinger and Zweimuller (1997) who base their analysis of endogenous growth and innovation on a purely economic mechanism, in particular exploring the relationship between income distribution and product diversity.

public investment in education policies.[24] In particular, as regards income inequality and economic growth concerns, these policies can either promote or discourage human capital accumulation and inequality can be either deepened or reduced. For example, as we will further show, the presence of political rivalry can discourage both the individual learning choice and public investments in human capital accumulation. The effect of fiscal and public investment in education policies on inequality and growth will be positive only as long as taxation is not increased by the presence of political rivalry.

Now consider country B with $\sigma < \gamma$. In this case, human capital accumulation for families with lower parental income is more limited, and, as we have seen above, there exists a critical income level, which further conditions the path of inequality evolution over time. Consequently, even more than in the previous case, for country B, fiscal and public investments in education policies pursued by the political elite are primarily important. Securing efficient policies that would either lower the critical income level or improve economic environment so as to facilitate social mobility and accelerate achieving and overcoming w^{CT}, thus reducing inequality and promoting growth, becomes fundamental. And, as we will show in our comparative statics analysis, investing in public education can achieve both a lower w^{CT} and a better economic environment. Indeed, when fiscal policy is directed towards human capital accumulation and there are no political rivalry effects, inequality decreases and economic growth increases.

These implications for public policy resulting from the relation between income inequality and parameters γ and σ could also provide an interesting perspective and motivation for an empirical cross-country study.

2.5 Economic growth rate

Having derived the elite's optimal policy choice, the workers' optimal wage and learning choice, and using equation (5), we can now obtain the optimal economic growth rate for our model, g^*. This, on its turn, depends on the behaviour of the exogenous variables, A and L and endogenous variables T^*, w^* and $(1-l)^*$ over time:

$$g^* \equiv g_{F(K^*,G)} = \frac{A_{t+2}}{A_{t+1}} \cdot \frac{L_{t+2}}{L_{t+1}} \cdot \frac{T^e_{t+1}}{T^e_t} \cdot \left[\frac{w_{t+1}}{w_t}\right]^{\gamma} \cdot \left[\frac{(1-l_{t+1})}{(1-l_t)}\right] - 1 \tag{17}$$

[24] See the comparative statics analysis in section 3.

Equation (17) suggests that the behaviour of the workers' optimal wage and learning choice over time is mostly relevant for defining the economic growth rate.[25] More specifically, variables that contribute to increasing $\frac{w_{t+1}}{w_t}$ and $\frac{(1-l_{t+1})}{(1-l_t)}$ eventually will have a positive effect on g^*. And recalling expressions (9) and (15) and the variables of interest in our model, we can see that the evolution of the workers' optimal wage and learning choice depends on the elite's political choices of τ and E. Thus, we can also consider the optimal economic growth rate, g^*, as a function of the elite's optimal fiscal and public investments policies, τ^* and E^*. The effects of these two endogenously derived policies implemented by the elite on our model's key variables are detailedly discussed in our next section.

3. COMPARATIVE STATICS ANALYSIS: EFFECTS OF PUBLIC INVESTMENTS IN EDUCATION AND POLITICAL RIVALRY

In our comparative statics analysis we will focus on the effects of the two endogenously derived policies, pursued by the elite, on the key variables of our model: the analysis in section 3.1 is dedicated to the effects of public investments in education, while section 3.2 focuses on the discussion of fiscal policy effects under conditions of political rivalry. The full expressions of all the derivatives presented in sections 3.1 and 3.2 can be found in the Appendix.

3.1 Effects of public investments in education

One of the main objectives of our paper is to assess the impact of public investments in education on economic growth and development and on inequality. Recalling expressions (5), (6), (7), (9) and (16), it can be easily verified that $\frac{\partial F(K^*,G)}{\partial E}$,[26] $\frac{\partial w_{t+1}}{\partial E}$, $\frac{\partial H_{t+1}}{\partial E}$, $\frac{\partial (1-l)}{\partial E}$ are all positive and $\frac{\partial w^{CT}}{\partial E}$ is negative.

The intuition behind these results is the following. As it should be expected, higher public investments in education, E, stimulate the individual learning choice, $(1-l_t)$, as the availability of a better public education

[25] In equation (17), we do not substitute the expressions for each component (derived in the respective sections above), as it significantly complicates the mathematical representation of g^* without bringing additional relevant contribution.

[26] Given the analytical complexity of the expression of g^*, the equilibrium output effects of public investments in education and political rivalry will be analysed on levels rather than on growth rates.

system in its complex nature (as specified in section 2.2) is more appealing. That is, increasing public investments in education not only improves the instrument for human capital accumulation—public education, but also increases personal motivation to use it. Consequently, a higher E exerts not only a direct positive effect on the stock of accumulated human capital, H, but also an indirect positive effect through increased individual learning incentives. These results are also in line with the previously referred historical examples regarding the global positive effects of increased public spending and educational reforms in Britain. Namely, at the beginning of the 20th century the education system either intended primarily for the elite, run by religious denominations or requiring poor people to pay fees, was made more accessible to the masses through a series of institutional changes. The newly adopted Educational Acts committed the government to the systematic provision of universal education and led to a large expansion in resources for schools. As the result of these changes the proportion of ten-year-olds enrolled in school increased to 100 per cent at the beginning of the 20th century, compared to the disappointing 40 per cent in 1870 (Acemoglu and Robinson, 2012).

The endogenous growth theory classic effects of an increased human capital stock are further verified, i.e. higher worker productivity, wages and final output. Moreover, as emphasized above, the inverse relation between E and w^{CT} implies that inequality is more easily overcome with public investments in education. This is particularly important in what regards vertical and intergenerational social mobility. Again, recalling some historical facts, for example Engerman and Sokoloff (1994, 2000) refer that an increase of public investments in education since the Industrial Revolution has also led to multiple positive effects, increasing learning incentives and accelerating human capital accumulation, improving worker productivity and wages therefore reducing inequality, which, together with the other effects, led to higher economic growth.

3.2 Effects of political rivalry

In this section, we will focus on political rivalry between the elite and other potentially politically powerful groups as a key factor distorting the implemented fiscal policy. More specifically, we will show that there is a strong negative impact of political rivalry on economic allocations and actions when goals pursued by the elite, instead of economic efficiency considerations, determine the policy choice. We specify three groups of political rivalry effects based on the variables affected: (1) equilibrium output, wages

and elite transfer; (2) public investment in education, individual learning choice and human capital accumulation; and (3) critical income level and income inequality. Given that, in our model, political rivalry translates into a higher output tax rate, we will assess its effects on the specified variables by computing their partial derivatives with respect to τ.

Before proceeding to the analysis of political rivalry effects in the specific framework of our model, it is worth noting that in fact various researchers on this subject generally sustain that institutions that excessively tax productivity-enhancing activities and primarily protect the interests of the elite will not encourage economic growth. For example, Ricardo was generally opposed to taxation, arguing particularly that all taxation had a tendency to injure the working class, diminishing wages and reducing aggregate production (see in, e.g. Hartwell, 1981). More recently, Piketty and Saez (2006) suggest that the sharp increase in the inequality over the last decades in many OECD countries can be linked to the emergence of a new elite—an economically and politically dominant social class that includes not only top managers but also influential politicians making key decisions in corporations and government. This may severely distort taxation and the provision of public goods, ultimately affecting human capital accumulation and thus economic growth and development.

On their turn, Acemoglu and Robinson (2012) argue that economic growth based on creative destruction (started by the Industrial Revolution) requires economic institutions that guarantee some degree of equality of opportunity in the society. In particular, a more efficient allocation of resources, greater encouragement to acquire education and skills and further innovations in technology empower the citizens at large and thus create a more level playing field. At the same time, the threat of losing hold on political power often determines the elite to form strong opposition against skill development and technological progress. Based on extensive historical examples, Acemoglu and Robinson (2012) show that although throughout the history there was always a temptation for the existing elites to close down the system to the new-comers, institutional innovations (i.e. making institutions more inclusive) fostered upward social mobility, while economic institutions that only protect the rights of a rich elite are not able to achieve equality of opportunity and often create distortions potentially retarding economic growth.

Finally, the latest empirical evidence in the work by Sochirca *et al.* (2016) indicates that political rivalry has a strong adverse impact on public investment in education, economic growth and income inequality, which supports the below presented analysis and further strengthens the importance of this complex issue.

3.2.1 Equilibrium output, wages and elite transfer

As it should be expected, equilibrium output, (5), and wages, (6), decrease when taxes increase and our model in fact yields $\frac{\partial F(K^*,G)}{\partial \tau} < 0$ and $\frac{\partial w_t}{\partial \tau} < 0$. Consequently, political rivalry has a direct negative impact on equilibrium output and wages.

Similarly, political rivalry negatively affects tax-collected revenues of the elite as, for values of τ higher than $1-\alpha$, we get $\frac{\partial T_t^e}{\partial \tau} < 0$.[27] Thus, choosing to implement a politically motivated fiscal policy aimed at impoverishing the middle-class, the elite know in advance that it implies lower tax revenues. However, given that $V^e(E) > V^e(M)$, they are willing to accept this decrease in tax-collected revenues in order to increase the probability of remaining in power (recall (12)), maintain control over policy and preserve access to exclusive rents.

3.2.2 Public investment in education, equilibrium learning choice and human capital accumulation

Taking the derivative $\frac{\partial E_t^e}{\partial \tau}$, it can be seen that an increase in the tax rate increases public investments in education only when $\tau < 1-\alpha$. Once political rivalry is introduced, the tax rate τ becomes higher than $1-\alpha$. In this case, public investments in education are negatively affected by further increases in τ, i.e. $\frac{\partial E_t^e}{\partial \tau} < 0$ for $\tau > 1-\alpha$.[28] This happens because, under conditions of political rivalry, public investments in education are highly distorted, given that the amount corresponding to $\frac{1-\alpha}{\alpha} \cdot \frac{\varsigma}{\gamma}$ of T_t^e, is now lower, since $\frac{\partial T_t^e}{\partial \tau} < 0$ for $\tau > 1-\alpha$. This relation between τ and E is of a particular importance given that, as mentioned in section 3.1, public investments in education influence all variables in our model. Thus, when political pressure for redistribution and not economic considerations determine the policy choice, induced negative variations in public investments in education are reflected in significantly distorted values of the main economic variables.

Inspection of expression (9) indicates that the optimal individual learning choice, $(1-l_t)^*$, is affected by τ in three ways. First, the worker when young

[27] Recall the potential result of the Laffer curve, when increasing tax rates beyond a certain point will be counter-productive for raising further tax revenues.

[28] This is a crucial difference between our result and the result in Glomm and Ravikumar (2003), where public investments in education always increase when there is an increase in the tax rate. Our new result is specifically due to the endogenous consideration of the fiscal policy choice.

knows in advance that the future benefits of learning will be reduced by τ, which lowers the incentives for learning. Second, the reduction in parental income, w_t, resulting from an increase in τ (see section 3.2.1) will also reduce time devoted to learning. Third, $(1-l_t)^*$ is also affected by τ via E: for lower/higher values of output tax, an increase in τ will raise/reduce public investments in education (see previous paragraph), thereby having a positive/negative impact on the optimal learning choice. Thus, considering all three effects combined, we can conclude that for lower tax levels the effect of τ on $(1-l_t)^*$ may be positive, while for higher levels it is unambiguously negative. More specifically, it can be verified by the partial derivative of the optimal learning choice with respect to τ (see the Appendix), that $\frac{\partial(1-l_t)^*}{\partial\tau} < 0$ for $\tau > \frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha)+\alpha(\gamma+2)}$.[29]

This result presents two important conclusions. On the one hand, given that $\frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha)+\alpha(\gamma+2)} < 1-\alpha$, the negative effect of τ on $(1-l_t)^*$ starts being exerted even for values of τ inferior to $1-\alpha$. That is, increases of τ beyond the turning point $\frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha)+\alpha(\gamma+2)}$ will discourage the optimal learning choice for workers when young even when there is no political rivalry. The presence of political rivalry will severely aggravate this negative impact. On the other hand, it shows that the sensitivity parameters ς and γ play an important role in determining the changes in the individual learning choice induced by changes in fiscal policy. More specifically, the closer the parameter ς is to 1, the closer the turning point is to $\tau=1-\alpha$, and the more it is possible to avoid, in the absence of political rivalry, negative impacts on individual learning choice, i.e. $\frac{\partial(1-l_t)}{\partial\tau} < 0$. On its turn, the sensitivity of human capital accumulation to parental income, γ, has an opposite effect. Namely, the closer γ is to 1, the further the turning point is from $\tau=1-\alpha$, and, consequently, $\frac{\partial(1-l_t)}{\partial\tau} < 0$ is more difficult to avoid. This suggests that, the negative impacts of increasing the tax rate above a certain level can be avoidable, in the absence of political rivalry, when the sensitivity of human capital accumulation to public education is higher than to parental income.[30]

[29] Again, this result is obtained when endogenously modelling fiscal policy choices and human capital accumulation in a framework that combines elements from Acemoglu (2006) and Glomm and Ravikumar (2003).

[30] Naturally, even when the role of public education is primarily important for human capital accumulation, the option of private investments, captured by parental income, should not be discarded. Families with higher incomes can always profit from their favourable conditions.

The effect of an increase in the output tax rate on human capital accumulation, $\frac{\partial H_{t+1}}{\partial \tau}$, is inferred by observing the effects on its constituting elements, E_t, w_t and $1-l_t$. As it was shown above, $\frac{\partial E_t}{\partial \tau} < 0$ for $\tau > 1-\alpha$, $\frac{\partial w_t}{\partial \tau} < 0$ for all τ, and $\frac{\partial (1-l_t)}{\partial \tau} < 0$ for $\tau > \frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha)+\alpha(\gamma+2)}$. Consequently, increases of τ beyond a turning point (even below the political rivalry level) will negatively affect human capital accumulation, that is, $\frac{\partial H_{t+1}}{\partial \tau} < 0$, and the presence of political rivalry will aggravate this effect.

3.2.3 Critical income level and income inequality

Recalling expression (16), it can be derived that excessive taxation generated by political rivalry increases the critical income level, thus making it more difficult to achieve income convergence and prolonging income inequality over time. In particular, taking the partial derivative of w^{CT} with respect to τ, we have that $\frac{\partial w^{CT}}{\partial \tau} > 0$ for $\tau > \frac{\varsigma(1-\alpha)}{\alpha+\varsigma}$. Thus, given that $\frac{\varsigma(1-\alpha)}{\alpha+\varsigma} < 1-\alpha$, the analysis of this result is similar to that regarding the political rivalry impact on individual learning choice.

Namely, the result obtained here indicates that the negative effect of τ on w^{CT} occurs even for values of τ inferior to $1-\alpha$, that is, the critical income level is increased and inequality is deepened. These negative impacts are aggravated by the presence of political rivalry. Similarly, the result of $\frac{\partial w^{CT}}{\partial \tau} > 0$ for $\tau > \frac{\varsigma(1-\alpha)}{\alpha+\varsigma}$ suggests that changes in the critical income level induced by changes in fiscal policy are influenced by the parameter ς. The closer ς is to 1, the closer the turning point is to $\tau = 1-\alpha$. This increases the possibility to avoid, in the absence of political rivalry, negative tax rate impacts on inequality, implying that a higher sensitivity of human capital accumulation to public education can help avoiding the negative impacts of increasing the tax rate above a certain level.

4. CONCLUSIONS

In this paper, our research was directed towards first, examining how different political incentives may affect the resulting policies and economic allocations and, second, studying the effects of political rivalry on human capital accumulation and income inequality.

Regarding our first research objective, our findings verify that different political incentives have distinct effects on the resulting policies and

economic allocations. When the incentives of the elite refer to elementary revenue extraction, it is in their interest to have a highly productive middle-class and increasing human capital accumulation, as this enables collecting higher output-tax revenues. This determines the elite to choose fiscal policies that generate positive effects by motivating individual learning choice, increasing human capital accumulation, wages and final output, and also fighting inequality. In this case, public investments in education can, in fact, be used as a social mobility promoter, enabling income convergence and overcoming inequality.

However, when the elite's incentive to remain in power for the next period goals, instead of economic efficiency considerations, determine the policy choice, political rivalry effects are generated. In this case, excessive taxation, which leads to an inefficient redistribution policy, will result in highly distortionary economic allocations and actions. Thus, as regards our second research objective, we have found that political rivalry reduces human capital accumulation through its negative impact on public investments in education, workers' wages and individual learning choice, and increases income inequality, by decreasing wages, raising the critical income level and affecting the income growth rate.

Also, we have shown that the sensitivity parameters of public investments in education and parental income play an essential role in determining human capital accumulation and inequality, thus having relevant public policy implications especially under conditions of political rivalry. In particular, we have found that when human capital accumulation is more sensitive to parental income, higher tax rate negative impacts on individual learning choice and future human capital accumulation may arise more easily. A higher sensitivity to parental income also implies that human capital accumulation for families with lower income is more limited. A more uneven income distribution is then more propense to deepening income inequality over time. However, when parental income is less important than a worker's individual preferences for learning, the availability of a publicly provided education offers a high potential for social mobility even for workers coming from a less favourable background.

The above referred key results and conclusions of our model can be directly related to the historical example of the Britain's Industrial Revolution, which, due to the emergence of uniquely inclusive institutions at that time, provided the incentives and conditions necessary for skills development and innovations and empowered positive social changes and economic growth. They are also in line with the latest empirical findings regarding the strong adverse impact of political rivalry on economic growth, public investments in education and income inequality.

The results and conclusions of our model also have some important testable implications. In particular, it would be relevant to empirically test the existence of a relationship between: (1) political rivalry and the tax rates applied in different countries; (2) income inequality and the share of public and private investments in human capital accumulation; and (3) human capital accumulation, political rivalry and tax rates, as implied by the results of our model's comparative statics analysis.

Moreover, we can also identify some venues for future research. For example, the skill biased technological change theory can provide a new approach to analysing the political rivalry effects on inequality and human capital accumulation through the composition of the labour force. In particular, depending on the level of political distortions, economic growth can be biased towards a more or less skilled labour. We can also consider including endogenous population growth in the model, analysing if the increase in income, resulting from persistent human capital accumulation, would be reflected quantitatively or qualitatively on future generations. Another research possibility is to consider the growth rate of aggregate labour-augmenting productivity, as an endogenous variable interacting with human capital accumulation. Also, as parameters defining the importance of public investments in human capital, parental income and individual learning preferences are crucial for some of the results obtained in this paper, another future challenge could be to endogenize them, taking into account their determining factors and how they can be influenced by public policy.

Appendix

The appendix presents the full expressions of the partial derivatives of the key model variables with respect to public investments in education, E_t, and output tax rate, τ, as follows:

$$\frac{\partial(1-l_t)}{\partial E}=\frac{\varsigma\frac{(1-\sigma)}{\sigma}\cdot E_t^{\zeta\cdot\frac{(1-\sigma)}{\sigma}-1}\cdot\left((1-\alpha)\cdot A_{t+1}\cdot w_t^{\gamma}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{(1-\sigma)}{\sigma}}}{\left(1+\left((1-\alpha)\cdot A_{t+1}\cdot w_t^{\gamma}\cdot\left(\frac{\beta^{-1}+\delta-1}{\alpha(1-\tau)}\right)^{\frac{\alpha}{\alpha-1}}\right)^{\frac{(1-\sigma)}{\sigma}}\right)^2}>0 \tag{A1}$$

$$\frac{\partial H_{t+1}}{\partial E}=\varsigma E_t^{\zeta-1}\cdot w_t^{\gamma}\cdot(1-l_t)+E_t^{\zeta}\cdot w_t^{\gamma}\cdot\frac{\partial(1-l_t)}{\partial E}>0 \tag{A2}$$

$$\frac{\partial F(K^*, G_{t+1})}{\partial E} = A_{t+1} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \cdot \frac{\partial H_{t+1}}{\partial E} > 0 \tag{A3}$$

$$\frac{\partial w_{t+1}}{\partial E} = (1-\alpha) A_{t+1} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \cdot \frac{\partial H_{t+1}}{\partial E} > 0 \tag{A4}$$

$$\frac{\partial w^{CT}}{\partial E} = -\frac{1}{\gamma} \zeta \cdot E_t^{-\frac{1}{\gamma}\zeta - 1} \cdot \left(\frac{\gamma - \sigma}{\sigma(1-\gamma)} \right)^{\frac{\sigma}{\gamma(1-\sigma)}} \cdot \left[(1-\alpha) A_{t+1} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \right]^{-\frac{1}{\gamma}} < 0 \tag{A5}$$

$$\frac{\partial F(K^*, G)}{\partial \tau} = -\frac{\alpha}{1-\alpha} A_t H_t \cdot (1-\tau)^{-1} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} < 0 \tag{A6}$$

$$\frac{\partial w_t}{\partial \tau} = -\alpha A_t H_t \cdot (1-\tau)^{-1} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} < 0 \tag{A7}$$

$$\frac{\partial T_t^e}{\partial \tau} = \omega \cdot \frac{S^m}{S^e} \cdot A_t H_t \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \cdot \left(1 - \frac{\alpha\tau}{(1-\alpha)(1-\tau)} \right) > 0, \quad \text{for } \tau < 1-\alpha \tag{A8}$$

$$\frac{\partial E_t^e}{\partial \tau} = \frac{\varsigma(1-\alpha)}{\gamma\alpha} \cdot \frac{\partial T_t^e}{\partial \tau} > 0, \text{for } \tau < 1-\alpha \tag{A9}$$

$$\frac{\partial(1-l_t)}{\partial \tau} = \frac{\frac{1-\sigma}{\sigma} \cdot \left((1-\alpha) \cdot A_{t+1} \cdot E_t^{\zeta} \cdot w_t^{\gamma} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \right)^{\frac{(1-\sigma)}{\sigma}} \cdot \left[\frac{\varsigma}{\tau} - \frac{\alpha}{(1-\alpha)(1-\tau)} \cdot (\gamma+2) \right]}{\left(1 + \left((1-\alpha) \cdot A_{t+1} \cdot E_t^{\zeta} \cdot w_t^{\gamma} \cdot \left(\frac{\beta^{-1} + \delta - 1}{\alpha(1-\tau)} \right)^{\frac{\alpha}{\alpha-1}} \right)^{\frac{(1-\sigma)}{\sigma}} \right)^2}$$

$$> 0, \quad \text{for } \tau < \frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha) + \alpha(\gamma+2)} \tag{A10}$$

$$\frac{\partial H_{t+1}}{\partial \tau} = \frac{\partial E_t^e}{\partial \tau} \cdot w_t^{\gamma} \cdot (1-l_t) + \frac{\partial w_t}{\partial \tau} \cdot E_t^{\zeta} \cdot (1-l_t) + \frac{\partial (1-l_t)}{\partial \tau} \cdot E_t^{\zeta} \cdot w_t^{\gamma} > 0, \quad \text{for } \tau < \frac{\varsigma(1-\alpha)}{\varsigma(1-\alpha)+\alpha(\gamma+2)} \tag{A11}$$

$$\frac{\partial w^{CT}}{\partial \tau} = \left[\left(\frac{\gamma-\sigma}{\sigma(1-\gamma)} \right)^{\frac{\sigma}{\gamma(1-\sigma)}} \cdot \left[(1-\alpha) A_{t+1} \cdot \left(\frac{\beta^{-1}+\delta-1}{\alpha} \right)^{\frac{\alpha}{\alpha-1}} \right]^{-\frac{1}{\gamma}} \right] \cdot E_t^{\varsigma} \cdot (1-\tau)^{\frac{\alpha}{1-\alpha}} \cdot \left(\frac{\varsigma}{\tau} - \frac{\alpha(\varsigma+1)}{(1-\alpha)(1-\tau)} \right) > 0, \quad \text{for } \tau > \frac{\varsigma(1-\alpha)}{\alpha+\varsigma} \tag{A12}$$

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Elena Sochirca
Faculty of Economics
University of Porto
4200-464 Porto
Portugal
E-mail: esochirca@eeg.uminho.pt

Oscar Afonso
Faculty of Economics
University of Porto
Rua Dr Roberto Frias
4200-464 Porto
Portugal
E-mail: oafonso@fep.up.pt

Sandra T. Silva
Faculty of Economics
University of Porto
4200-464 Porto
Portugal
E-mail: sandras@fep.up.pt