# Special Interests and Technological Change[¤]

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### Abstract

We model an OLG economy where productivity growth comes from two alternative sources: process innovation and learning-by-doing. There is a trade-o¤ between the two in so far as frequent technological updates reduce the scope for learning on existing technologies. A con‡ict is shown to arise between the young and the old, because the former favor innovation while the latter prefer learning. We model the interaction between di¤erent generations and short-lived policy makers as a dynamic common agency problem, where competing generations invest a certain amount of resources to lobby either for the maintainance of the current technology or the adoption of a new one. By focusing on truthful Markov perfect equilibria, we characterize the political equilibrium and show its dependence on the underlying technological parameters.


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## 1. Introduction

> "the country that is more developed industrially only shows, to the less developed, the image of its own future" (Karl Marx)

As pointed out by Lucas (1988) in his breath-taking manifesto, one the greatest challenges to economic thinking is to understand the origins of large international income di¤erences, the reason being that such wide di¤erences - of factor 30-40 between the tails of the per capita income levels distribution - seem to signal the existence of huge unexploited possibilities for improving human welfare. A decade after, even if our understanding has made important steps forward, the challenge is still there (Prescott, 1998). On the one side, neoclassical growth theory has driven our attention to international di¤erences in the stocks of productive factors. However, simple growth accounting exercises show that di¤erences in such stocks could explain di¤erences in per capita income levels only if investment in intangible assets (e.g. human and organizational capital) were implausibly large - in some instances, as large as GDP. On the other side, new growth theory has stressed the role of international di¤erences in endogenously accumulated stocks of usable knowledge as signalled by di¤erences in total factor productivities. However, this perspective clashes with the observed absence of clear national biases in international absolute labor productivities across sectors: after all, if workers in one country were better educated or had better work practices than workers in another country, the former should be more productive than the latter in all sectors. Therefore, di¤erences in the stocks of factors and of usable knowledge provide only a partial explanation of international income discrepancies.

Prescott (1998) argues that, in order to complete the explanation, it is not usable knowledge in itself that has to be considered but rather the amount of usable knowledge that is actually used. Total factor productivities di¤er because countries di¤er in terms of their ability to adopt or fully exploit newer and newer available technologies, or what Kindleberger (1962) calls "the capacity to transform". Because new technology adoption induces structural changes whose acceptance requires to trade o¤ short term adjustment sacri…ces against long term e¢ciency gains, the capacity to transform is largely determined by the composition of 'progressive' and 'conservative' con‡icting interests ("the clash between progress and security", Fisher, 1935). Under this perspective, the wealth of nations comes to depend on the e¢cacy of institutional interest intermediation processes that lead to national decision making. This vision is strongly supported by historical evidence (Olson, 1982; Gilpin 1987; Mokyr, 1990). A classical example of the failure of institutional interest intermediation is the inertial explanation of the decline of Great Britain as the world hegemonic economic power towards the end of the nineteenth century: "Britain was caught in a set of ideological traps. All the strategies available to her were blocked o¤ in one way or another" (Lewis, 1978). The vision is also broadly consistent with evidence coming from international sectorial analyses (e.g., Clark, 1987; Baily, 1993; Wolcott, 1994; Baily and Gersbach, 1995) and business-oriented case studies which point out how ideological traps may oppose the development of …rms 'competitive advantage' through technological upgrading (Porter, 1990).

Our aim is to investigate how ideological traps blocking the adoption of new technologies may arise from unbalanced interest representation as well as short-sighted decision making and, thus, to suggest that international di¤erences in total factor productivity may be linked to international discrepancies in the mechanics of political intermediation between conservative and progressive interests.

To capture in a simple way such a clash between conservative and progressive interests, we model an OLG economy where productivity growth comes from two alternative sources: process innovation and learning-by-doing. There is a trade-o¤ between the two insofar as frequent technological updates reduce the scope for learning on existing technologies. A con‡ict is shown to arise between the young and the old, because the former favor innovation while the latter prefer learning. Under this respect, the economics of the paper is much in the spirit of Krusell and Rìos-Rull's (1996) path-breaking contribution based on the vintage human capital model of Chari and Hopenhayn (1991). However, in order to make our point as clear as possible, we use the streamlined version of that work as presented by Aghion and Howitt (1998). The idea is simple. At each point in time there is an incumbent vintage of an aggregate technology. Such a vintage can either be still improvable or obsolete. In the former case, learning-by-doing can enhance its productivity, in the latter the scope for learning is exhausted. Also at each point in time there is a new vintage, which is freely available and, if adopted, becomes more productive than the old one only after some running in. This initial productivity gap is the more severe the less learning has taken place on the previous vintage. Therefore, there is a trade-o¤ between innovation and learning-by-doing, which creates a potential con‡ict of interests between the young and the old who, due to their di¤erent life horizons, tend to favor innovation and learning by doing respectively.

A more signi…cant departure from the existing literature is made in terms of interest intermediation. Both Krusell and Rìos-Rull (1996) and Aghion and Howitt (1998) assume that the intergenerational con‡ict is handled by democratic voting so that the interests of the larger generation prevail. While an enlightening …rst step, this approach is unsatisfactory for two main reasons. First, when technological change is involved, public intervention usually takes the form of government regulation in areas such as product and security standards, environmental policy, restrictions on entry, and trade barriers, which are the realm of organized interest group action rather than of democratic voting (Viscusi, Vernon and Harrington, 1993). Second, by attributing an overwhelming role to demographic factors, democracy somehow obscures the underlying economic stances.[1] For both reasons, we model an alternative mechanism of interest intermediation, based on the action of organized interest groups, that will be shown to yield a resolution of the intergenerational con‡ict in which economic factors play a relevant role. In so doing, we build on the ideas of Olson (1965) who argues that what matters for the success of special interest groups are the relative surpluses that they are able to generate for their members, rather than their relative demographic sizes. His insights have been recently formalized in terms of a common agency set-up where, in the wake of Bernheim and Whinston (1986), competing interest groups (principals) lobby an incumbent policy maker (agent) in order to in‡uence her decisions (see, e.g., Grossman and Helpman, 1994; Dixit, Grossman and Helpman, 1997; Grossman and Helpman, 1998).[2] The policy maker knows the e¢cient decision to make for the living generations, but she is assumed to trade o¤ aggregate welfare against special interests.

While our work is deeply rooted in the common agency approach to politics, we depart from its standard implementation under one major respect that brings

[1] From an empirical point of view, this feature may also clash with the insigni…cance of demographic variables often found in growth regressions (Levine and Renelt, 1992).

[2] See also the elegant foundation by Grossman and Helpman (1996) who introduce lobbies in a democratic environment where competing ideologically oriented parties use campaign contributions from aligned groups of voters in order to win seats in parliament. Such contributions are spent to in‡uence the voting behavior of uninformed (not aligned) citizens.

us back to the original menu auction of Bernheim and Whinston (1986). We like to think of our regulator (auctioneer) as being uninformed and with no personal preferences over alternative policy choices. Moreover, her decision making is (possibly slightly) costly so that inertia is the policy outcome in the absence of any external stimulus. Interest groups (bidders) understand the potential role of their activities (menus of o¤ers) in fostering the implementation of their favorite policies and are willing to use resources to make themselves heard. The strengths of their competing e¤orts transmit their private information to the policy maker. In our simple framework, this means that competing generations invest a certain amount of resources in supporting either the maintenance of the current vintage technology or the adoption of the new one. In doing so, they expect the policy maker to implement the alternative, whose support absorbs the larger amount of resources. Therefore, our characterization of special interest politics is essentially di¤erent from the one based on in‡uence/campaign driven contributions (Tullock, 1967; Krueger, 1974; Bhagwati, 1982; Becker, 1983; Snyder, 1990) even in its recent common agency formulation and it is closer to the idea of informational lobbying (Banks and Weingast, 1992; Ainsworth, 1993; Austen-Smith and Wright, 1992 and 1994; Lohmann, 1995), which views interest groups as sources of information for imperfectly informed politicians.

As in Grossman and Helpman (1998), political myopia is embedded in the model by assuming that regulators stand in o¢ce for one period only. This leads to the characterization of the mechanics of interest intermediation in each moment as a menu auction game between a one-period-lived auctioneer and two overlapping generations of bidders. We are not aware of any study of such a game and even related results are scarce. Bergemann and Välimäki (1998a) analyze a repeated common agency game with imperfect observability. They also investigate a dynamic common agency game with in…nitely-lived players and propose the Truthful Markov Equilibrium concept that we also adopt (Bergemann and Välimäki, 1998b). Grossman and Helpman (1998) characterize the Markov Perfect Equilibrium of a common agency game in which there are overlapping generations but only the older is exogenously assumed to act as an active principal. Moreover, while their policy space is continuous, our technology adoption choice is inherently binary. This discrete feature will be shown to give rise to endogenous lobby formation.[3]

By assuming for simplicity that auctioneers maximize total bids and perfect information on the side of the bidders (Bernheim and Whinston, 1986), we are able to show that, first, the winner of the auction is the interest group that is able to generate the larger relative surplus for its members independently from its size. Second, because of perfect information, the expected loser does not organize any collective action. Third, the winner's effort absorbs an amount of resources which is equal to the relative surplus that the losing group would obtain were it to chose the policy (second-price) so that, provided that existing generations have free access to the lobbying process, the outcome is efficient from their point of view. This result, which is a corollary of well-known properties of auctions (Riley and Samuelson, 1981; Bernheim and Whinston, 1986; Wolfstetter, 1996), is reminiscent of the efficiency argument by Wittman (1989) who sustains that competing uninformed political entrepreneurs have all the incentives to discover and exploit unknown political demands. Fourth, the identity of the winner depends crucially on the underlying economic parameters. Fifth, a cycle which involves periods of stagnation being followed by periods of technological change may arise endogenously from the competing actions of organized interest groups. Sixth, such economic cycle is accompanied by an endogenous political cycle of lobbies formation. Seventh, because policy makers are short-lived and living generations do not take into account the impact of their choices on all future generations, in general the political outcome is dynamically inefficient from the point of view of future generations. Therefore, unbalanced interest representation and short-sighted decision making lead to inefficient technological trajectories.

The implication of our analysis is that international income differences could be traced back to more or less severe problems of interest representation and policy makers' planning horizons. Interestingly enough, since, due to more contained free rider problems and incumbent advantages, more concentrated and better-established interests are likely to face substantially lower costs of collective action than more diffuse and recent ones (Olson, 1965; Bendor and Mookerjee, 1987), our analysis also suggests that extended democratic mandates can be interpreted as a 'second-best' political solution that sacrifices some information about the personal intensities of citizens' preferences ('intensive information') in favor of

[3] Nonetheless, as Grossman and Helpman (1998), we assume away the problem that free riding creates to the organization of collective action (Olson, 1965).

wider participation to the policy making process ('extensive information') (Dahl, 1994).

The remainder of the paper consists of four additional sections. The first introduces the model. After presenting the political equilibrium concept, the second solves the model and comments on the efficiency of the policy outcome. The third studies the emergence of endogenous economic and political cycles in relation to the underlying parameters. The fourth concludes.

## 2. The model

### 2.1. Economics

Consider an overlapping generations framework consisting of agents who live for two periods only. At any moment in time two generations are alive: the old $O$ and the young $Y$ with lifetime horizons of one and two periods respectively. Population grows at a costant rate $n$.

Each generation is made of homogeneous agents. At birth the lifetime preferences of the representative agent born at time $t$ are represented by the following intertemporal utility function:

$$u^t = c_t^t + \rho c_{t+1}^t \tag{2.1}$$

where $c_s^t$ is consumption at time $s$ of the agent born at $t$ and $\rho \in (0;1)$ is the discount factor.

Independently from their generation, all agents supply inelastically one unit of the sole factor of production, say labor $L$, which is employed to produce a unique consumption good $X$ under constant returns to scale. At any point in time per-capita output is given by:

$$x_t = \lambda A^{\alpha} \tag{2.2}$$

where $x_t$ is the output share of each individual alive at time $t$, and $\lambda A^{\alpha}$ is labor productivity. The final good cannot be stored and there are no capital markets. Thus, in each period and for each generation, consumption equals disposable income.

Labor productivity improves in time due to process innovation. Progress comes in the form of new vintages $\alpha$ of technology. Each vintage induces an improvement of size $A \in (1, \infty)$. However, the full exploitation of a new vintage technology requires learning-by doing. In particular, we assume that learning takes one period so that $\lambda \in (0; 1)$ when the new vintage is introduced and $\lambda = 1$ after one period. Moreover, part of the learning obtained on the old vintage spills over to the new vintage: $\lambda = \underline{\lambda}$ if learning-by-doing did not occur on the old vintage, and $\lambda = \bar{\lambda} > \underline{\lambda}$ if it occurred.

Accordingly, when deciding whether to substitute the existing vintage $\alpha$ with the new vintage $\alpha + 1$, agents may face a trade-off between the productivity gains of learning-by-doing and those of process innovation. In particular, this is the case if:

$$\underline{\lambda}A < 1 < \bar{\lambda}A \tag{2.3}$$

The existence of a trade-off between innovation and learning-by-doing creates a potential intergenerational conflict. The old, who will not be there next period, may prefer the current productivity gains arising from learning on the existing vintage. On the contrary, the young, who will be alive next period, may like to trade such gains for future productivity improvements stemming from current innovation.

### 2.2. Politics

Innovation policy is the outcome of a process of interest intermediation by public regulators. Regulators are assumed to be short-lived in that they remain in charge for one period only and they are all identical (Grossman and Helpman, 1998). On the one hand, they have no inherent preferences about policies and are a priori unaware of the existence as well as the potential of new vintages so that, when left alone, they maintain the status quo technology. On the other hand, they can be forced into action by special interests.

We model the mechanism of interest intermediation as a common agency game. Each generation has the opportunity of getting organized as a pressure group in order to influence the regulator's decision through collective activities. These activities may materialize in support demonstrations or in various sorts of direct and indirect side-payments to the incumbent regulator, such as bribes and campaign contributions. Due to coordination problems, such collective activities absorb resources. Only if a pressure group spends a positive amount of resources, the regulator is able to hear its voice. The efficacies of collective activities depends only on the amount of resources spent and neither the identity nor the size of the corresponding interest group. This amounts to assuming, first, that the 'pressure-formation function', which maps a group's lobbying expenditures into regulator's payoff, exhibits constant returns to scale as well as unitary unit input coefficient and, second, that the regulator's payoff is a simple sum of groups' collective expenditures.

The specific mechanism we consider is a first-price menu-auction game (Bernheim and Whinston, 1986) in which each period $t$ the regulator selects an action and each lobby of the living cohorts offers a menu of contributions contingent on the action chosen. The lobbies pay their announced contributions for the allocation ultimately chosen by the regulator and this choice is made to maximize the regulator's payoff, given the menus of offers announced. A complication with respect to the original set-up by Bernheim and Whinston (1986) comes from the fact that, in choosing their contributions at time $t$, the young must look ahead to period $t + 1$. This is because they will still be around and their future consumption will be affected by both the policy adopted and the contributions paid at that time.

In principle, this game has a potentially large set of equilibria. To limit their number, we restrict our attention to Nash equilibria which are both 'truthful', in that the corresponding contributions correctly reflect relative preferences for the various alternatives and Markov-perfect in that, in a stationary environment, expected policies are not only self-fulfilling but also depend only on the values of the state variable expected at that time (Krusell and Rìos-Rull, 1996).[4]

Specifically, we extend the common agency model of Bernheim and Whinston (1986) to a dynamic setting. In each period there are three players: an agent (the regulator) and two principals (the lobbies of the currently young and old). Players are short-lived. The regulator lives one period only and so does the lobby of the currently old. The lobby of the currently young becomes next period old lobby. Therefore, we have a dynamic common agency set-up with one-period-lived agents and overlapping generations of principals.[5]

[4] Truthful Nash equilibria are appealing because they are the only Nash equilibria that are stable when nonbinding communication is possible. Moreover, as we will see, they have strong efficiency properties.

[5] Short-lived agents and overlapping generations of principals differentiate our extension from the dynamic common agency game with infinitely lived players studied by Bergemann and

Time is discrete and is denoted by $t = 0, 1, ..., \infty$. The lobbies are indexed by $i \in I = \{Y, O\}$. In each period the regulator can select an action (policy) $p_t \in P \in \{I, N\}$ where $I$ and $N$ stand respectively for 'innovation' and 'no innovation'. Each lobby offers a reward scheme (contribution) $r_i(p_t; z_t) \in R^2_+$ which depends on the history $z_t$ and the action $p_t$ chosen by the regulator in period $t$. Let $r_t \equiv (r_O(I; z_t); r_O(N; z_t); r_Y(I; z_t); r_Y(N; z_t))$ be the list of lobbies' contributions in period $t$, $p \equiv (p_0; ...; p_t; ...)$ be the list of policies chosen in each period and $r \equiv (r_0; ...; r_t; ...)$ be the list of the lists of lobbies' contributions in each period.

The history of the game in period $t$ is $z_t \equiv (p_0; ...; p_{t-1}; r_0; ...; r_{t-1})$ and $Z_t$ is the set of all possible $t$ period histories. The future in period $t$ is the sequence of future actions $(p^t; r^t) = (p_{t+1}; ...; r_{t+1}; ...)$. We denote by $Z(z_t)$ the set of all possible histories $z_{t+1}$ which are accessible from history $z_t$, and analogously $Z(p_t; z_t)$ the set of all possible histories $z_{t+1}$ generated by $z_t$ and $p_t$. Both actions $I$ and $N$ can be implemented by the regulator at no cost and no inherent personal benefit. On the contrary, they are not indifferent to the lobbies. The instantaneous flow benefit of regulator's action $p_t$ to lobby $i$ is $v_i(p_t; z_t)$.

A reward strategy for lobby $i$ is a mapping $r_i : P \times Z_t \to R^2_+$ which assigns to every possible action $p_t \in P$ of the regulator a nonnegative reward contingent on the past history of the game. A strategy for the regulator is an action $p : R^2_+ \times Z_t \to P$ which depends on the aggregate reward in period $t$.

With history $z_t$ the expected payoff for the regulator of an action $p_t$ is the total reward raised: $r_O(p_t; z_t) + r_Y(p_t; z_t)$. The expected payoff for the old lobby is the current flow benefit net of the regulator's reward:

$$n_O(p_t; z_t) \equiv v_O(p_t; z_t) - r_O(p_t; z_t)$$

while the expected payoff of the young lobby also includes the expected next-period flow benefit $V(p_t; z_t)$ if in period $t$ the action was $p_t$ and history was $z_t$:

$$n_Y(p_t; z_t) \equiv v_Y(p_t; z_t) - r_Y(p_t; z_t) + \rho V(p_t; z_t)$$

To reduce the number of potential equilibria, we restrict our attention to strategies that in any period $t$ do not depend on the entire history of the game $z_t$, but only on the previous period regulator's action $p_{t-1}$ (Markov strategies)

Välimäki (1998).

and that in addition are 'truthful' (Bernheim and Whinston, 1986; Bergemann and Välimäki, 1998b). Notice that the previous period regulator's action is the "natural" choice as the state variable of the economy, since current payoffs (and therefore current actions) depend crucially on whether in the previous period there was a technological change or not.

**Definition 1.** A markovian reward strategy $r_i(p_t; p_{t-1})$ for lobby i is said to be truthful with respect to $(\tilde{p}; p_{t-1})$ if and only if for all $p_t \in P$, either

(i) $n_i(p_t; p_{t-1}) = n_i(\tilde{p}; p_{t-1})$

or

(ii) $n_i(p_t; p_{t-1}) < n_i(\tilde{p}; p_{t-1})$, and $r_i(p_t; p_{t-1}) = 0$.

Accordingly, we propose the following recursive definition of the equilibrium of our dynamic political common agency game:

**Definition 2.** The strategies $r^*_O(p_t; p_{t-1})$, $r^*_Y(p_t; p_{t-1})$ and $p^*(r(:); p_{t-1})$ form a Markov Perfect Equilibrium (MPE) in truthful strategies if and only if:

(i) for all $p_{t-1}$ and all $r(:)$, $p^*(r(:); p_{t-1})$ is a solution to

$$\max_{p_t \in P} \{r_O(p_t; p_{t-1}) + r_Y(p_t; p_{t-1})\}$$

(ii) for all $p_{t-1}$, there is no other reward function $\hat{r}_O(p_t; p_{t-1})$ such that

$$n_O(\hat{p}_t; p_{t-1}) > n_O(p^*_t; p_{t-1})$$

where $p^*$ and $\hat{p}$ are best response actions to $(r^*_O(:); r^*_Y(:))$ and $(\hat{r}_O(:); r^*_Y(:))$ respectively.

(iii) for all $p_{t-1}$, there is no other reward function $\bar{r}_Y(p_t; p_{t-1})$ such that

$$n_Y(\bar{p}_t; p_{t-1}) > n_Y(p^*_t; p_{t-1})$$

where $p^*$ and $\bar{p}$ are best response actions to $(r^*_O(:); r^*_Y(:))$ and $(r^*_O(:); \bar{r}_Y(:))$ respectively.

(iv) $r^*_O(:)$ and $r^*_Y(:)$ are truthful strategies with respect to $p^*(:)$.

## 3. The political equilibrium

Operationally, the characterization of the set of truthful equilibria requires the evaluation of the young lobby's next-period expected benefit $V(p_t; z_t)$. Such evaluation can be done by following Definition 2, which implies that the two different triples of players, who are active in two different periods $t_1$ and $t_2$, will take the same equilibrium actions when confronted with the same history $p_{t_1-1} = p_{t_2-1}$. This restricts the set of candidate equilibria to those entailing only four alternative patterns of technological change $(p_t; p_{t-1}) \in \{(I; I); (N; I); (I; N); (N; N)\}$.

The following result applies:

**Proposition 1.** Assume $\lambda A > \beta$ and define $R_{it} = r_{it}/A\beta$ where $\beta = \sum_{s=0}^{t} F_s$ with $F_s = 1$ for $p_s = I$ and $F_s = 0$ for $p_s = N$. Then

(i) $(R^*_{Ot}; R^*_{Yt}; p^*) = [0; (1-\lambda A); I]$ when $p_{t-1} = I$ and $(R^*_{Ot}; R^*_{Yt}; p^*) = [0; \varepsilon; I]$ when $p_{t-1} = N$ is the only MPE in truthful strategies if and only if

$$\rho > \frac{2+n}{1+n}\frac{(1-\lambda A)}{A(\lambda A-\beta)} \tag{3.1}$$

(ii) $(R^*_{Ot}; R^*_{Yt}; p^*) = \left[\lambda A(1+A\rho) - 1 - \rho\beta\lambda A; 0; N\right]$ when $p_{t-1} = I$ and $(R^*_{Ot}; R^*_{Yt}; p^*) = [0; \varepsilon; I]$ when $p_{t-1} = N$ is the only MPE in truthful strategies if and only if:

$$\frac{(1-\lambda A)}{A(\lambda A-\beta)} < \rho < \frac{2+n}{1+n}\frac{(1-\lambda A)}{A(\lambda A-\beta)} \tag{3.2}$$

(iii) $(R^*_{Ot}; R^*_{Yt}; p^*) = [0; 0; N]$ when $p_{t-1} = I$ and $(R^*_{Ot}; R^*_{Yt}; p^*) = [0; \varepsilon; I]$ when $p_{t-1} = N$ is the only MPE in truthful strategies if and only if:

$$\rho < \frac{(1-\lambda A)}{A(\lambda A-\beta)} \tag{3.3}$$

**Proof.** The game is a first-price menu auction where the winner pays the second-highest bid (Bernheim and Whinston, 1986). First, we can rule out candidates for equilibrium where both O and Y contribute. If both lobbies want the same policy, only one will contribute an infinitely small amount $\varepsilon$. This is what is meant by $R^*_{Ot} = 0$ and $R^*_{Yt} = \varepsilon$. On the other hand, if their interests conflict, only the winning lobby contributes, while the other, realizing that it cannot win, does not contribute at all.

Second, we can rule out candidates for equilibrium with $p_t = N$ when $p_{t-1} = N$, the reason being that, when the current state is N, both groups benefit from innovation. Thus, all equilibria, must have $p_t = I$ whenever $p_{t-1} = N$.

Third, $p_t = I$ with only Y contributing is the equilibrium outcome when $p_{t-1} = I$ if and only if $[v_Y(I; I) + \rho V_Y(I; I)] - [v_Y(N; I) + \rho V_Y(N; I)] > v_O(N; I) - v_O(I; I) > 0$. This explains condition (3.1).

Fourth, $p_t = N$ with only O contributing is the equilibrium outcome when $p_{t-1} = I$ if and only if $v_O(N; I) - v_O(I; I) > [v_Y(I; I) + \rho V_Y(I; I)] - [v_Y(N; I) + \rho V_Y(N; I)] > 0$. This explains condition (3.2).

Fifth, $p_t = N$ with neither group contributing is the equilibrium outcome when $p_{t-1} = I$ if $v_O(N; I) - v_O(I; I) > [v_Y(N; I) + \rho V_Y(N; I)] - [v_Y(I; I) + \rho V_Y(I; I)] > 0$. This explains (3.3). ■

In other words, there are three alternative MPE in truthful strategies depending on parameter values. In one equilibrium, which occurs when condition (3.1) is satisfied, innovation takes place at every point in time and learning-by-doing never takes place. When (3.1) holds, restless technological update is sustained by the organized collective action of the young. In a second equilibrium, which occurs when condition (3.2) is satisfied, a period of technological update is followed by a period of stagnation and viceversa. Growth alternatively relies on innovation and learning-by-doing. When (3.2) holds, technological change is blocked every second period by the organized collective action of the old. The same kind of technological cycle characterizes the third equilibrium, which occurs when condition (3.3) is satisfied. The difference with respect to the previous case is that, when (3.3) holds, technological change is triggered every second period by the organized collective action of either lobby. In any case, in both the second and third equilibria, technological change is accompanied by endogenous cycles of lobbies' formation.

It is worthwhile noticing that, because strategies are truthful, the MPE entails the step-wise maximization of lobbies' welfare. However, the MPE will be generally inefficient from a dynamic point of view due to the fact that short-sighted regulators and overlapping generations' lobbies do not take into account that current technological choices affect future regulators' payoff and future generations' welfare. As shown by Bergemann and Välimäki (1998b) dynamic efficiency of dynamic common agency games requires infinite planning horizons.

## 4. Comparative statics

In this section, we study how the political equilibria that we characterized in Proposition 1 depend on the subjective discount factor $\rho$, on the rate of growth of population n and on the technological parameters $\lambda$, $\beta$ and A. To derive our results, we will focus on the relevant trade-off faced by different generations in their choice of lobbying for the implementation of a new technology versus the continuation of the existing one.

As we discussed in the previous section, only strategies and actions when the history of the game is I need to be analyzed. In the other case, when previous period action was N, the only possible equilibrium policy is to innovate, which is the preferred policy of both lobbies. More specifically, we will study if, following a change in the above parameters, the political equilibrium where technological change occurs in every period is more or less likely to occur relative to the equilibrium cycle, where periods of innovations and periods of technological rest alternate.

First of all, we will now argue that when the intertemporal discount rate decreases, equilibrium cycles where periods of technological innovations follow periods of stagnation are more likely to occur. Assume that the state of the game is I. If innovation takes place in the current and in the next period, the discounted value of next period benefit for the young is given by $\rho\gamma A^{\alpha+2}$: If instead, no innovation occurs in the current period (and obviously innovation does take place in the next one), the discounted value of next period benefit is given by $\rho\frac{\beta}{\lambda}A^{\alpha+1}$. Given our assumptions, $\rho\left[\gamma A - \frac{\beta}{\lambda}\right] > 0$ so that the higher is $\rho$ the more likely that the young will lobby for continuous innovations.

Let us now consider how the equilibrium changes when the degree of positive externality from the learning by doing on the old technology to the productivity of the new technology changes. This positive externality is represented by the parameter $\frac{\beta}{\lambda}$: Intuitively, when $\frac{\beta}{\lambda}$ increases (decreases), it should be less (more) likely that agents choose to innovate in every period. By looking at condition (3.1) (which is the necessary and sufficient condition for innovation to arise in every period), we can easily see that this is indeed the case.

When $\gamma$ changes, future productivity gains that are independent from the full exploitation of current technology change as well. If $\gamma$ increases (and therefore future productivity gains also increase), we would expect agents to find continuous technological innovation relatively more attractive. Again, inspection of condition (3.1) shows that this anticipation is correct. Finally, notice that the changes in the parameter A are economically similar to changes in $\gamma$. Thus, their effects on the equilibrium can be explained in the same way.

To conclude, changes in the rate of population growth n affects the politico-economic equilibrium because they alter the relative size of the lobbies. The higher is n the larger is the lobby of the young and the larger is their aggregate contribution relative to the contribution of the old. Thus, the equilibrium with continuous innovations is more likely to arise when the rate of growth of population is high.

## 5. Conclusion

In this paper, we constructed a model where the interaction between organized special interests and the policy makers generates a political equilibrium which involves either continuous process innovations or periods of technological change followed by periods of stagnation (i.e. technological cycles). The prevailing equilibrium depends on technological and preference parameters, and not only on the demographic structure of the population as it happens in ‘democratic’ models. More speci…cally, equilibrium technological cycles are likely to arise when agents put little value on future consumption, when the positive externality on future productivity gains of current learning-by-doing is high and when the future productivity gains that do not depend on the full exploitation of current technology are low. In any case, technological change is accompanied by endogenous cycles of lobbies’ formation and, because the interests of future generations are not taken into account, it will be generally ine¢cient from a dynamic point of view. International income di¤erences could be traced back to more or less severe problems of interest representation and policy makers’ planning horizons.

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