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When Elders Rule: Is Gerontocracy Harmful for Growth?

A Comparative Study of Seven European Countries

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Abstract

We study the relationship between gerontocracy and aggregate economic performance in a simple theoretical model where growth is driven by human capital accumulation and productive government spending (investments in ICT). We show that gerontocratic élites display the tendency to underinvest in public education and productive government services, thus being harmful for growth. In absence of inter-generational altruism, the damage caused by gerontocracy is mainly due to the lack of long-term delayed return on investments, originated by the shorter life horizon of the elder ruling class. An empirical analysis is carried out to test theoretical predictions across different countries and different economic sectors. The econometric results confirm our main hypotheses.

***Keywords**: Gerontocracy, Economic Growth and Aggregate Productivity, Education, ICT.*
***Jel codes**: J1, O4.*

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1 Introduction

Over the last twenty years, per capita income growth rates have ceased to converge across OECD countries and there has been a surge of academic research and policy attention about the causes underlying differences in economic growth performance across these countries. While productivity has accelerated in some of the most emerging economies and, most notably, in the United States, it has substantially slowed down especially in continental Europe and Japan (OECD [27]). Focusing on Europe, it is easily observed that since the mid-1990s, the economic performance has experimented a significant contraction compared to earlier periods. The economic literature developed so far has provided various explanations for such a sclerosis (Blanchard [8], Gordon [17]). The most commonly cited causes of the slow growth concern the rigidity of the European economic model, the burden of taxation, the strict dependency of citizens on the welfare system and the evidence that Europe has used some of the past productivity improvements to increase leisure rather than income. In particular, a wide consensus has been reached among reserachers regarding the "European model", which, despite its successes during the post-war era, is proving to be inadequate now that the economic development is increasingly based on innovation and national firms can no longer be protected from foreign competition. Moreover, several studies point out that the adoption of important general purpose technologies associated with the Information and Communication Technologies (ICT) revolution has been hindered or impeded in Europe by an excessively regulated labor market and an insufficient level of competition (van Ark et al.[30]). Despite this productivity crisis is a common feature of a number of European economies, remarkable differences emerge from cross country comparisons.[1]

Most recently, a new strand of the literature has emerged, prospecting the idea that a large share of the heterogeneity in productivity growth across countries (and within Europe in particular) could be attributed to the economic and political élites' capacity of managing a country (Caselli and Morelli [12], Mattozzi and Merlo [24] [**?**]). Along these lines of thinking, the élites' responsibilities, with respect to the institutional, social and technological delays accumulated in the recent past, have become an issue in the European economic panorama.

However, differently from this literature, our claim in this paper is that the élites' responsibility does not exclusively derive from their simple tendency to maintain the *status quo*. It is also due to their inability to seize the opportunity given by new technologies and to implement the best choice for the economy as a whole, a direct consequence of the obsolescence of their personal human capital. Indeed, as pointed out by Messner and Polborn [25], many political or economic reforms resemble investment projects in their return streams: initially, there is a cost to be borne, but eventually there will be benefits. In this frame, young people will be able to enjoy the benefits longer and hence will be more inclined to favor reforms than older people. It then follows that, among individuals of different ages, the oldest ones will not be in favor of the change because they mainly suffer the costs without being able to reap much of the benefits. Therefore we define a gerontocratic society as a place where the decision-making process and the political environment are dominated by the

[1]For example, OECD [27] reports that, compared with the previous decade, hourly labor productivity picked up in a group of economies, including Norway, Portugal, Germany, Finland and Sweden, while remained stable or reduced in the others.

oldest individuals, with negative consequences on economic performance in periods of rapid change and instability, when innovation and flexibility are at a premium.

The inability of an older ruling class in managing innovation is therefore a key feature of our research. Existing literature on labor economics provides further support in favor of this idea. Several studies show that a negative link between size and productivity exists and it is even more pronounced in the ICT sector (See Daveri and Maliranta [15]). Indeed, workforce aging is known to entail skill deterioration and lessened ability to adapt and learn new things. One possible explanation relies on the cognitive abilities' tendency to deteriorate with age. Although this decline is not uniform across abilities, after a certain age threshold, further advancements in age are seemingly associated with lower productivity at work. Beyond that threshold, further increases of experience add little or nothing to the working ability of a given worker. There are no reasons to believe that power élites are excluded from this process.

Along this line of reasoning, our work is also related to the literature on interest group politics, where existing powerful interest groups may impede the introduction of new technologies in order to protect their economic rents (Acemoglu and Robinson [1], Alesina and Rodrik [2], Fernandez and Rodrik [16]). In these contributions political élites block technological and institutional development because of a political replacement effect. Innovations often erode élites' incumbency advantage, increasing the likelihood that they will be replaced. Fearing replacement, political élites are unwilling to initiate change and may even block economic development. Moreover, the theoretical model we develop belongs to the broad literature that studies the links between different political variables and economic growth (Bellettini et al. [7], Hashimzade and Davis [19], Hopenhayn and Muniagurria [20], Krusell and Rios-Rull [22], Krusell et al. [23]). In particular, Hashimzade and Davis [19] provide an interesting example on how political uncertainty might impede economic growth. The main conclusion of their theoretical work is that an increase in a political instability produces growth-reducing policies because leads governments to invest less in activities that support human capital accumulation. Along the same line of reasoning, through a simple model very close to the one developed by those authors, we argue that gerontocracy, involving an elder ruling class with a shorter life horizon, determines lower investments in human capital and in productive public services and thereby depresses economic development.

Therefore, our aim with this paper is to study the relationship between country economic performances and the age of the political élite of a society. Using a simple theoretical framework, we show that an older ruling class, whose interest may be less devoted to long-term delayed return on investment, may weaken the human capital accumulation process because of inadequate public education policies and hinder private sector productivity growth because of poor expenditure in productive services. In this sense, we argue that gerontocracy is harmful for growth. To measure the impact of this phenomenon on economic growth, in our empirical analysis we combine information on socio-economic characteristics and background of the political élites (i.e., the parliamentarians of a group of European countries) along with information from a rich industry-level data set. Our main goal is to exploit differences in the politicians' age across countries to estimate the effect that gerontocracy exerts on the allocation of public spending on productive investments and thus on economic growth.

The plan of the article is the following. Section 2 lays out the baseline model and discusses

the links among gerontocracy, public investments and economic growth. Our main conclusion is that gerontocracy is an important source of innovation-retarding policies and therefore depresses economic development. Therefore, it can be seen as plausible explanations of the growth differentials across countries. Section 3 discusses the data. Due to limitations on the availability of political data, we have not been able to extend the analysis to all EU countries. The countries involved in our study are Denmark, Finland, France, Italy, Germany and UK that, anyway, represents a large share of the European economy and population. Section 4 presents our empirical analysis, and our focus is to show how the performances recorded by a group of European countries, whose political structures are often characterized by leaders who are significantly older than most of the adult population, can be explained once this peculiarity is recognized. The empirical results are consistent with the model theoretical predictions. Finally, Section 6 concludes.

2 Theoretical model

In this section we present our theoretical model that extends the framework proposed by Hashimzade and Davis [19] by taking into account the role of public productive service, along with the public investment in education, as engine of the human capital accumulation.

Demography. In a discrete-time $t \in \{0, 1, \dots \infty\}$ economy, a continuum of measure 1 of consumers/workers produces a single homogenous good. At every moment, the same number of people are born and die, so the population is constant and normalized to one. Each agent has an uncertain lifetime and faces a probability υ of dying at any date. Following Boucekkine, de la Croix and Licandro [9], we model mortality such that the measure of each generation declines deterministically through time. The unconditional probability for an agent of reaching age $a \in [0, \overline{a}]$ is defined as:[2]

$$\upsilon(a) = \frac{e^{-\varrho a} - \kappa}{1 - \kappa} \quad \text{with} \quad \kappa > 0, \varrho < 0, \quad \text{or} \quad \kappa \in (0, 1), \varrho > 0 \tag{1}$$

where the maximum age $\overline{a}$ that an agent can reach is given by:

$$\overline{a} = \frac{-log(\kappa)}{\varrho} \tag{2}$$

No dynastic concerns are taken into account and people care only about their own utility. Similar to Glomm and Ravikumar [18], in each period agents allocate their time between education (e) and production ($1 - e$).

Technology. Production function requires the use of human capital and government purchases and takes the form:

$$Y_t = AG_t^{\eta} \left[(1 - e) H_t\right]^{1-\eta} \tag{3}$$

where $A > 0$ is the constant social marginal return of human capital, $(1 - e)H_t$ is the stock of human capital at time t (i.e. efficiency of labor hour), G_t is the productive government

[2]Typically, individual mortality does not depend only on the individuals age and hinges also on the own consumption of health care and on the level of aggregate activity within a health care system. Boucekkine, de la Croix and Licandro [9] exstensively discuss the survival law defined by equation (1).

spending (e.g. the provision of productive services, the roll-out and adoption of broadband, antitrust legislation, etc) available at the beginning of period t and $0 < \eta < 1$.[3]

Human capital accumulation is determined according to the following production function:

$$H_{t+1} = H_t + \phi(H_t, E_t) \tag{4}$$

where no depreciation is assumed, E_t is the public investment in education and ϕ is the learning technology described by the following homothetic function:

$$\phi(H_t, E_t) = e\zeta H_t^{\alpha} E_t^{1-\alpha} \tag{5}$$

with $\zeta > 0$ and $0 < \alpha < 1$. Output is taxed at fixed rate τ. This implies that the following condition, representing the government budget constraint, must hold:

$$\tau Y_t = G_t + E_t + R^g = \sigma_{gt}\tau Y_t + \sigma_{et}\tau Y_t + (1 - \sigma_{gt} - \sigma_{et})\tau Y_t \qquad \text{with} \quad (\sigma_{gt} + \sigma_{et}) \leq 1 \quad \forall t \tag{6}$$

where σ_{gt} and σ_{et} are the share of revenues allocated to finance productive government spending and public education, respectively. It then follows that the share $(1 - \sigma_{gt} - \sigma_{et})$ is used to finance expenditure that produces no benefit for the community and it can be seen as private benefit (or appropriation of tax revenues) enjoyed by the élites. Therefore, we call it *government rent* (R_t^g). Finally, $C_t^p = (1 - \tau)Y_t$ is consumed by the consumers/workers.

Political environment. We assume that all the politicians in the office belong to the same generation. This simplification allows to consider each Government as a single individual of age $a \in [0, \overline{a}]$. We consider an environment where two governments randomly alternate in office. To keep matter simple, we follow Hashimzade and Davis [19] in assuming that the two governments are identical and face the same exogenous probability π of being voted out and replaced. At each time t the government in charge chooses σ_{gt} and σ_{et}. At time zero, political élites know their status $\epsilon_0 \in \{l, w\}$. When $\epsilon = l$ the incumbent government has lost the election. We assign at this event a positive probability π. At the opposite, with probability $(1 - \pi)$, $\epsilon = w$ and the incumbent government remains in charge. In the former case ($\epsilon = l$) government receives a retirement rent R^r, while in the latter ($\epsilon = w$) it allocates again tax revenues between productive government spending, public education and its own (unproductive) rent.

2.1 The optimization process

Political élites' maximize the following instantaneous return function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\beta \upsilon(a))^t \left[\theta U(R_t^g) + (1 - \theta) U(C_t^p)\right] \tag{7}$$

where U is the strictly concave twice differentiable instantaneous return function, $R_t^g = (1 - \sigma_{gt} - \sigma_{et})\tau Y_t$ is the government rent, C_t^p is the private consumption, β is the time discount factor, while $\mathbb{E}_0$ denotes the expectation conditional on information available at date $t = 0$.[4] Finally, it is worth noting that in equation (7) θ can be seen as a measure of

[3] The public factor in equation (3) is a common external input. That is G is a pure public good.

[4] Notice that the expectation $\mathbb{E}$ is with respect to ϵ and is understood to be conditional on σ_{et} and σ_{gt}.

politicians' "selfishness", as it defines the weight the government assigns to government rent and private consumption: the higher is θ, the higher is the degree of "selfishness". It then follows that the *policy vector* is defined by $\Psi = \{(\sigma_{g1}, \sigma_{e1}), (\sigma_{g2}, \sigma_{e2}), \dots\}$.

In this environment the controls σ_g and σ_e at date t depend only on the current state H, so that $\sigma_{gt} = \sigma_g(H_t)$ and $\sigma_{et} = \sigma_e(H_t)$. This implies that any given policy generates a stochastic law of motion for the state:

$$H_{t+1} = \Xi\left(H_t, \sigma_{gt}, \sigma_{et}, \epsilon\right)$$

which will be stationary if σ_g and σ_e are stationary.

Following the standard notation used in literature, let denote the variables at time t and $t+1$ as those without and with primes. The functional equation associated to the maximization problem faced by a government in charge at the beginning of period t is

$$V(H,\epsilon) = \max_{\{\sigma_e,\sigma_g\}_{t=0}^{\infty}} \left\{ \left[\theta U(R^g) + (1-\theta)U(C^p)\right] + \beta \upsilon(a) E\left[V(H^{'}, \epsilon^{'})\right] \right\} \tag{8}$$

$s.t$

$$\begin{aligned} Y &= Y = AG^{\eta}\left[(1-e)\,H\right]^{1-\eta} \\ H_0 &> 0 \\ H^{'} &= \Xi\left(H, \sigma_g, \sigma_e, \epsilon\right) \\ C &= (1-\tau)Y \\ R^g &= \begin{cases} (1-\sigma_g-\sigma_e)\tau Y & \text{if } \epsilon = w \\ R^r & \text{if } \epsilon = l \end{cases} \end{aligned} \tag{9}$$

where at time $t=0$, H_0 is pre-determined, R_0^g and H_1 are chosen, and the uncertainty is due to the risk of an electoral loss in the subsequent period. Notice that equation (8) holds for any $t \in (0,\infty)$. The value function (8) is the present discount value of the incumbent ruling class evalueted along the optimal program.

As previously mentioned, R^r indicates the retirement rent gained in case of electoral loss. Since we are focusing on the burden that gerontocracy places on the economic performance, it seems reasonable to assume that the role played by the retirement rent - whose benefits can actually be enjoyed over a short period of time - in the political élites' decision process is negligible. Therefore we assume that R^r is a constant and lower than $(1-\sigma_g-\sigma_e)\tau Y$.

The following assumptions are maintained for the remainder of this section.

Assumption 1. *Life expectancy declines through time according to (1).*

Assumption 2. $H \in \mathcal{H} \subset \mathcal{R}$, $(\sigma_g + \sigma_e) \in (0,1)$ *and* $E, G \in \mathcal{A} \subset \mathcal{R}$.

Assumption 3. $U : X \to \mathcal{R}$ *is a strictly increasing, twice continously differentiable and concave utility function, with* $U'(0) = \infty$ *and* $U'(\infty) = 0$.

Assumption 4. *Retirement rent* $R^r = \overline{R} < (1-\sigma_e-\sigma_g)\tau Y$.

In this model we choose to focus on the optimizing behavior of the political élites. Therefore we postpone to a further extension the modeling of a voting stage and the analysis of the role that population's age may exert on the political outcomes and then on the aggregate

economic performance. In other words, in order to be able to analyze our main question in a meaningful way, we need to find a link between the age structure of the political élites and the policies implemented. For that reason we focus on a such simple environment. Moreover we added an aggregate technology that ensures a perpetual growth driven by productive government services and investment in education. The provision of both government services and public education is financed by a tax on income, whose revenues are also used to finance the élites' unproductive rent R^g. As it will be more clear in the following paragraph, this assumption is crucial to highlight the trade-off faced by the policy maker and the role of gerontocracy. Each rational government will choose the amount of tax revenues to invest in innovation and education that will yield a rent R^g as large as possible, under the uncertainty of being re-elected in the subsequent election. In this conceptualization, the term $\upsilon(a)\pi$ can be interpreted as complement to 1 of the turnover rate, among politicians belonging to different generations. According to the empirical evidence, this turnover rate raises as the political élite gets older. As it appers clearly from equation (8), the lower is $\upsilon(a)\pi$ the higher is the relative weight of the current benefit with respect to the future, making it optimal for politicians to raise their private unproductive rent and lower the productive public investments.

2.2 Equilibrium and comparative statics

Here we are interested into analyzing the long-run effects of gerontocracy. Therefore, we focus on the stationary equilibrium which involves time-invariant decision rules in the infinite horizon. This concept uses a recursive representation of the political élites' problem.

Definition 1. *Given the initial H_0 and $H_t \in \Gamma(H_{t-1}) \subset \mathcal{H}$, with Γ continuous and compact-valued, a* Balaced Growth Path *(hereafter* BGP*) for the economy is a collection of sequences $\{H, Y, C^p, R^g, \sigma_g, \sigma_e, G, E, e\}_{t=0}^{\infty}$ such that:*

i) H evolves according to (4);

ii) government budget is balanced, $\tau Y_t = G_t + E_t + R_t^g$;

iii) politicians solve problem (8-9).

Let now V_l denote the value of an electoral loss, which occurs with probability π, and V_w the value of being (re)electeded, which occurs with probability $(1-\pi)$. Then the optimal value function V for the political élites' optimization problem (8-9) is obtained as solution to the following Bellman equation:

$$V(H) = \max_{\{\sigma_e, \sigma_g\}_{t=0}^{\infty}} \left\{ \left[\theta U(R^g(H)) + (1-\theta) U(C^p(H))\right] + \beta \upsilon(a) \left[\pi V_l(H') + (1-\pi) V_w(H')\right] \right\} \quad (10)$$

subject to (9).

With interior equilibrium, the first order conditions and the envelope condition for the

political élites' problem are respectively:

$$[FOC] \qquad \frac{\partial V}{\partial \sigma_g} = 0 \Rightarrow \frac{\partial U}{\partial \sigma_g} + \beta \upsilon(a) \left[\pi \frac{\partial V_l}{\partial H^{'}} \frac{\partial H^{'}}{\partial \sigma_g} + (1-\pi) \frac{\partial V_w}{\partial H^{'}} \frac{\partial H^{'}}{\partial \sigma_g} \right] = 0 \tag{11}$$

$$[FOC] \qquad \frac{\partial V}{\partial \sigma_e} = 0 \Rightarrow \frac{\partial U}{\partial \sigma_g} + \beta \upsilon(a) \left[\pi \frac{\partial V_l}{\partial H^{'}} \frac{\partial H^{'}}{\partial \sigma_e} + (1-\pi) \frac{\partial V_w}{\partial H^{'}} \frac{\partial H^{'}}{\partial \sigma_e} \right] = 0 \tag{12}$$

$$[ENV] \qquad \frac{\partial V_l}{\partial H} = \frac{\partial U(\overline{R})}{\partial H}; \quad \frac{\partial V_w}{\partial H} \frac{\partial}{\partial H} \left[\theta U(R^g) + (1-\theta) U(C^p) \right] \tag{13}$$

Conditions (11-12-13), togheter with the trasversality condition:

$$\lim_{t \to \infty} \left(\beta \upsilon(a) \right)^t \frac{\partial U(\cdot)}{\partial H} H_t = 0 \tag{14}$$

and the initial condition of the economy fully characterize the solution of the political élites' problem.

Finally, the assumption of identical governments implies that they choose the same optimal level of σ_e and σ_g, which is constant along the BGP where all the *per capita* variables grow at the same rate given by

$$\gamma = \zeta e \left[A^{1/(1-\eta)} \sigma_e \sigma_g^{\eta/(1-\eta)} \tau \left(1-e\right) \right]^{1-\alpha} \tag{15}$$

Simple algebra provides the following proposition.

Proposition 1. *Along the* BGP*, the growth rate of* per capita *variables is increasing in the amount of tax revenues used to finance education and productive services:*

$$\left. \frac{\partial \gamma}{\partial \sigma_e} \right|_{BGP} > 0 \quad \textit{and} \quad \left. \frac{\partial \gamma}{\partial \sigma_g} \right|_{BGP} > 0$$

Proof 1. *See appendix A.1.*

Recalling that along BGP, $H^{'} = H(1+\gamma)$, proposition 1 also implies:

$$\frac{\partial H^{'}}{\partial \sigma_e} = H \left(\frac{1-\alpha}{\sigma_e} \right) \gamma \tag{16}$$

$$\frac{\partial H^{'}}{\partial \sigma_g} = H \left(\frac{1-\alpha}{1-\eta} \frac{\eta}{\sigma_g} \right) \gamma \tag{17}$$

Finally, in order to obtain explicit solutions for σ_e and σ_g and do some comparative statics, we assume now that the politicians' preferences are logarithmic. Provided that υ depends on the politicians' age according to (1), solving (11-13) with respect σ_g and σ_e yields:

$$\sigma_g^* = \eta \frac{\beta v \left(1-\pi\right)\left(1-\alpha\right)}{\theta + \beta v \left(1-\pi\right)\left(1-\alpha\right)}, \tag{18}$$

$$\sigma_e^* = \left(1-\eta\right) \frac{\beta v \left(1-\pi\right)\left(1-\alpha\right)}{\theta + \beta v \left(1-\pi\right)\left(1-\alpha\right)}. \tag{19}$$

Proposition 2. *Along the BGP, the optimal government spending in productive services σ_g^* and education σ_e^* decline when the political élite gets older. Thus, the older is the political élite (i.e. the higher is a) the lower is the equilibrium growth rate γ.*

Proof 2. *See appendix A.2.*

In a simple framework, we showed that politicians' age is negatively related to their intentions in favor of adopting potential growth enhancing policies. Our main finding is that public investments do respond to changes in the ruling class age structure, which affect the re-election probabilitiy, and therefore size of the unproductive rent enjoyed by the élite. We conclude that the older is the political élite, the lower are the public resources devoted to productive services and education, human capital accumulation declines and the economic growth slows considerably.

3 The data

The data used in the empirical analysis have been collected from different sources. In what follows we provide a description of the data and discuss the procedures adopted to merge data from different sources in a single dataset.

The first source is the DataCube dataset, obtained from the EURELITE network, that collects information on personal characteristics of national parliamentarians in several European countries from 1983 to 2004.[5] DataCube includes about fifty variables related to the social and political background of national parlamentarians. Beyond some basic socio-demographic variables (i.e., occupation, education, age and sex), the dataset includes also information on politicians' background, with particular attention to the pre-parliamentary political experience, including political and administrative appointments at local level (town, county, and region), parliamentary career (i.e., age at entry into parliament and the number of elections for which they had stood successfully), leading party functions, and government appointments. However, our primary focus within this dataset is on two main variables: *i*) the average age of the parliament in each country, which represents our measure of gerontocracy, and *ii*) the percentage of newcomers in each electoral round, which provides a measure of the political turnover.

The second source is represented by the EU-KLEMS dataset, which contains variables measuring output, productivity, employment (skilled and unskilled), physical capital, ICT investments and technological change at industry level, for all European Union member states from 1970 onwards.[6] The availability of data at industry level is extremely important for our analysis, as we believe that the relationship between the level of gerontocracy, investments in ICT and economic growth may be quite heterogeneous across the many sectors of the economy. Industry level data will then be able to capture such heterogeneity better than aggregate measure, such as the *per capita* GDP. Moreover, EU-KLEMS provides information on the public ICT investment, proxied by the ICT investment of the non-market economy (public administration and education, health and social services).

As the number of countries covered and the time span length of the EU-KLEMS are both larger than those available in the EURELITE dataset, the merging procedure of these two

[5]For more information on the EURELITE network see the following web page address: http://www.eurelite.uni-jena.de/eurelite/portrait/introduction.html.

[6]For more information on the EU-KLEMS dataset the interested reader can refer to the following web page: http://www.euklems.net/.

sources has produced a sample that includes 7 countries (Denmark, Finland, France, Germany, Italy, The Netherlands and UK) and 71 industries that we have further re-aggregated into 6 "macro"sectors (Manufacturing, Electrical machinery and telecommunication, Finance and business services, Retail and distribution services, Personal and social services, and Non-market services plus other goods producing industries), with a time span ranging from 1983 to 2004.[7]

Finally, we have added a variable accounting for public expenditure on education at country level as provided by EUROSTAT and UNESCO.[8] For our purposes, this variable has been standardized with respect to GDP. However, since we do not have information on the German public education expenditure before the pre-unification period, in our empirical analysis we split our sample in two sub-samples. The first sub-sample, made of **2,916** observations, spans the whole period from 1984 up to 2004 and includes data from all country but Germany. The second sub-sample, made of **1,485** observations, spans the sub-period from 1995 up to 2004, but includes data from Germany. Finally, we obtain a sub-sample of control, made of **1,269** observations, that spans the sub-period from 1995 up to 2004, but do not include Germany.

Table 1 reports all summary statistics. According to our data, only 21% of the national representatives are female and the average age is about 58 years, with France showing the oldest parliament and The Netherlands the youngest (see figure 1 for a detailed picture of the cross country differences in life expectancy and politicians' age in the sample). About 60% of parliamentarians in the sample has a university degree. Furthermore, about 60% of them had a previous local/regional background activity in terms of being a representative elected by citizens and about 60% have been elected in the same place of origin.

Concerning the economic data, we see that workers with average skills account for about two thirds of total hours worked, with low skilled and high skilled workers that follows. In particular, high skilled workers account for only 13% of total hours (see table2).

For a better understanding of our data and the relationships among them, we have also computed unconditional correlation coefficients between gerontocracy and TFP growth and between ICT (both private and public) and TFP growth. In table 3 the (n,m) cell shows the average correlation between the TFP growth of industry n and the level of gerontocracy attributed to country m. The general negative impact exerted by gerontocracy is quite transparent when looking at the last row of the table, which reports the correlation column average by country. In particular, this detrimental effect seems to be stronger the higher is the technological complexity of the industry, being larger in the Electrical machinery and telecommunication sector. Notice that (on average) the older are the politicians the larger are the negative correlations. As suggested by our theoretical model, a positive correlation between public ICT and TFP growth should emerge from the data, with the former positively affecting the latter and being complement with the private ICT. The unconditional correlation coefficients reported in table 5 seem to confirm our theoretical predictions, with

[7]We decided to keep the electrical machinery and telecommunication sector separated from the aggregated manufacturing sector because we believe that in this sector the correlation between investment in ICT and TFP growth could be particularly relevant.

[8]Data source: http://appsso.eurostat.ec.europa.eu for the period 1995-2004 and http://www.uis.unesco.org/Education/Pages/default.aspx for the period 1983-1994.

public ICT and TFP strongly correlated, and with public and private investments in ICT being complement (see figure 2 where we plot the (log of) public and private ICT). Finally, in table 6 we observe the correlation between private ICT and TFP. Even in this case the positive correlation seems to hold and it is stronger in those sectors where we expect ICT to be a major driver for TFP.

Finally, a different picture emerges if we look at the correlation between the (log of the) age of the newcomers in each national Parliament and the TFP growth. The results reported in table 4 suggest that the problem is not the politicians' age *sic et simpliciter*. In comparison with the previous table, correlations are much more tenuous and, often, are positive. A possible explanation could be that older newcomers, during their working life (presumably in the private sector), have acquired skills and competences that (partially or completely) compensate the human capital obsolescence due to aging.

4 The empirical model

In this section we present the empirical strategy used to test the main hypothesis of our theoretical model, namely that gerontocracy negatively affects economic growth due to its incapacity to provide sufficient investments in innovation (public and private) and education. However, as we lack adequate information on education expenditure, we limit the empirical analysis to the study of the effect of gerontocracy on innovation, thus assuming that the level of expenditure in education is given.[9] Therefore, our empirical model will be specified to estimate the impact of gerontocracy on public productive investments and, only indirectly, on the TFP growth. In a more formal way, the model can be formalized using the following reduced form three equation system:

$$\begin{aligned} log(tfp_{ijt}) &= \alpha_0 + \alpha_1 log(pexpedu)_{jt} + \alpha_2 log(ict)_{ijt-1} + \alpha_3 log(gict)_{jt-1} + \\ &+ \alpha_4 du95 + \alpha_5 du95 \cdot log(ict)_{ijt-1} + \alpha_6 \mathbf{S}_{ijt-1} + \alpha_7 \mathbf{X}_{jt} + \eta_{ijt} \end{aligned} \tag{20}$$

$$\begin{aligned} log(ict_{ijt}) &= \beta_0 + \beta_1 log(pexpedu)_{jt} + \beta_2 log(gict)_{jt} + \beta_3 \mathbf{S}_{ijt} + \\ &+ \beta_4 \mathbf{X}_{jt} + \varepsilon_{ijt} \end{aligned} \tag{21}$$

[9] Unfortunately, homogeneous and comparable data on education expenditure at country level is available only in aggregate, thus preventing us from distinguishing expenditures at different levels of education. In fact, we expect that expenditure at lower levels of education, although important for the economic growth, may be positively related with gerontocracy that, in fact, could be aligned with vested interests of teacher unions for preserving a *status quo* where insiders obtain all the benefits, without caring about quality. On the contrary, the financing of higher education and research activities may be much less correlated with gerontocracy as it usually leads to breakthroughs and innovations that are not in line with the idea of maintaining the *status quo* of a gerontocratic system. Based on simple descriptive statistics, our data do not show any correlation between gerontocracy and public expenditure on education.

$$
\begin{aligned}
log(gict_{ijt}) \quad = \quad & \gamma_0 + \gamma_1 log(pexpedu)_{jt} + \gamma_2 log(gerontocracy)_{jt-1} + \\
& + \gamma_3 log(newcomers)_{jt-1} + \gamma_4 local_{1jt-1} + \gamma_5 local_{2jt-1} + \\
& + \gamma_6 roots_{it-1} + \gamma_7 background_{it-1} + \gamma_8 log(education)_{jt-1} + \\
& + \gamma_9 \mathbf{S}_{ijt} + \gamma_{10} \mathbf{X}_{jt} + \xi_{ijt}
\end{aligned} \tag{22}
$$

where i is the sector, j is the country and t is time, and where tfp_{ijt} is the TFP growth index, $log(ict)_{ijt}$ is the logarithm of the private ICT capital service, while $log(gict)_{jt}$ is the logarithm of the public ICT capital service. Furthermore, $\mathbf{S}_{ijt}$ is a vector of sector-specific variables (share of labor input with different skilld and share of workers with different age) and $\mathbf{X}_{jt}$ is a vectors of other controls at country level, such as market openness and country dummies. Following the empirical evidence reported in van Ark et al. [30] and Dahl et al. [14], we include in our TFP equation the dummy variable ($du95$) and its interaction with ict to captures a structural break that could have changed the productivity trend from 1995 onward. All other listed variables are self-explanatory. Finally, to avoid potential endogeneity problems, whenever reasonable regressors have been lagged one period.

Given our system of equations 21 and 22, we can easily see that gerontocracy affects private ICT only through the public ICT ($gict$). At the same time, gerontocracy affects TFP through both the private and public ICT (equations 21 and 22). Therefore, the total effect of gerontocracy on TFP is given by

$$
\frac{\partial TFP}{\partial gerontocracy} = (\alpha_3 \gamma_2) + (\alpha_2 + \alpha_5 du95)\, \beta_2 \gamma_2
$$

where the first term on the right side of the equation reflects the (direct) effect of gerontocracy on TFP through the public ICT investment and the second term is the (indirect) effect through the private ICT investment.

As we assume a recursive structure for our empirical model, the parameters have been estimated using SUR technique (Zellner [31], Zellner and Huang [32] and Zellner [33]). In what follows, we start presenting the results obtained pooling all countries and sectors and later we discuss the results obtained fitting our model by sector or by country.

5 The empirical results

In this section we present and comment the empirical results. We first discuss the results obtained with the pooled data (all sectors and countries) and then introduce and compare the results by sector and country. Finally, we present some robustness check analyses that should help reinforce the conclusion of our study. All analyses have been carried out using the three different samples discussed in section 3.

5.1 Estimates from the pooled data

Table 7 presents the estimates of the parameters in equations (20-22) for the pooled data, using the three samples. Overall, the results clearly corroborate our theoretical predictions, with the gerontocracy variable that negatively affects public ICT, that in turn affects TFP. This result is robust across sub-samples. Furthermore, and coherently with our theoretical

predictions, gerontocracy affects TFP mainly through the public ICT investment channel. In fact, as can be seen in the top panel of table 8, using the pooled data a 1% increase in the level of gerontocracy affects TFP level by -0.339% or -0.748%, depending on the sample employed. By disentangling the total effect into its direct and indirect components, we note that the direct effect is what really drives the result. Finally, by comparing the different samples we notice also that the negative effect of gerontocracy has increased over time (by comparing the sample 1 across the two periods) and it seems to have an important effect in Germany (by comparing sample 1 and sample 2 across the same period).

Consistently with the idea that the attitude to innovate declines with the politicians' age, from table 7 we see that past experience of political government at local/regional level (*background*) seems to be negatively related with *gict*. In particular, *background* affects negatively and significantly the TFP growth index in sub sample 2 (with elasticity equal to -0.650 respectively), when the role of public ICT capital is crucial, while plays an irrelevant role in the first sub sample (with elasticity 0.016), when the impact of *gict* on TFP is relatively smaller. This may be partly explained by thinking that being elected to national parliament can be seen as the culmination of a political carreer spent largerly at local or regional level. Under this perspective, *background* proxies politicians'age and therefore the same argument used for *gerontocracy* can be applied to explain its effect on productive public spending.

Our estimates document also a switch occurred in 1994 from private to public ICT capital as a main determinant of the TFP growth index. In fact, although the parameter of *gict* is positive and significant in both samples, it is definitely greater after 1994. On the contrary, the contribution of the private ICT is positive and not significant when the time horizon is longer, while it is negative and significant when we focus on the last decade of our dataset, irrespective of the presence of Germany in the dataset. This result is consistent with the literature on TFP growth in the European countries. In fact, along a time span similar to the one taken into account in the present analysis, Van Ark et al.[30] show that the effect of private ICT on TFP growth for the continental European countries is zero up to the mid-1980s, significantly negative until the 1991-1996 period and again zero after that, leading the authors to conclude that ICT has at best had no effect on TFP index.

Estimates document also the complementarity between ICT (public and private) capital and non-ICT capital (*nict*), which enters in the TFP equation with a negative and significant parameter in two of the three samples employed. Furthermore, they show that over the whole period the TFP growth index increases with the share of medium skilled workers (*hhms*), while all employees contribute to the investment in private and public ICT (with some differences). On the contrary, when we consider the shorter samples, high skilled workers never play a role.

Similarly to what happens in the political arena, our estimates suggest also that age affects the contribution of the workforce (i.e. the labor productivity) to the TFP and private ICT, given that the parameter associated to younger ages (h_{29} and h_{49}) is generally greater than the one associated to h_{+50}. The worker age does not seem to have an effect on the public ICT equation.

Finally, looking at education (the second channel through which *gerontocracy* may affect economic performance according to our theoretical model), our results do not support the idea that public expenditure on education - whose limits we have previously described -

unambigously enhance TFP. Regressions ran with alternative aggregate measure (i.e. the share on the TPE) confirm that, regardless the proxy employed, the final impact of *pexpedu* on TFP growth is rather inconclusive.

5.2 Estimates using data by sector and countries

The results presented so far, although interesting, provide only an aggregate picture of the relationship between gerontocracy, ICT and TFP. However, we know that it can be highly heterogeneous across the many sectors of the economy and/or by country. As already discussed in the previous sections, some of the relationship between ICT and TFP may be stronger or weaker depending on the specific sector/country where they apply. Therefore, in what follow we first present elasticity results obtained splitting our pooled samples by sector and later we comment on the results by country.[10]

Table 8 provides the elasicities of TFP growth with respect to *gerontocracy* by sector. The main result that emerges looking across the sectors is that the more ITC intensive is the sector, the stronger is the total effect exerted by *gerontocacry* on TFP growth. In particular "Electrical machinery and TC"and "Manufacturing"have been characterized by the higher direct effect via *gict* (with significant elasticities in the range from -0.385 up to -0.962). Second, consistently with estimates of the pooled regressions, the elasticities estimated in the sub sample 2 have been generally higher than the ones referred to sub sample 1: in particular we find high and significant elasticities in "Finance and business services"(-0.602) and in "Personal and social services"(-0.711).

Finally elasticities computed by country, reported in table 9, show that the loss in terms of TFP growth has been particularly relevant in Germany (7.741), Italy (-3.227) and Netherland (-1.134) but even dramatic in Finland, where the estimated elasticity has been greater than 24%.

5.3 Robustness checks

In order to check the robustness of our results to different model specifications, in this section we briefly present all the alternatives we have estimated and compare the results with our baseline specifications presented in the previous subsection. As our results seem to be very robust to alternative specifications, for sake of brevity we do not present all the parameter estimates. However, they are available upon request by authors.

Our first robustness check has been devoted to analyze the effect on the estimates of the inclusion of the gerontocracy variables as regressors in the private ICT equation (Eq. 21). In fact, although according to our theoretical model the set of gerontocracy related variables should not affect private ICT, we have run a model specification that includes them. Results have shown that these variables are never statistically significant and, in any case, the magnitude of the parameter estimates has always been very low across samples, sectors and countries.

We have further checked if alternative specifications, involving gerontocracy variable interactions and politicians' background variables could have had an effect on the overall

[10]The full set of parameter estimates by sector and country are available upon request by authors.

results. According to our results, adding these interactions produces slightly less accurate estimates, but the main results do not change significantly with respect to those reported in the previous section. This effect has been noticed in particular in the estimates by sector and by country, and in our view this should simply reflect a problem of efficiency (due to small sample size in presence of an increased number of parameters to be estimated).

As a further robustness check we have also estimated a model in which the lagged logarithm of private ICT enters as regressor in the *gict* equation. While the overall results and economic conclusions do not change, it is interesting to note that with this new specification there is a strong feedback effect between *ict* and *gict*, self reinforcing each other. No change is observed in terms of gerontocracy effect on TFP.

We have also adjusted *gerontocracy* and *newcomers* (which are computed as country mean age of the politicians in the office and country mean age of the newcomers) for country specific life expectancy, in order to account for different interpretations of *gerontocracy* according to country specific social norms imposed by different country average age. All results are fully confirmed in terms of sign, magnitude and significance.

Finally, as our education variable does not produce convincing results, we have estimated our model using a measure of education expenditure obtained as ratio to Total Public Expenditure (TPE) rather than to GDP. Even in this case, education appears to affect private and public ICT not in an unambiguous way, while the results in terms of gerontocracy remain perfectly in line with those presented in the previous section.

6 Concluions

In this paper we argue that when relatively young people cease to be the engine of an economy, long-run economic growth is endangered. Over the last three decades, many European economies have fallen into an old-age trap, a self-reinforcing mechanism whereby élites, generally the most aged individuals, have used control of the political system to exclude new generations, who are reasonably the most dynamic and innovative part of the population, from the access to power.

While we do not analyze this mechanism formally (i.e. we do not explain what are the determinants of gerontocracy), nor we do focus on some possible "positive"consequences that gerontocracy may have on a society as a whole, for example in reducing the inequalities, we focus our effort to explore the possible linkages between the age of the ruling class and the long-run growth rates both theoretically and empirically.

To achieve this goal, we have developed a simple endogenous growth model where long-run growth rate is directly affected by public productive services and public investment on education. The main testable hypothesis coming out from our theoretical model is that the older is the ruling class the lower is the public investment in education and productive services.

The empirical analysis corroborates these findings. Estimates indicates that, on average, a decrease of gerontocracy increases unambiguously the TFP, with elasticities ranging between -0.339% or and -0.748%, depending on the sample employed. Furthermore, we find that the direct effect of gerontocracy (via *gict*) is higher than the indirect one (via *ict*) and this result holds using both the pooled data or the data by country and sector. Also, the negative effect

of *gerontocracy* on TFP growth is stronger in those sectors such as the electrical machinery and telecommunication where we expect the ICT to play an important role. Finally, this effect result larger in Finland, Germany and Italy compared to the other European countries included in our sample.

Finally, in terms of our future agenda, there are several extensions to our approach that are worth pursuing. In the theoretical model for instance, we introduce several assumptions aimed at obtaining an analytical friendly framework. The next step will be to test how robust these results are when these simplifications are relaxed. In particular, we plan to address in a subsequent work the formal attempt to endogenize the gerontocracy. Moreover, from an empirical standpoint we delegate to a further paper the extension of our data set in order to include information on the managers employed in the private sector.

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A Appendix

A.1 Proof of proposition 1

Along the BGP:

$$\left.\frac{Y_{t+1}-Y_t}{Y_t}\right|_{BGP} \equiv \gamma = \left[A\left(\tau\sigma_g A\right)^{\frac{\eta}{1-\eta}}\left(1-e\right)^{\frac{\eta}{1-\eta}}\right]\left(H_{t+1}-H_t\right)-1 \tag{23}$$

Recalling that $E_t = \sigma^e \tau Y_t$ and $G_t = \sigma_g \tau Y_t$, we obtain:

$$\gamma = e\zeta\left[\tau\sigma_e A^{\frac{1}{1-\eta}}\left(\tau\sigma_g(1-e)^{\eta}\right)^{\frac{\eta}{1-\eta}}\right]^{1-\alpha}$$

Differrentiating γ w.r.t. σ_e and σ_g yields:

$$\frac{\partial\gamma}{\partial\sigma^e} = e\zeta\left(\sigma_e\tau\, A^{\frac{1}{1-\eta}}\left(\tau\,\sigma_g\left(1-e\right)^{\eta}\right)^{\frac{\eta}{1-\eta}}\right)^{1-\alpha}\frac{\left(1-\alpha\right)}{\sigma_e} > 0 \tag{24}$$

$$\frac{\partial\gamma}{\partial\sigma_g} = e\zeta\left(\sigma_e\tau\, A^{\frac{1}{1-\eta}}\left(\tau\,\sigma_g\left(1-e\right)^{\eta}\right)^{\frac{\eta}{1-\eta}}\right)^{1-\alpha}\frac{\left(1-\alpha\right)\eta}{\left(1-\eta\right)\sigma_g} > 0 \tag{25}$$

A.2 Proof of proposition 2

$$\frac{\sigma_g^*}{da} = \frac{d\sigma_g^*}{dv}\frac{dv}{da} = \eta\frac{\beta\left(1-\pi\right)\left(1-\alpha\right)}{\left[\theta+\beta v\left(1-\pi\right)\left(1-\alpha\right)\right]^2}\frac{dv}{da} < 0$$

$$\frac{\sigma_e^*}{da} = \frac{d\sigma_e^*}{dv}\frac{dv}{da} = \left(1-\eta\right)\frac{\beta\left(1-\pi\right)\left(1-\alpha\right)}{\left[\theta+\beta v\left(1-\pi\right)\left(1-\alpha\right)\right]^2}\frac{dv}{da} < 0$$

because of assumption (A.2) which implies that $v'\left(a\right) < 0$.

Table 1: Summary statistics

Variable	**Definition**	**Sample 1 - 1983:2004**		**Sample 2 - 1995:2004**		**Sample 3 - 1995:2004**	
		Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
background	% of politicians with local/regional political background	60.27	17.71	59.33	15.50	60.19	16.55
female	% of female politicians	20.54	12.11	24.72	11.12	23.80	11.78
gerontocracy	politicians' mean age	48.32	1.92	48.74	1.99	44.58	2.11
newcomers	newcomers' mean age	43.63	3.03	44.60	2.59	44.65	2.78
hhs	hours worked by high-skilled workers (% of total hours)	10.37	9.47	11.38	9.72	12.21	10.18
hms	hours worked by medium-skilled workers (% of total hours)	64.17	17.39	67.70	14.70	68.13	15.68
hls	hours worked by low-skilled workers (% of total hours)	25.45	16.52	21.02	13.01	19.66	13.40
h_{29}	hours worked by persons engaged aged 15-29 (% total hours)	27.63	7.82	24.44	7.26	24.92	7.60
h_{49}	hours worked by persons engaged aged 29-49 (% total hours)	53.99	7.83	55.58	7.27	55.28	7.61
h_{+50}	hours worked by persons engaged aged 50 and over (% total hours)	18.38	6.40	19.98	6.72	19.80	7.00
tfp	TFP (value added based) growth, 1995=100	100.00	57.10	104.84	17.76	104.63	17.21
gos	gross operating surplus	0.18	0.12	0.18	0.11		
ict	ICT capital services, volume indices, 1995 = 100	117.59	105.52	191.08	109.90	197.89	114.84
nict	non ICT capital services, volume indices, 1995 = 100	98.41	18.39	109.22	16.21	110.08	16.63
gict	public ICT capital services, volume indices, 1995 = 100	111.63	86.38	176.29	79.68	185.31	82.59
tax	taxes (minus subsidies on production) over gross output	0.01	0.02	0.01	0.03	0.01	0.02
marketopenness	exports/gdp (constant US$)	0.34	0.13	0.33	0.13	0.37	0.14
$log(pexpedu)_{gdp}$	public expenditure on education as a % of GDP	5.80	1.00	5.66	1.25	5.85	1.26
observations		2916		1485		1269	

Note: Sample 1 refers to the period 1983-2004 and it includes only DNK, FIN, FRA, ITA, NLD and UK; Sample 2 includes all countries, but it spans a shorter period from 1995 to 2004. Finally, Sample 3 contains data from all the countries included in Sample 1 but with respect the sub-period period 1995-2004.

Table 2: Hours worked by person engaged: by sector, 1983-2004

Sector	High skilled	Medium skilled	Low skilled
1	10.03 %	66.64 %	23.33 %
2	8.51 %	63.16 %	28.33 %
3	23.19 %	62.49 %	14.35 %
4	6.51 %	67.51 %	25.98 %
5	12.18 %	62.04 %	25.78 %
6	9.13 %	64.83 %	26.04 %
avg	11.59 %	64.44 %	23.97 %

Note: 1 - Electrical machinery and tele-communication, 2 - Manufacturing, 3 - Finance and business services, 4 - Retail services, 5 - Personal and social services, 6 - Non-market services + other goods producing industries.

Table 3: Correlation between TFP growth index and Gerontocracy, 1983-2004

country/ sector	DNK	FIN	FRA	GER	ITA	NLD	UK	avg
1	-0.521	0.129	-0.179	-0.645	-0.444	-0.741	-0.635	-0.434
2	0.034	0.146	-0.101	-0.537	-0.606	-0.565	-0.503	-0.305
3	-0.109	0.007	0.197	0.108	0.146	0.473	0.427	0.178
4	-0.083	0.239	-0.040	-0.609	-0.617	-0.643	-0.637	-0.341
5	0.648	-0.035	0.065	0.515	0.348	0.295	0.479	0.331
6	-0.281	0.128	0.038	-0.491	-0.013	-0.022	-0.454	-0.157
Avg	-0.052	0.102	-0.003	-0.277	-0.198	-0.201	-0.220	-0.121

Note: 1 - Electrical machinery and tele-communication, 2 - Manufacturing, 3 - Finance and business services, 4 - Retail services, 5 - Personal and social services, 6 - Non-market services + other goods producing industries.

Table 4: Correlation between TFP growth index and Newcomers, 1983-2004

country/ sector	DNK	FIN	FRA	GER	ITA	NLD	UK	avg
1	-0.230	-0.195	0.450	-0.825	-0.404	0.292	0.442	-0.067
2	0.061	-0.067	0.235	-0.586	-0.578	0.467	0.454	-0.002
3	-0.022	0.019	-0.305	0.597	0.169	-0.572	-0.470	-0.084
4	-0.051	-0.012	0.259	-0.552	-0.574	0.309	0.472	-0.021
5	0.369	-0.100	-0.261	0.681	0.543	-0.558	-0.284	0.056
6	-0.092	-0.027	-0.111	-0.622	0.055	0.170	0.342	-0.041
Avg	0.006	-0.064	0.045	-0.218	-0.131	0.018	0.159	-0.026

Note: 1 - Electrical machinery and tele-communication, 2 - Manufacturing, 3 - Finance and business services, 4 - Retail services, 5 - Personal and social services, 6 - Non-market services + other goods producing industries.

A.3 Data definitions and sources

Table 5: Correlation between TFP growth index and Public ICT, 1983-2004

country/ sector	DNK	FIN	FRA	GER	ITA	NLD	UK	avg
1	0.911	0.878	0.966	0.908	0.693	0.759	0.931	0.864
2	0.014	0.818	0.535	0.693	0.671	0.672	0.462	0.552
3	0.306	0.127	-0.829	-0.160	-0.147	-0.684	-0.202	-0.227
4	0.091	0.671	0.328	0.823	0.613	0.638	0.741	0.558
5	-0.907	0.068	-0.494	-0.727	-0.719	-0.491	-0.837	-0.587
6	0.619	0.723	-0.266	0.694	0.070	0.114	0.758	0.387
avg	0.172	0.547	0.040	0.372	0.197	0.168	0.309	0.258

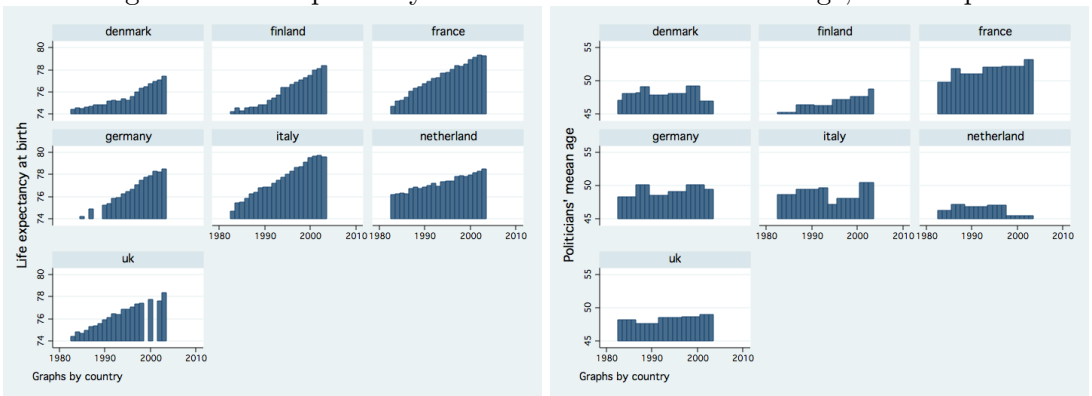
Note: 1 - Electrical machinery and tele-communication, 2 - Manufacturing, 3 - Finance and business services, 4 - Retail services, 5 - Personal and social services, 6 - Non-market services + other goods producing industries.

Table 6: Correlation between TFP growth index and Private ICT, 1983-2004

country/ sector	DNK	FIN	FRA	GER	ITA	NLD	UK	Avg
1	0.912	0.881	0.781	0.729	0.619	0.663	0.953	0.791
2	0.017	0.654	0.558	0.625	0.287	0.594	0.509	0.463
3	0.167	-0.157	-0.892	-0.298	-0.084	-0.737	-0.229	-0.319
4	0.120	0.714	0.200	0.744	0.568	0.629	0.763	0.534
5	-0.902	0.259	-0.780	-0.740	0.501	-0.574	-0.861	-0.442
6	0.479	0.772	-0.098	0.347	0.281	0.118	0.478	0.340
avg	0.132	0.521	-0.038	0.235	0.362	0.116	0.269	0.228

Note: 1 - Electrical machinery and tele-communication, 2 - Manufacturing, 3 - Finance and business services, 4 - Retail services, 5 - Personal and social services, 6 - Non-market services + other goods producing industries.

Figure 1: Life expectancy at birth & Politicians' mean age, our sample



Source: our calculations based on EURELITE data

Table 7: Parameter estimates: pooled data

	Sample 1 - 1983:2004			**Sample 2 - 1995:2004**			**Sample 3 - 1995:2004**		
	$log(tfp)$	$log(ict)$	$log(gict)$	$log(tfp)$	$log(ict)$	$log(gict)$	$log(tfp)$	$log(ict)$	$log(gict)$
$log(hhs)_{t-1}$	0.0123	0.0317**	0.0524***	0.0040	0.0109	0.0065	0.0153	-0.0120	0.00330
$log(hms)_{t-1}$	0.135***	0.165***	0.135***	0.0856**	0.0134	0.0378*	0.0544	0.0812	-0.000403
$log(hls)_{t-1}$	-0.0112	0.0739***	0.131***	0.0264**	0.0117	-0.0055	0.0294**	0.00366	0.00756
$log(h_{29})_{t-1}$	0.1393***	0.196***	-0.167***	0.0975***	0.206***	0.0151	0.112***	0.162**	-0.00295
$log(h_{49})_{t-1}$	0.2074***	0.311***	-0.313***	0.371***	0.310**	-0.0159	0.356***	0.320**	0.00908
$log(h_{50+})_{t-1}$	0.0784***	0.0302	-0.126***	0.0221	0.122**	0.0469***	0.0399	0.0930	0.00338
$log(gerontocracy)_{t-1}$			-4.5578***			-5.0014***			-3.294***
$log(newcomers)_{t-1}$			0.9068***			0.6866***			0.386***
$log(background)_{t-1}$			0.1963***			-0.4346***			-0.855***
$log(female)_{t-1}$			0.0123			0.0290*			0.0275*
$pexpedu_{t-1}$	-0.0211**	0.0229	0.184***	-0.0633***	-0.0692*	-0.0040	-0.0623***	-0.0786**	0.00332
$log(ict)_{t-1}$	0.0104			-0.0720***			-0.0580***		
$du95$	0.0178***								
$du95 \cdot log(ict)_{t-1}$	-0.0083**								
$log(nict)_{t-1}$	-0.0981***	0.287***		-0.0744**	0.702***		-0.0452	0.601***	
$log(gict)_{t-1}$	0.0783***	0.606***		0.196***	0.647***		0.183***	0.714***	
gos_{t-1}	0.2194***	0.169**		0.287***	-0.0969		0.307***	-0.190*	
$log(marketopeness)_{t-1}$	0.2020***			0.0623			-0.0511		
$trend$		0.0468***	0.118***		0.0309***	0.110***		0.0217**	0.121***
$constant$	2.9171***	-95.96***	-218.8***	2.437***	-64.89***	-196.7***	2.200***	-46.41**	-221.5***
$country\ dummies$	yes	yes	yes	yes	yes	yes	yes	yes	yes
$observations$	2,803	2,803	2,803	1,336	1,336	1,336	1,144	1,144	1,144
$R-squared$	0.150	0.831	0.929	0.161	0.685	0.967	0.156	0.685	0.979

Note: Sample 1 includes DNK, FIN, FRA, ITA, NLD and UK from 1983 to 2004. In sample 2 we add GER but limit the time period from 1995 to 2004.
Sample 3 includes countries of Sample 1 but spans from 1995 to 2004. *** Indicates significance at the 1% level; ** significance at 5%, * significance at 10%.

Table 8: Elasticities of the effect of Gerontocracy on TFP growth: pooled data and by sector

Sample	**Direct effect via** *gict*	**Indirect effect via** *ict*	**Total effect**
Pooled data (2,803 obs., 1,144 obs., 1,336 obs.)			
Sample 1 - 1984:2004	-0.333***	-0.005	-0.339***
Sample 3 - 1995:2004	-0.602***	0.136***	-0.465***
Sample 2 - 1995:2004	-0.981***	0.233***	-0.748***
Electrical machinery and TC (249 obs., 96 obs., 112 obs.)			
Sample 1 - 1984:2004	-0.570***	0.002	-0.568***
Sample 3 - 1995:2004	-0.385	-0.156	-0.541**
Sample 2 - 1995:2004	-0.962***	-0.077	-1.040***
Manufacturing (1,290 obs., 480 obs., 560 obs.)			
Sample 1 - 1983:2004	-0.490***	0.105	-0.385***
Sample 3 - 1995:2004	-0.392***	0.105	-0.288***
Sample 2 - 1995:2004	-0.490***	0.105	-0.385***
Finance and business services (238 obs., 88 obs., 104 obs.)			
Sample 1 - 1983:2004	-0.285**	0.069*	- 0.216*
Sample 3 - 1995:2004	-0.154	0.088	- 0.242
Sample 2 - 1995:2004	-0.577**	-0.024	-0.602**
Retail services (468 obs., 192 obs., 224 obs.)			
Sample 1 - 1983:2004	-0.340***	-0.024	-0.364***
Sample 3 - 1995:2004	-0.208	-0.039	-0.168
Sample 2 - 1995:2004	-0.090	-0.019	-0.109
Personal and social service (258 obs., 96 obs., 112 obs.)			
Sample 1 - 1983:2004	-0.142**	0.001	-0.141**
Sample 3 - 1995:2004	-0.384***	-0.072	-0.457***
Sample 2 - 1995:2004	-0.592***	-0.119	-0.711***

Note: Sample 1 includes DNK, FIN, FRA, ITA, NLD and UK from 1983 to 2004. In Sample 2 we add GER but limit the time period from 1995 to 2004. Sample 3 includes countries of Sample 1 but spans from 1995 to 2004.

*** Indicates significance at the 1% level; ** significance at 5%, * significance at 10%.

Table 9: Elasticities of the effect of Gerontocracy on TFP: by country

Country	**Sample**	**Obs.**	**Direct effect via** *gict*	**Indirect effect via** *ict*	**Total effect**
Denmark	*Sample 1 - 1983:2004*	480	-0.216	0.033	-0.182
Finland	*Sample 1 - 1983:2004*	480	-21.044***	-3.198	-24.124***
France	*Sample 1 - 1983:2004*	480	0.011	0.010	0.021
Germany[a]	*Sample 2 - 1995:2004*	216	-7.260**	-0.482	-7.741**
Italy	*Sample 1 - 1983:2004*	415	-3.246***	0.019	-3.227***
Netherland	*Sample 1 - 1983:2004*	468	-1.989***	0.855***	-1.134***
UK	*Sample 1 - 1983:2004*	480	0.203***	0.003	-0.201***

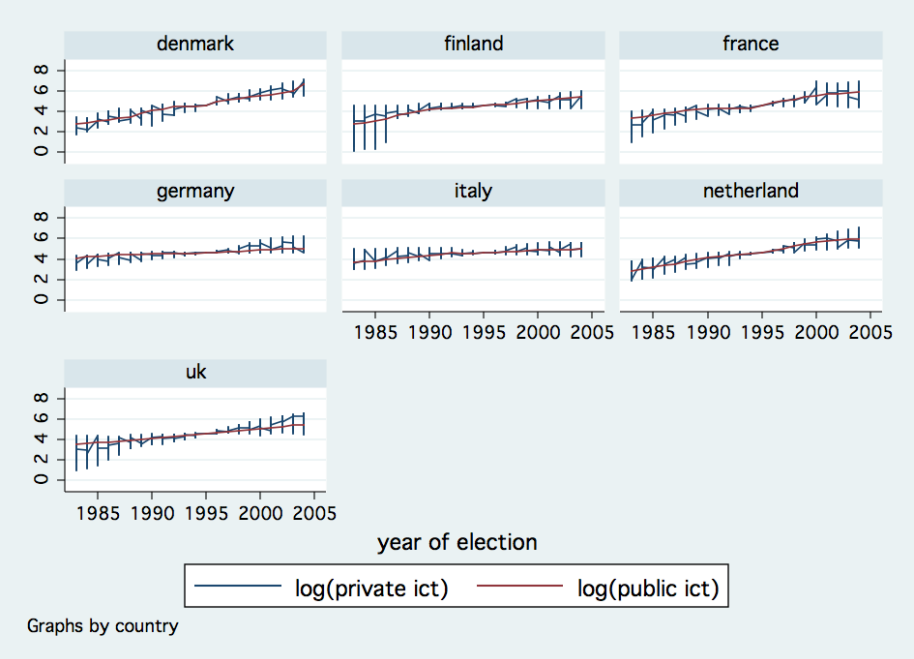
[a] Due to constancy over time, some variables referred to politician characteristics have not been included as controls in the TFP equation for Germany and, therefore, it is slightly different from those of other countries.

Note: *** Indicates significance at the 1% level; ** significance at 5%, * significance at 10%.

Table 10: Data definitions and sources

Variables	Source
Gerontocracy related variables	
$log(gerontocracy)$ = log of the politicians' mean age	EURELITE
$log(newcomers)$ = log of the newcomers' mean age	EURELITE
$background$ = % of politicians with local/national political backbround	EURELITE
$female$ = % of female politicians	EURELITE
Growth accounting variables	
tfp = TFP (value added based) growth (1995=100)	EU-KLEMS
$log(ict)$ = log of ICT capital services (1995=100)	EU-KLEMS
$log(nict)$ = log of non-ICT capital services (1995=100)	EU-KLEMS
$log(gict)$ = log of non-market + other goods industries ICT capital services (1995=100)	our calculation on EU-KLEMS
$log(hhs)$ = log of hours worked by high-skilled persons engaged (share in total hours)	EU-KLEMS
$log(hms)$ = log of hours worked by medium-skilled persons engaged (share in total hours)	EU-KLEMS
$log(hls)$ = log of hours worked by low-skilled persons engaged (share in total hours)	EU-KLEMS
$loh(h_{29})$ = log of hours worked by persons engaged aged 15-29 (share in total hours)	EU-KLEMS
$log(h_{49})$ = log hours worked by persons engaged aged 29-49 (share in total hours)	EU-KLEMS
$log(h_{+50})$ = log of hours worked by persons engaged aged 50 and over (share in total hours)	EU-KLEMS
tax = taxes minus subsidies on production/gross output	EU-KLEMS
gos = Gross operating surplus (in millions of local currency)	EU-KLEMS
$log(marketopenness)$= log of exports plus Imports divided by GDP is the total trade as a percentage of GDP	PWT 6.1
Education variables	
$pexpedu_{pe}$= public expenditure on education as a percentage of total public expenditure	EUROSTAT
$pexpedu_{gdp}$= public expenditure on education as a percentage of GDP	EUROSTAT

Figure 2: Private and public ICT



Source: our calculations