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The Grand Experiment of Communism: Discovering the Trade-off between Equality and Efficiency

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Abstract

This paper aims to explain the rise and fall of communism by exploring the interplay between economic incentives and social preferences in different economic systems. We introduce inequality-averse and inefficiency-averse agents responding to economic incentives and transmitting their ideology as they are affected by evolving outcomes. We analyze their conflict through the interaction between leaders with economic power and followers with ideological determination. The socioeconomic dynamics of our model generate a pendulum-like switch from markets to a centrally-planned economy abolishing private ownership, and back to restoring market incentives. The grand experiment of communism is thus characterized to have led to the discovery of a trade-off between equality and efficiency at the scale of alternative economic systems.

Key words: capitalism; communism; inequality; inefficiency; ideological transmission; economic transitions

JEL classification codes: C72, D31, D63, D74, D83, P51

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> February 1848: "The Communists disdain to conceal their views and aims. They openly declare that their ends can be attained only by the forcible overthrow of all existing social conditions. Let the ruling classes tremble at a Communistic revolution. The proletarians have nothing to lose but their chains. They have a world to win." Karl Marx and Frederick Engels, *Manifesto of the Communist Party.*[1]

> September 2010: "There were many odd things about my recent Havana stopover [...] but one of the most unusual was Fidel Castro's level of self-reflection. [...] I asked him if he believed the Cuban model was still something worth exporting. 'The Cuban model doesn't even work for us anymore,' he said." Jeffrey Goldberg, "Fidel: 'Cuban Model Doesn't Even Work for Us Anymore'," *The Atlantic.*[2]

1 Why Another Fable of the Grand Experiment?

Communism was the grand illusion of the 20-th century. It was also its grand experiment. In terms of utopian vision, radical implementation and socioeconomic impact, communism has left a lasting mark in history. The rise and fall of communism is a complex and multi-faceted theme interpreted from different theoretical and methodological perspectives in social sciences. Works from many disciplines, going beyond politics and economics, have tried to portray or, more ambitiously, explain the various manifestations of communism across the map of the world – from nascent and militant through mature and oppressive into stagnating and decaying.

So why another attempt to reconsider the key driving mechanisms behind the genesis of the revolutionary communist project and the gradual mass disillusionment with its realities? The novelty of our approach consists in using economic theory to examine the interactive dynamics of economic incentives and social preferences in a society experimenting with an economic system that has never been implemented before. We focus on the scenario that led to the October Revolution of 1917 and the subsequent establishment of the Soviet Union in a big region of the world where capitalism was less developed and, perhaps more importantly, any democratization of the society was avoided or much delayed. Our model also accommodates the alternative scenario explored in Acemoglu and Robinson (2000), where democratic reforms such as the extension of the franchise and the increase of redistribution have enabled Western European countries to avoid the revolutionary advent of communism.

In what follows, we build a single model to formalize the socioeconomic process that led to communism via a forced revolution and nationalization of capital, as well as its reversal back to markets. In essence, this grand experiment has led to the discovery of a trade-off between equality and efficiency in terms of productivity at the scale of alternative economic systems.[3] Our theoretical account of the rise and fall of communism,

[1] Chapter IV. Position of the Communists in Relation to the Various Existing Opposition Parties, translated by Samuel Moore in cooperation with Frederick Engels, 1888, http://www.marxists.org/archive/marx/works/1848/communist-manifesto/ch04.htm

[2] http://www.theatlantic.com/international/archive/2010/09/fidel-cuban-model-doesnt-even-workfor-us-anymore/62602/

[3] For instance, Stretton (1976) writes: "Equalities can always be ill-designed, or enforced by oppressive methods. When they are, they may reduce productivity, as well as freedom. Some communist countries

from the revolutionary enthusiasm of Marx and Engels through the disillusionment of Castro we quoted in the beginning, is framed as a stylized game of class struggle involving economic decisions, transmission of ideology across generations and social learning. This is along the lines of North (2005), who interprets the experience with communism in Russia as "a story of perceived reality → beliefs → institutions → policies → altered perceived reality and on and on." (p. 4). Aoki (2011) further describes the role of institutions as "social artifacts that cognitively mediate agents' strategic interactions and their individual beliefs in societal games".[4]

We model two types of agents, inequality-averse and inefficiency-averse ones, responding to economic incentives and transmitting their values as they are affected by evolving economic outcomes. While the mechanism in Bisin and Verdier (2001) is generally applied to show how intergenerational transmission of attitudes explains the persistence of socioeconomic status across generations, we use the transmission and evolution of preferences to shed light on the dynamics of regime switches across economic systems.[5] In particular, we first show how capital accumulation by the minority elite and the resulting inequality leads to increasing social discontent over time and, eventually, the overthrow of the system. We then show how a centrally-planned system aimed at equality also fades away due to misalignment of individual and aggregate incentives, lower well-being and the gradual redirection of ideas towards a market system.[6]

The incentive structure under the two economic systems is captured in our model by the *(mis)alignment* of *ownership* and *control*. This is in line with the large literature on the key weaknesses of socialism: one strand dealing with the pervasive problems arising from the 'soft budget constraints' of socialist enterprises (e.g., Kornai, 1980) – what Roemer (2009) labels 'lack of incentives'; another pointing to the overambitious task of central planning, given 'dispersed and local information', to ensure better allocative decisions than markets (e.g., von Hayek, 1940, 1945) – what Roemer (2009) labels 'lack of coordination'. Our approach highlights these two familiar disadvantages of a communist economy at their crucial link, the *intertemporal optimization decision*, at which the (mis)alignment of ownership and control manifests itself. The choice of consumption and accumulation out of one's own wealth given the signals of competitive markets and locally relevant information under capitalism sustains efficiency but generates inequality. Delegating this choice to an egalitarian planner forces equality by revolution but erodes economic efficiency, thus making everyone equal in their poverty.[7]

Combining features of the above literatures, we devise a non-cooperative game be-

have flattened their margin for skill or hard work too far, with apparently bad effect on economy efficiency."

[4] This view somewhat departs from earlier seminal works on communism versus capitalism, and related studies on the comparative efficiency of the two systems. Among many others, see Lange (1956 [1936]), von Hayek (1940, 1945), Tinbergen (1960), Lancaster (1973), Kornai (1980), Roemer (1980, 1985).

[5] See Bisin and Verdier (2010) for a survey of literature. Also recent empirical work in Dohmen et al. (2011) for instance show evidence in the context of attitudes towards trust being passed over generations and how the inertia works against the effect of institutional change that might be expected to change willingness to trust.

[6] Doepke and Zilibotti (2008) study the role of the intergenerational transmission of taste for leisure and patience in the success of institutional changes brought about by the industrial revolution. See also Saint-Paul (2010) on the impact of the evolution of beliefs on ideological bias in the society and political reform.

[7] Note that we ignore neither that inequalities were *de facto* existing in communist countries, nor that they were creating resentment (see, e.g., Joo, 2005, for an account). However, considering explicitly the nomenklatura would only complicate the model without changing the substance of the results (in effect, only accelerating the swing back from plan to market).

tween agent types that takes place in every period of an overlapping-generations (OLG) framework to demonstrate how the equilibrium strategies drive the long-run socioeconomic dynamics and can generate such pendulum-like switch from markets to an egalitarian economy abolishing private ownership, and back to rebuilding market incentives to sustain society. The economic literature, and the literature on communism or social evolution more generally, has not provided so far a consistent theory on the institutional change experienced by the Soviet Union and its satellite countries in Eastern Europe throughout the 20-th century accounting for both these transitions. In this consists the contribution of our simple and stylized but historically trust-worthy formal analysis of the rise and fall of communism.

The paper is organized as follows. In the next section we construct our model, presenting the types of agents, their objectives, constraints, ideological conflict, and the transmission of their beliefs across generations. Section 3 then solves the optimization problems of the agent types and the von Stackelberg game between them. Section 4 derives the intergenerational dynamics and highlights the resulting economic outcomes. The last section concludes by placing our theory in the context of more discursive interpretations of long-run economic changes. The Appendix provides additional derivation details on the within-period von Stackelberg game, itself replayed in each subsequent generation.

2 The Model

2.1 Economic Systems, Agent Types and Conflict

We consider two economic systems under which society can evolve: one is market-based (capitalist), denoted by M, and the other centrally-planned (communist), denoted by C. True to the historical genesis of communist ideas, our analysis begins with a market-based system founded upon property rights over the means of production and the corresponding private incentives to capital accumulation. Our interest is in a particular region that at some point in time splits apart and experiments with communism. Its total adult population is normalized to 1.

There are two types of agents in the initial capitalist society. The large majority are born without inheriting capital: they are the 'workers'. They are 'unprivileged' in the sense that they can only sell their labor force in the market in order to subsist, as Marx argued. Being the have-nots, they care about inequality in the capitalist society, whose victim they are by birth. We call them *inequality-averse* agents and denote their type as A. A minority of agents are born with inherited capital: they are the 'capitalists'. They extract rents from their private capital, and care about the relative inefficiency between the two systems. We call them *inefficiency-averse* agents and denote their type as B.

Initially, types (A and B) and 'classes' (workers and capital owners) coincide, by definition. In a conventional way, this can be interpreted in terms of the class struggle between capital and labor. However, over time preference types evolve, so that class and preference type may diverge. We consider an OLG model, where agents live for two periods. During childhood (in the first period of life), they are 'socialized' and acquire a particular type just when becoming adult. When mature (in the second period of life), they perform active economic and ideological roles in the society, and die at the end of the period, investing any capital wealth they have accumulated.

Under both systems, M and C, economic power belongs to the preference type who decides upon – and enforces – the intertemporal allocation between capital accumulation

and consumption. The other preference type can then only try to change the economic system through ideological influence. We denote the degree of strength of each type relative to the other by the conflict function $q_t(\cdot)$ and $1 - q_t(\cdot)$, respectively for types A and B in any period t, and measure it by an index, $0 < q_t(\cdot) < 1$. More precisely, this index can be defined to be some increasing function of the relative intensity of the preference itself (social resentment or ideological determination), $0 < m_t < 1$, and the relative size (or fraction) of each preference type in the total adult population, $0 < n_t < 1$: $0 < q_t(m_t, n_t) < 1$, with $\frac{\partial q_t(\cdot)}{\partial m_t} > 0$ and $\frac{\partial q_t(\cdot)}{\partial n_t} > 0$. It also captures the probability of a regime shift in any period t.[8] It will be seen that such economic transitions can only occur once the strength of the oppressed type dominates that of the ruling type: $q_t(\cdot) > 0.5$ for A and $1 - q_t(\cdot) > 0.5$ for B.

2.2 Preferences

The utility of agent i for $i = A, B$ under each system $j = C, M$ takes the form

$$U^i(c^i_{j,t}, b^i_{j,t+1}, \upsilon_t, \chi_t) = c^i_{j,t} + \beta b^i_{j,t+1} - E^i_t(\upsilon_t, \chi_t) - \frac{\tau^i(\upsilon_t, \chi_t)^2}{2}, \tag{1}$$

with $c^i_{j,t}$ denoting individual consumption levels, $b^i_{j,t+1}$ the private or social returns from intergenerational transfers,[9] and $0 < \beta < 1$ the discount factor assumed to be identical for all agents. The third term generally represents the disutility from a change in the system of property rights and control, which also implies that relative status, or reference points, with respect to others matter as well. More precisely, $E^A_t(\upsilon_t)$ and $E^B_t(\chi_t)$ are the expected inequality and inefficiency that depend on the regime in the next period

$$E^A_t(\upsilon_t) = q_{t+1} \ln \upsilon_{C,t} + (1 - q_{t+1}) \ln \upsilon_{M,t}, \tag{2}$$

$$E^B_t(\chi_t) = q_{t+1} \ln \chi_{C,t} + (1 - q_{t+1}) \ln \chi_{M,t}, \tag{3}$$

where $\upsilon_{j,t}$ measures income of type B relative to A, or inequality within the society at t, and $\chi_{j,t}$ the relative efficiency, in terms of productivity and potential growth possibilities, of individual optimization under market capitalism over a centrally planned communist system. Note that communism forcefully proclaims complete equality in the society, $\upsilon_{C,t} = 1$, yielding $\ln \upsilon_C = 0$. Similarly, inefficiency is initially normalized under capitalism, $\chi_{M,t} = 1$, and so $\ln \chi_M = 0$. $\upsilon_{M,t}$ and $\chi_{C,t}$ will be defined further below. The relative strength of the preference types, q_{t+1}, determines the probability of a regime change in period $t + 1$. Finally, utility depends on costly socialization effort functions $\tau^A_t(\upsilon_t)$ and $\tau^B_t(\chi_t)$, with $0 \leq \tau^i_t(\cdot) \leq 1$, to be discussed in section 2.5.

2.3 Production and Income

We consider a one-sector real model where a single good is produced using a constant-returns-to-scale technology. The output produced at time t in regime j is

$$H(A_{j,t}, K_{j,t}, L) = A_{j,t} \left\{ (\alpha K_{j,t})^\rho + [(1 - \alpha)L]^\rho \right\}^{\frac{1}{\rho}} \tag{4}$$

[8] Alternatively, Ellis and Fender (2011) show how a revolution can materialize under full rationality in a set-up of Bayesian perfect equilibrium with asymmetric information.

[9] Note that this formulation is equivalent to dynastic OLG models with altruistic preferences à la Barro (1974), where owners of capital leave a stock of wealth to their descendants as a bequest.

for $j = C, M$ and depends on two productive factors, capital $K_{j,t}$ depreciating fully during t and labor L supplied inelastically by households. To further simplify matters, we focus on the case of $\rho = 1$, which implies perfect substitutability between capital and labor. The technological parameter $A_{j,t} \equiv A(w_{j,t})$ measures productivity. As will be made clear, $A_{j,t}$ can be thought of as a function of managerial and technical skills developed for improving the production process, determined by the incentives of workers. We approximate incentives by wages in workers' families, or their material well-being based on consumption. The relative importance of capital and labor in producing output are denoted by α and $1 - \alpha$, respectively. Returns to labor and capital can then be written as

$$w_{j,t} = (1 - \alpha)A_{j,t}$$

and

$$r_{j,t} = \alpha A_{j,t}.$$

Both factor returns are j-indexed, because of the potentially different productivity levels under the two systems.

We consider a subsistence consumption level $\bar{c}$, never reached by the A type so that only capital owners can invest. In the market system, income for capital owners and workers in each period is respectively

$$y^B_{M,t} = r_{M,t}s^B_{t-1} = \alpha A_{M,t}s^B_{t-1}, \tag{5}$$

where s^B_{t-1} is savings in the previous period, and

$$y^A_{M,t} = w_{M,t} = (1 - \alpha)A_{M,t}. \tag{6}$$

Under communism, capital is nationalized, i.e. capitalists are deprived of their ownership, and investment decisions are no longer individual but made by the egalitarian planner. As a consequence, individual income becomes a centralized allocation of an equal share of output to each member of the society, i.e. wage:

$$y^B_{C,t} = y^A_{C,t} = w_{C,t} = (1 - \alpha)A_{C,t}. \tag{7}$$

Note that in this case the whole population, including B types, forms the working class ($c^A_{C,t} = c^B_{C,t} = c_{C,t} = w_{C,t}$).

Income inequality arising from saving decisions by capitalists made in period t is denoted by the index

$$\upsilon_{M,t} \equiv \frac{r_{M,t}s^B_t}{w_{M,t}} = \frac{\alpha}{1 - \alpha}s^B_t, \tag{8}$$

where imposing the initial condition $y^B_{M,0} > y^A_{M,0}$ prevents a capitalist from switching types and becoming a worker. Index $\upsilon_{M,t}$ is in other words a measure of income from capital versus that from labor in period t.

2.4 Savings and Efficiency

A capitalist, type B, chooses *individual* savings to maximize utility in (1) given the budget constraint

$$c^B_t + s^B_t \leq y^B_{M,t}. \tag{9}$$

The timing of events during the accumulation process is as follows: the savings of the previous period s^B_{t-1} comprise the private capital stock of each type B agent in the present period $k_{M,t}$, which will then be put into production given (4). The private yields from capital ownership $y^B_{M,t} = r_{M,t}s_{t-1}$ are then divided between consumption c^B_t and savings s^B_t (forming the future capital stock).

An egalitarian planner instead maximizes utility (1) in the name of the type A agents under the national budget constraint

$$C_t + S_t \leq H_{C,t}. \tag{10}$$

The savings decision by the planner differs from private ones in that *aggregate* values are considered (which we denote by uppercase C_t, K_t, S_t, Y_t). The same timing holds for the accumulation process under the communist regime: S_{t-1} comprises K_t, which is used for national production along with labor and yields $Y_t = r_{C,t}S_{t-1}$. Total output, $H_{C,t}$, is then allocated between further savings, S_t, and aggregate consumption in the society, C_t, divided equally among all agents via identical wages assigned to all workers, $w_{C,t} = c_{C,t}$. Note that in this regime there is no market price of capital, therefore $r_{C,t}$ is the shadow price of capital referred to in period t by the planner.

We can now define the (inverse) inefficiency index of the communist system, $\chi_{C,t}$, in terms of relative growth potential of the two regimes by means of savings or capital formation

$$\chi_{C,t} \equiv \frac{r_{M,t}\hat{s}^B_t}{r_{C,t}S^*_t} = \frac{A_{M,t}\hat{s}^B_t}{A_{C,t}S^*_t}, \tag{11}$$

where S^*_t is the optimal savings chosen by the egalitarian planner, and $\hat{s}^B_t$ a notional value computed by individuals should the market system be operative. Index $\chi_{C,t}$ is in other words a measure of income from capital under markets versus that under communism in period t.

2.5 Intergenerational Transmission of Beliefs

We assume that type A agents always teach a communist ideology to their offspring to abolish inequality, while type B agents always teach a pro-market ideology favoring efficiency. This is a first channel of transmitting beliefs that captures the influence on ideology intensity within the family, and corresponds to what is termed 'direct vertical transmission' in the literature (Bisin and Verdier, 2001, 2010). The evolution over time of the relative degree of ideological determination to change the status quo, however, is also affected outside the family. This second channel operates through the influence on ideology intensity by peers and the broader environment, and is known as 'oblique transmission'.

Socialization efforts $\tau^i_t(\cdot)$ affect the determination of the next generation to mobilize in order to change the system. Socialization effort by type A, $\tau^A(\upsilon_t)$, is generated by resentment from inequality υ_t, and for type B, $\tau^B(\chi_t)$, by the inferior efficiency with respect to markets χ_t. The properties of these socialization functions are standard:

$$\tau^i(1) = 0,\ \tau^{i\,\prime}(\cdot) > 0,\ \tau^{i\,\prime\prime}(\cdot) < 0. \tag{12}$$

Property $\tau^i_t(1) = 0$ in (12) states that socialization effort is only activated upon sufferance.[10]

[10] This is a special case of Bisin and Verdier (2001) arising from resentment, where only one agent type at a time engages in the transmission of his preferences. The use of this setting allows us to simplify our notation, while maintaining the generality of our results.

[Figure 1 about here]

Figure 1 presents the socialization process of the agents of each type, A and B. The transition probabilities at time t, $P_t^{i\uparrow}$, that a parent of type i has a child with a *stronger* ($\uparrow$) or *weaker* ($\downarrow$) ideological determination can be written as

$$\begin{aligned} P_t^{A\uparrow} &= \tau^A(\upsilon_t) + [1-\tau^A(\upsilon_t)]q_t; \\ P_t^{A\downarrow} &= [1-\tau^A(\upsilon_t)]\,(1-q_t)\,; \\ P_t^{B\uparrow} &= \tau^B(\chi_t) + [1-\tau^B(\chi_t)]\,(1-q_t)\,; \\ P_t^{B\downarrow} &= [1-\tau^B(\chi_t)]q_t. \end{aligned} \tag{13}$$

Given these transition probabilities, the relative strength of individuals of type A in period $t+1$ is

$$\begin{aligned} q_{t+1} &= q_t P_t^{A\uparrow} + (1-q_t)P_t^{B\downarrow} \\ &= q_t + (q_t - q_t^2)[\tau^A(\upsilon_t) - \tau^B(\chi_t)]. \end{aligned} \tag{14}$$

The dynamics of the probability of a regime shift are endogenous to the present economic situation and depend on the disutility experienced by each type. The properties of the socialization functions imply that $\tau_t^A(\upsilon_t) = 0$ under communism while $\tau_t^B(\chi_t) = 0$ under a market economy. Accordingly, the law of motion in (14) simplifies to

$$q_{M,t+1} = q_{M,t} + (q_{M,t} - q_{M,t}^2)\tau^A(\upsilon_t) \tag{15}$$

under markets and to

$$q_{C,t+1} = q_{C,t} - (q_{C,t} - q_{C,t}^2)\tau^B(\chi_t) \tag{16}$$

under communism.

Thus, in the market system the degree of ideological determination of type A to change the status quo, $q_{M,t+1}$, increases with any positive socialization effort by type A, $\tau^A(\upsilon_t) > 0$. Above the critical value $q_{M,t} = 0.5$, the threat to overthrow the capitalist regime becomes credible. Analogously, in the communist system the ideological determination of type B to change the status quo increases, i.e. $1 - q_{C,t+1}$ increases, with any positive socialization effort by type B, $\tau^B(\chi_t) > 0$. Above the critical value $1 - q_{C,t} = 0.5$, the threat to abolish the communist regime as type B agents promote market values becomes credible.

3 Economic Systems and Interaction of Agents

We assume a plausible *sequencing of actions* appropriate for both economic systems, in which the agent type who exercises ownership and control (economic power) to decide on the split between consumption and saving moves first. The agent type who has no ownership and control rights can only have socialization (or ideological) power by instilling beliefs against the regime in force, that is, trying to teach the next generation in favour of his/her own values. The sequence of events at time t is illustrated in Figure 2 parallel to the process of capital accumulation in the same period (see Section 2.4).

[Figure 2 about here]

3.1 Market-Based Economy

In the market system, capitalists both own the capital stock and control the allocation of their income between consumption and savings, to be invested and used to produce in the next period by the next generation. In contrast, workers do not own and control anything apart from their labor force, which they supply inelastically in the model. It is therefore optimal saving and capital accumulation within the capitalist 'dynasties' (where ownership and control rights are *aligned and effective*) that drives the efficiency and sustainability of the market system, but deepens the social inequality.

The type B agents in this case are the first movers in a von Stackelberg leadership game and decide on savings, while taking into consideration in their maximization problem the socialization reaction of type A agents to the inequality caused by their own savings. Starting with type A agents (the working class), they take savings as fixed and maximize their utility using (1):

$$\max_{\tau^A(\upsilon_t)} \quad U^A_{M,t}(\cdot) = c^A_{M,t} - \underbrace{E^A_t(\upsilon_t)}_{(1-q_{t+1})\ln \upsilon_{M,t}} - \frac{\tau^A(\upsilon_t)^2}{2},$$

where we have substituted for $E^A_t(\upsilon_t)$ from (2) after noting that $\ln \upsilon_{C,t} = 0$. Replacing for $\upsilon_{M,t}$ from (8) and for $q_{M,t+1}$ from (15), the optimization problem becomes:

$$\max_{\tau^A(\upsilon_t)} \quad c^A_{M,t} - \left\{1 - \left[q_t + q_t(1-q_t)\tau^A(\upsilon_t)\right]\right\} \ln\left(\tfrac{\alpha}{1-\alpha} s^B_t\right) - \tfrac{\tau^A(\upsilon_t)^2}{2}.$$

The first-order condition yields the optimal reaction of type A as follower:

$$\begin{aligned} \frac{\partial U^A_{M,t}(\cdot)}{\partial \tau^A(\upsilon_t)} &= q_t(1-q_t)\tau^{A\,\prime}(\upsilon_t)\ln\left(\frac{\alpha}{1-\alpha}s^B_t\right) - \tau^A(\upsilon_t)\tau^{A\,\prime}(\upsilon_t) = 0 \\ &\Leftrightarrow \quad \tau^A(\upsilon_t)^* = q_t(1-q_t)\ln\left(\frac{\alpha}{1-\alpha}s^B_t\right). \end{aligned} \tag{17}$$

This equation delivers a preliminary insight on the mechanisms that drive the evolution from one system to another. It is easy to see that an increase in the private savings (by the capitalists) leads to increased socialization effort by type A agents. The latter can only expect a growing inequality between the two types of agents, which reinforces their determination to change the regime. More precisely, the higher the expected inequality, the higher the effort to transmit their preferences towards a more equal society.

Turning to type B agents, they move first by making a decision on the amount of their savings:

$$\begin{aligned} \max_{s^B_t} \quad U^B_{M,t}(\cdot) &= c^B_{M,t} + \beta y^B_{M,t+1} - E^B_t(\chi_t) - \frac{\tau^B(\chi_t)^2}{2} \\ \text{s.t. } c^B_{M,t} + s^B_{M,t} &\leq y^B_{M,t}. \end{aligned}$$

Note that savings by capitalists have no direct negative externality on productivity because the decision is made at an individual level and consumption by workers $c^A_{M,t}$ is not affected by it. The productivity $A_{M,t}$ hence is at that point assumed to be non-decreasing over time as long as markets are in place, or – to sharpen our analysis – to

remain at its initial value $A_{M,0}$.[11] This enables us to hereafter drop the time subscript to consumption in the productivity function under markets so that $A_{M,t} = A_{M,0} = A_M$.

After a series of substitutions (see Appendix A.1) and omitting the M-subscript to savings due to the absence of individual savings under communism in our model, we rewrite

$$\max_{s_t^B} \quad \alpha A_M s_{t-1}^B + (\beta\alpha A_M - 1)\, s_t^B - \left[q_t + (q_t - q_t^2)\tau^A(\upsilon_t)\right] \ln\left(\chi_{C,t}\right).$$

Replacing for $\tau^A(\upsilon_t)$ with the optimal reaction of type A agents from (17) and taking the first-order condition yields optimal savings by type B as leader:

$$\begin{aligned} \frac{\partial U_{M,t}^B(\cdot)}{\partial s_t^B} &= \beta\alpha A_M - 1 - \frac{q_t^2(1-q_t)^2}{s_t^B} \ln\left(\chi_{C,t}\right) = 0 \\ &\Leftrightarrow \quad s_t^{B*} = q_t^2(1-q_t)^2 \frac{\ln\left(\chi_{C,t}\right)}{\beta\alpha A_M - 1}, \end{aligned} \tag{18}$$

where $A_M > 1/\beta\alpha$ must hold for positive savings by the capital owners. The last equation reveals that increased expected inefficiency under the alternative (communist) system induces higher accumulation by capital owners in an effort to further consolidate the capital stock and, hence, the productive potential of the market economy. In addition, the higher the productivity A_M the lower the need to save.

Substituting (18) back into (17) to derive the optimal socialization effort of the type A in its final form, we get

$$\tau^A(\upsilon_t)^* = q_t(1-q_t)\ln(\frac{\alpha}{1-\alpha}s_t^{B*}). \tag{19}$$

Substituting $\tau^A(\upsilon_t)^*$ from (19) into (14), next-period ideological determination of type A to change the status quo becomes

$$\begin{aligned} q_{t+1} &= q_t + (q_t - q_t^2)\tau^A(\upsilon_t)^* \\ &= q_t + q_t^2(1-q_t)^2 \ln(\frac{\alpha}{1-\alpha}s_t^{B*}). \end{aligned} \tag{20}$$

It is seen from (20) that the evolution of q_t over time under a market system takes a positive value when $\tau^A(\upsilon_t)^* > 0$. This is true as long as

$$\upsilon_{M,t} \equiv \frac{\alpha}{1-\alpha}s_t^{B*} > 1, \tag{21}$$

which given $y_{M,0}^B > y_{M,0}^A$ always holds.

Lemma 1 *Given the initial condition $y_{M,0}^B > y_{M,0}^A$, optimal individual savings by capital owners s_t^{B*} always increase inequality, provoking type-A workers into more intensive transmission of their social discontent and more effort to instigate a regime change.*

Proof. *See equation (21) where $\frac{\partial \upsilon_{M,t}}{\partial s_t^{B*}} > 0$ increases $\tau^A(\upsilon_t)^*$ and q_{t+1} in (19) and (20), respectively.* ■

In sum, capital owners allocate their income between consumption and savings, the type A agents then react by choosing their socialization effort, which in turn affects the ideological determination and strength of the next generation of A types to change the status quo.

[11] Allowing $A_{M,t}$ to increase over time only strengthens the mechanism at work in our model and results in the same outcomes.

3.2 Centrally-Planned Economy

Under communism, no one makes economic decisions apart from the egalitarian planner, who is of type A and splits total consumption equally across all members of society.[12] After the nationalization following the communist revolution the society, *de jure* (but not *de facto*) owning the capital, delegates control to the egalitarian planner. Individuals do not control the choice of aggregate consumption and investment out of national income, which is also national output. Thus, under communism, there is *misalignment* of ownership and control rights creating inefficiency. We capture and interpret it in comparing the optimization problems under central planning (aggregate, then disaggregated top-down by equal split) vis-à-vis the market (individual, aggregated bottom-up).

The egalitarian planner is the first mover and takes into consideration the socialization reaction of type B agents to the relative efficiency of the system caused by their centralized decision. Starting with type B agents (market advocates), they take savings as fixed and maximize:

$$\max_{\tau_t^B(\chi_t)} \quad U_{C,t}^B(\cdot) = c_{C,t}^B - \underbrace{E_t^B(\chi_t)}_{q_{t+1}\ln\chi_{C,t}} - \frac{\tau^B(\chi_t)^2}{2},$$

where we have substituted for $E_t^B(\chi_t)$ from (3) after noting that $\ln\chi_{M,t}=0$. Replacing for $\chi_{C,t}$ from (11) and for $q_{C,t+1}$ from (16) the optimization problem becomes:

$$\max_{\tau_t^B(\chi_t)} \quad c_{C,t}^B - \left\{q_t + q_t(1-q_t)[-\tau^B(\chi_t)]\right\}\ln\left(\frac{A_M\hat{s}_t^B}{A_{C,t}S_t}\right) - \frac{\tau^B(\chi_t)^2}{2}.$$

The first-order condition then yields:

$$\begin{aligned}\frac{\partial U_{C,t}^B(\cdot)}{\partial\tau^B(\chi_t)} &= q_t(1-q_t)\tau^{B\,\prime}(\chi_t)\ln\left(\frac{A_M\hat{s}_t^B}{A_{C,t}S_t}\right) - \tau^B(\chi_t)\tau^{B\,\prime}(\chi_t) = 0 \\ &\Leftrightarrow \quad \tau^B(\chi_t)^* = q_t(1-q_t)\ln\left(\frac{A_M\hat{s}_t^B}{A_{C,t}S_t}\right). \end{aligned} \tag{22}$$

Hence, an increase in the planner's aggregate savings directly reduces the socialization effort by type B agents. This is due to the fact that, as seen in (11), such an increase gives a boost to the efficiency of the communist system. While this effect *per se* could reduce inefficiency, it will be seen below that this accumulation process has an adverse effect on productivity, leaving the total effect of aggregate savings on relative efficiency of the system and socialization effort by the type B agents who share the values of capital owners ambiguous.[13]

The egalitarian planner as a first mover maximizes utility in the name of the type A agents taking into account aggregate values. Therefore, the egalitarian planner (not individual capitalists, whose capital has been nationalized) optimally chooses the level of aggregate savings, i.e. national investment. This also determines the allocation of output to be distributed equally among the total population for consumption.

[12] This follows our assumption of inequality aversion characterizing type A agents, to conform with the preference for equality among the thinkers and pioneers of communism. Different from maximizing social welfare, it presumes that the central planner himself experiences a disutility from inequality.

[13] This ambiguity resembles historical evidence such as those in Broadberry and Klein (2011), who for example shows Czechoslovakia's comparative productivity position under the central planning regime with respect to the UK to have initially improved before falling back to lower levels.

$$\begin{aligned} \max_{S_t} \quad U^A_{C,t}(C_t, Y_{t+1}, \upsilon_t) &= C_t + \beta Y_{t+1} - E^A_t(\upsilon_t) - \frac{\tau^A(\upsilon_t)^2}{2} \\ \text{s.t. } C_t + S_t &\leq H_{C,t}. \end{aligned}$$

Parallel to the market economy, the planner takes βY_{t+1} as the value of the intergenerational transfer in his optimization problem using the *shadow* price of capital $r_{C,t}$ ($Y_{t+1} = r_{C,t}S_t = \alpha A_{C,t}S_t$). However, it will be seen below that the social returns to capital realized in $t+1$ turn out to be *lower* than those evaluated by the shadow price ($\alpha A_{C,t+1}S_t < \alpha A_{C,t}S_t$). This is due to an externality caused by productivity becoming a function of consumption, which is now changing over time in the new economic system, $A_M \to A(c_{j,t})$.[14] Furthermore, $A'(\cdot) > 0$ represents the incentive of the society to engage in technological progress as a function of consumption, and $A''(\cdot) < 0$ assures that productivity gains are decreasing.[15]

Aggregate decision making by an egalitarian planner under a communist regime affects total and per capita levels of consumption, therefore changing productivity over time. This is because the national budget constraint implies $C_t + S_t = H_{C,t}$, that is, output in the aggregate has to be equal to the sum of consumption and investment in every period. Therefore, each individual gets an identical consumption level equal to the assigned wage by the planner

$$w_{C,t} = c_{C,t} = \frac{H_{C,t} - S_t}{1} = C_t. \tag{23}$$

Since allocation between saving and consumption takes place after production in each period, consumption in t determines productivity in the following period $t+1$.

Lemma 2 *The budget constraint of an egalitarian planner in (10), $C_t + S_t = H_{C,t}$, implies that higher aggregate savings cut consumption by the whole population. This results in a negative effect on productivity $A_{C,t+1}$ and makes the latter time-dependent.*

Proof. *We can conclude from (23) and the properties of $A_{C,t+1}$ that*

$$\frac{\partial A_{C,t+1}}{\partial S^*_t} = -\frac{\partial A_{C,t+1}}{\partial C_t} = -\frac{\partial A_{C,t+1}}{\partial w_{C,t}} = -\frac{\partial A_{C,t+1}}{\partial c_{C,t}} = -A'_{C,t+1} < 0.$$

■

Substituting further from Appendix A.2, we obtain:

$$\begin{aligned} \max_{S_t} \quad & A_{C,t}[\alpha S_{t-1} + (1-\alpha)L] - (1 - \beta\alpha A_{C,t})S_t \\ & - \left(1 - \left[q_t - (q_t - q_t^2)\tau^B(\chi_t)\right]\right) \ln(\upsilon_{M,t}). \end{aligned}$$

Replacing for $\tau^B(\chi_t)$ with the optimal reaction curve by type B agents derived in (22) and taking the first-order condition yields:

[14] Similar results are obtained when treating utility from the intergenerational transfer as the amount of capital left to produce in the next period, K_{t+1}. This could, for instance, account for the attempt to catch up due to a lower capital base in the communist region or to the loss of capital as a consequence of destruction during the revolution.

[15] In a somewhat related context, Acemoglu and Robinson (2000) assume productivity to be higher in the market relative to home production.

$$\begin{aligned}\frac{\partial U^A_{C,t}(\cdot)}{\partial S_t} &= (\beta\alpha A_{C,t}-1)+\frac{q_t^2(1-q_t)^2\ln(\upsilon_{M,t})}{S_t}=0\\ &\Leftrightarrow \quad S_t^*=\frac{q_t^2(1-q_t)^2\ln(\upsilon_{M,t})}{1-\beta\alpha A_{C,t}},\end{aligned} \tag{24}$$

where $A_{C,t} < \frac{1}{\beta\alpha}$ must hold for positive savings by the planner. The last equation notably reveals that increased expected inequality under the alternative (market) system induces higher savings by the egalitarian planner in an effort to further consolidate the capital stock and, hence, the productive potential of the communist system. In addition, putting the requirements to have positive (optimal) savings under both economic systems together, we can deduce

$$A_{C,t} < \frac{1}{\alpha\beta} < A_M,$$

which translate into the lower bound on capitalist productivity being the upper bound on communist productivity.

Substituting (24) back into (22) to derive the optimal socialization effort of type B in its final form, we get

$$\tau_t^B(\chi_t)^* = q_t(1-q_t)\ln\left(\frac{A_M\hat{s}_t^B}{A_{C,t}S_t^*}\right). \tag{25}$$

And now substituting $\tau_t^B(\chi_t)^*$ from (25) into (14), the next-period proportion of the population in favor of a market-based system becomes

$$\begin{aligned}q_{t+1} &= q_t-(q_t-q_t^2)\tau^B(\chi_t)^*\\ &= q_t-q_t^2(1-q_t)^2\ln\left(\frac{A_M\hat{s}_t^B}{A_{C,t}S_t^*}\right).\end{aligned} \tag{26}$$

It immediately appears from (26) that the ideological stance of type A's relative to type B's under the communist system weakens when $\tau^B(\chi_t)^* > 0$. This is true as long as

$$\chi_{C,t} \equiv \frac{A_M\hat{s}_t^B}{A_{C,t}S_t^*} > 1, \tag{27}$$

which will turn out to be the initial condition at the moment of the revolution, T, due to destruction of some fraction of the capital stock (see section 3.3 to follow immediately). Inefficiency increases when the direct positive effect of aggregate savings S_t^* on efficiency is dominated by its negative effect via productivity in the next period, $A_{C,t+1}$. In words, when the egalitarian planner increases aggregate savings S_t^* to trigger an acceleration of the accumulation process and a fall in $\chi_{C,t}$, he must assign a lower consumption level to all workers according to Lemma 2. Since productivity depends positively on wages, worker incentives to upgrade the production process and therefore productivity under communism, $A_{C,t+1}$, are reduced. If the latter effect dominates, inefficiency increases and type B agents recruit intertemporally by increasing their socialization effort.[16]

[16] Lindbeck and Nyberg (2006) discuss the disincentive effects on work of welfare-state arrangements, stressing in particular that the "negative effects of the poor incentives for work in former socialist countries in Eastern Europe also seem to have materialized with a time lag".

Lemma 3 *Savings by the egalitarian planner have a negative effect over time if the indirect negative effect of savings on next period productivity ($\frac{\partial \chi_{C,t+1}}{\partial A_{C,t+1}} \frac{\partial A_{C,t+1}}{\partial S_t^*} < 0$) dominates the direct positive effect of savings on efficiency, $\frac{\partial \chi_{C,t+1}}{\partial S_{t+1}^*} > 0$. When this condition holds, saving by the egalitarian planner leads type B agents into more propaganda to proliferate market ideas and to stimulate transition.*

Proof. *Inefficiency in period $t+1$ increases if the direct positive effect of saving in $t+1$ is dominated by the negative lagged effect of saving in t via a reduction in $A_{C,t+1}$:*

$$\left| \underbrace{\frac{\partial \chi_{C,t+1}}{\partial A_{C,t+1}}}_{+} \underbrace{\frac{\partial A_{C,t+1}}{\partial S_t^*}}_{-} \right| > \underbrace{\frac{\partial \chi_{C,t+1}}{\partial S_{t+1}^*}}_{+}$$

where we know $\frac{\partial A_{C,t+1}}{\partial S_t^*} < 0$ from (23). ■

Looking back at the production function in (4) and recalling $S_t^* = K_{t+1}$ reveals that Lemma 3 also entails a strong marginal loss of productivity from lower consumption that prevents $H_{C,t}$ to grow over time. This rules out the possibility of investments raising total output over time and bringing by higher consumption possibilities. In order to simplify the exposition of the model and focus on our area of interest, we assume hereafter that the condition in Lemma 3 holds.

In sum, the egalitarian planner allocates national income between consumption and savings at the aggregate level, the type B agents then react by choosing their socialization effort to influence the ideology of the rest of the society (type A). The proportion of type B agents in the next period $(1 - q_{t+1})$ is then determined. Indeed, we can see from expression

$$\frac{\partial q_{t+1}}{\partial A_{C,t}} = \frac{q_t^2 (1 - q_t)^2}{A_{C,t}(1 - \beta \alpha A_{C,t})} > 0, \tag{28}$$

that although savings directly increase productivity in support of communism, the disincentives created by reduced consumption due to more government savings increases the relative strength of type B's to change the status quo (now also proportion of the population who sympathize with communism, as more agents convert to the type B ideology).[17]

3.3 The Moment of Revolution

Before analyzing the dynamics of capital accumulation, it is helpful to have a closer look at the first period immediately following the communist revolution, T. Aggregating all capital stock in the hands of the individual capitalists that has been nationalized at the beginning of T and taking into account the costs of the revolution in terms of a destroyed fraction of capital $1 - \mu$, we get:

$$(1 - n_T)\, s_{T-1}^B = (1 - n_T)\, k_T \overset{\text{revolution}}{\underset{\text{cost (loss)}}{\Rightarrow}} \mu\, (1 - n_T)\, k_T = K_T.$$

[17] Note that $\frac{\partial \tau_t^B (\chi_{C,t+1})^*}{\partial A_{C,t+1}} < 0$; that is, socialization effort by type B increases due to decreased consumption, incentives, and productivity. For an insight on the reduced consumption opportunities delivered by communist regimes, see for example Bergson (1991).

The left-hand side of this expression is the capital stock invested by the individual capitalists just before the revolution and aggregated at the national level, $(1-n_T)\,s^B_{T-1}$; the right-hand side is the same capital stock after accounting for the capital losses during the revolution and the nationalization of all the inherited and surviving capital, $\mu\,(1-n_T)\,k_T$. The latter capital stock, K_T, is what remains for the egalitarian planner to put into production in period T and, obviously, $K_T < (1-n_T)\,k_T$. Note that productivity in T does not change leaving the planner with unchanged productivity, A_M, but a lower capital stock, K_T. This results in reduced output in T relative to $T-1$, inducing the planner to increase savings in his very first intertemporal allocation decision. Such a decision could, of course, be motivated by the need to rebuild the capital base and compensate for the loss from the revolution, or to catch up with the rest of the world.

From then on, in essence, period T has a lagged effect on output in period $T+1$ via two channels: (i) increasing the capital stock, $K_{T+1} = \alpha S_T$, through more savings in the preceding period increases output, H_{T+1}; (ii) also decreasing wages and consumption that are equally assigned to all workers as from period T; this reduces productivity in the next period $A_{C,T+1}$ resulting in a lower output H_{T+1}. To sum up, if Lemma 3 holds, an elastic negative response of productivity to savings across generations is ensured and communism is not sustainable in the long run.

4 Intergenerational Dynamics and Economic Outcomes

In this section, we highlight our principal analytical findings derived from the dynamics of q_t and the resulting economic outcomes. That is, having precedingly analyzed the within-period leadership game equilibrium strategies of our two agent types, we are now well equipped to proceed to the analysis of the feedback from ideological strength q_t to strategies across generations. Given that agents only live one period of adulthood, players in the von Stackelberg game change every period. In other words, the same game is played by the next generation, with the level of strength q_t attained by socialization of agents in the previous period as the initial condition. This allows us to observe the law of motion of q_t and potential economic transitions over time. In what follows, we assume that a change of system in our model occurs once the strength of the follower type dominates that of the leader type in the conflict function.

4.1 Capitalism and the Communist Revolution

We first consider the dynamics underlying the transition from a market-based to a centrally-planned economic system. We can state:

Proposition 1 (Communist Revolution) *Suppose type A is initially weaker than type B ($q_0 < 0.5$). Given $\tau^A(\upsilon_t)^*$, s_t^{B*}, and the law of motion of q_t, the optimal saving by type B's is* increasing *in q_t. This implies that a higher $q_{M,t+1}$ will result in more savings by type B's in the next generation von Stackelberg game ($\frac{\partial s^{B*}_{t+1}}{\partial q_{t+1}} > 0$). Such a trend continues until $q_t > 0.5$ where a communist revolution becomes credible.*

Proof of Proposition 1. We derive the effect of the relative strength of workers in some period t on the saving behavior of the capital owners in that period:

$$\frac{\partial s_t^{B*}}{\partial q_t} = 2q_t(1-q_t)(1-2q_t)\frac{\ln\left(\chi_{C,t}\right)}{\beta\alpha A_M - 1} \begin{array}{ll} > 0 & \text{if } q_t < 0.5 \\ < 0 & \text{if } q_t > 0.5 \end{array}. \tag{29}$$

Thus, for any low $q_t < 0.5$, we have $\frac{\partial s_t^{B*}}{\partial q_t} > 0$. In words, the optimal reaction functions of the two types in the von Stackelberg game of class struggle under markets lead to a progressive increase of q_t until it surpasses some 'critical mass'. Beyond this threshold type A's become sufficiently strong and ideologically determined to represent a credible threat to overthrow the existing capitalist social order. For $q_t > 0.5$, a communist revolution happens with probability q_t; alternatively, the optimal savings by type B's, s_t^{B*}, become decreasing in q_t stabilizing the capitalist market-economy system. ■

Our interpretation of Proposition 1 is the following: a capitalist system is only feasible when type A's are weaker than type B's ($q_0 < 0.5$). An increase in this strength caused by social resentment induces more savings by future capital owners. This increases the efficiency of the system, augmenting the revenues of the capital owners; but it also increases inequality, feeding the resentment of type A agents, and ultimately increasing the probability of a regime change. So as the working class increases mobilization and becomes more ideologically motivated to overthrow the system, capitalists accumulate more. Hence, the market system moves towards its fall as resentment within type A agents has a reinforcing effect on capital accumulation, and inequality, rather than mitigating it. Historically, this could be relevant to the case of the uprising of the working class in Russia, on which we focus here.

Corollary 1 *Should a communist revolution not occur when $q_t > 0.5$, the substantial threat from strong type A's revolting induces the leader to accommodate its strategy in search of a compromise by* decreasing *savings, s_t^{B*}, mitigating inequality and stabilizing the market system.*

Proof. See proof of Proposition 1. ■

The alternative in Corollary 1 occurs because for relatively strong type A's the probability of a regime change is perceived by type B's as credible, thus the latter adapt their behavior. Given the optimal socialization effort of type A agents and the law of motion of q_t, an increase in the probability of a regime change ($q_{t+1} > q_t$) induces a reduction in capital accumulation by the only type who can save under the system and, as a result, in income inequality. By reducing the ideological determination of type A's to change the status quo, such a reaction by capital owners can avoid slipping towards communism. Historically, this seems to have been the case of social democracies and the welfare state, where democratization of capitalism and redistribution of income have preserved the market system (although modified). This scenario is not at the center of our interest, and has been analyzed elsewhere in the literature.

4.2 Communism and the Transition to Markets

We turn to the dynamics underlying the transition from a centrally-planned to a market-based economic system in another proposition:

Proposition 2 (Market Transition) *Suppose type B is initially weaker than type A ($q_T > 0.5$) and that Lemma 3 holds. Given $\tau^A(\upsilon_t)^*$, s_t^{B*} and the law of motion of q_t, the optimal saving by the egalitarian planner is* increasing *in $1 - q_t$. This implies that a higher $q_{C,t+1}$ will results in more savings by the egalitarian planner in the next generation von Stackelberg game ($\frac{\partial S_{t+1}^*}{\partial q_{t+1}} < 0$). Such a trend continues until $q_t < 0.5$ where a transition back to a market-based economy becomes credible.*

Proof of Proposition 2. We derive the effect of the relative strength of market advocates in some period t on the saving behavior of the egalitarian planner in that period:

$$\frac{\partial S_t^*}{\partial q_t} = 2q_t(1-q_t)(1-2q_t)\frac{\ln\left(\frac{\alpha}{1-\alpha}s_t^B\right)}{1+\beta\alpha A_{C,t+1}A'_{C,t+1}} \begin{array}{ll} >0 & \text{if } q_t<0.5 \\ <0 & \text{if } q_t>0.5 \end{array}. \tag{30}$$

Thus, for any high $q_t > 0.5$ (i.e. any low $1-q_t < 0.5$), $\frac{\partial S_t^*}{\partial q_t} < 0$ (i.e. $\frac{\partial S_t^*}{\partial(1-q_t)} > 0$). In words, the optimal reaction functions of the two types in the von Stackelberg game of conflicting beliefs under communism lead to a progressive increase of $1-q_t$, i.e. a progressive decrease of q_t until it drops below certain 'critical mass'. Beyond this threshold type B's become sufficiently strong and ideologically determined to cause a credible threat to bring down communism by pro-market transition reforms. For $q_t < 0.5$, a market transition occurs with the probability $1-q_t$; alternatively, the optimal aggregate saving, S_t^*, is increasing in q_t (that is, decreasing in $1-q_t$) stabilizing the communist system. ■

Our interpretation of Proposition 2 is the following: a communist system is only feasible when type A's are weaker than type B's ($1-q_T < 0.5$). An increase in this strength caused by a shift of ideology that arises from lower relative efficiency under communism induces more savings by the next egalitarian planner. He responds by attempting more investment and accumulation at the aggregate level, reducing wages, total available consumption and hence productivity. As this ultimately increases inefficiency, type B agents respond by higher socialization effort, and more discontented people who have now observed the consequences of communism shift ideology to support a market system. The planner responds by further increasing savings, only to exacerbate the relative inefficiency of the communist regime making it less and less sustainable.[18] The convergence of beliefs continues until the point where economic transition is triggered and the regime reverts to the market system. Historically, this could be relevant to the Soviet and East European case, on which we focus here.

Corollary 2 *Should market transition not occur for $q_t < 0.5$, a substantial threat from strong type B's to overturn the regime induces the leader to accommodate his strategy in search of compromise by* decreasing *savings, S_t^*, increasing longer-run efficiency (via higher wages and consumption) and stabilizing the communist system.*

Proof. See proof of Proposition 2. ■

The alternative in Corollary 2 occurs because for relatively strong type B's the probability of a regime change is perceived by the egalitarian planner as credible, thus the latter would adapt his behavior. Given the optimal socialization effort of type B and the law of motion of q_t, an increase in the probability of a regime change ($q_{t+1} < q_t$) induces a reduction in aggregate savings by the egalitarian planner. This increases consumption allocations (material well-being), hence productivity and ultimately the efficiency of the communist system. The latter occurs because the marginal gain in productivity from lower saving is sufficiently large for the range of parameter values where Lemma 3 holds. By reducing the ideological determination of type B's to change the status quo, such a reaction by the egalitarian planner can prolong the life of a communist regime and,

[18] Essentially, such a set-up resembles the overinvestment experience in communist countries during their period of initial industrialization and subsequent attempts to increase future production (and, in historical context, catch up with the West).

potentially, avoid surrendering central planning. Historically, this resembles the Chinese social market economy, where pro-market reforms were undertaken widely in coexistence with the centralized system.

[Figure 3 about here]

Figure 3 summarizes the dynamics of the model across generations. To elucidate it, we briefly revisit the events that lead to revolution and back to transition. Initially under markets, a positive inequality index of $\upsilon_{M,0} > 1$ leads to $\tau^A(\upsilon_{M,0})^* > 0$ from (19), which itself brings about an increase in the strength of type A's in the next period q_1. According to equation (18) and Proposition 1 this increases optimal savings in the following period $s_1^{B,*}$ ($\upsilon_{M,t} > 0 \rightarrow s_t^B > 0 \rightarrow \tau_t^A > 0 \rightarrow q_{t+1} \uparrow\rightarrow s_{t+1}^B \uparrow \rightarrow ...$). This cycle repeats every period until $q_t > 0.5$, after which either revolution occurs (Proposition 1) or the system stabilizes (Corollary 1). In the case of revolution, a positive inefficiency index of $\chi_{C,T} > 1$ satisfying condition (27) gives $\tau^B(\chi_{C,T})^* > 0$ from (25), which itself leads to a higher proportion of B type agents in the following period q_{T+1}. According to equation (24) and Proposition 2, this increases optimal savings in the following period S_{T+1}^*. As a result, inefficiency with respect to the market system increases as long as Lemma 3 holds, triggering a continuing cycle towards transition back to the market system ($\chi_{C,T} > 0 \rightarrow S_T > 0 \rightarrow (C_T \downarrow\rightarrow A_{C,T+1} \downarrow\rightarrow \chi_{C,T+1} \downarrow) \rightarrow \tau_T^B > 0 \rightarrow 1 - q_{T+1} \uparrow\rightarrow S_{T+1} \uparrow \rightarrow ...$). This cycle repeats every period until $q_t < 0.5$, after which either transition occurs (Proposition 2) or the system stabilizes (Corollary 2).

5 Discussion and Concluding Remarks

Our theoretical analysis above summarized the rise and fall of communism as a process of experimenting with a new economic system that failed. It also showed how the same general mechanism we emphasized as driving social evolution could generate, under certain conditions and under minor regime-dependent specificity, not just the advent of communism but also its demise. That is, we proposed a model of long-run economic dynamics as one possible explanation for a principal insight from the history and the turn of events during the last century and a half.

Our work is in line with North (2005)' arguments on the process of long-run economic change. He characterizes succinctly the nature of this social evolutionary process as follows:

> "In contrast to Darwinian evolutionary theory, the key to human evolutionary change is the intentionality of the players. (...) Economic change, therefore, is for the most part a deliberate process shaped by the perceptions of the actors about the consequences of their actions. The perceptions come from the beliefs of the players – the theories they have about the consequences of their actions – beliefs that are typically blended with their preferences." (North, 2005, p. viii)

While the book by North (2005) is framed along purely descriptive argumentation, in the tradition of the new institutional economics, the chain of logic in the last quote certainly is compatible with a more technical, statistical literature, featuring learning (that could be Bayesian, social or of other methodological strand or aggregation level). Our guiding principle was, therefore, to keep the framework fairly general and the learning

process by all agents in the experiment with communism under aggregate uncertainty – or, more precisely, ambiguity hidden within an unattempted ever economic system – quite straightforward. Of course, many more additional ingredients, considerations and complications could be built into the set-up presented. We ourselves believe there are a number of interesting and relevant avenues to enrich the basic model we developed. Yet our goal with this paper was to capture the 'perceived reality → beliefs → institutions → policies → altered perceived reality' chain North (2005) emphasized in words into a coherent and general theoretical construct capable to summarize the experiment of communism as social learning in the face of ambiguity highlighting the trade-off between equality and efficiency.

Indeed, our model begins with a 'perceived reality' that is unjust for our type A agents, as they are born unequal and poorer. Their 'beliefs' are thus shaped out by the ideal of achieving equality, and are propagated by socialization and the spread of ideology across society in our model. At this initial point in our model, however, the world has never operated a communist economic system, to which the A types strive. In other words, the society faces huge (aggregate) ambiguity if it decides to attempt a change in the status quo. The experimentation with communism can, in this light, be seen as the 'necessary evil' to pass through in order to learn (more) about (the properties of) an unknown form of socioeconomic organization. The experiment accordingly creates its own 'institutions' and 'policies', forcing equality in incomes and a central planning system to replace the role of capitalists and markets. But after repeating a few generation-spans of production and consumption, the social realities imposed by the revolution and nationalization turn out simply not to work. All members of the communist region suffer lower and lower material well-being due to misaligned incentives resulting from a distorted ownership and control structure. This will be, in fact, the main social learning outcome after experimenting with an unknown economic system abolishing private property and market signals: all agents will gradually discover that communism forces equality of ownership through a centralized allocation that comes at the cost of lower productivity and poor coordination. While observing as a reference point the rest of the world that has remained market-based and is performing better, a drive to pro-market reforms – the 'altered perceived reality' – reverts the society back to sustainability. Although we stop modeling the chain of social evolution at this point, it certainly does not end here, but continues by experimenting and discovering 'on and on'.

Sometimes – if not often – in history, the society faces the unavoidable challenge to experiment with its own existence and future under huge ambiguity. With heterogenous agents, information sets, expectations and interests, it is not always easy to converge to a commonly shared plan, or at least hope for such a plan to possibly end up successfully. Doubts, conflicts and ideologies emerge naturally, values and institutions evolve, responding to evolving realities, experiences, learning. Indeed,

> "Men make their own history, but they do not make it just as they please: they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past. The tradition of all the dead generations weighs like a nightmare on the brain of the living."[19]

At times, the experiment discovers a positive outcome. And then society finds and

[19] Karl Marx, 1852, *The Eighteenth Brumaire of Louis Bonaparte*, Chap. 1.

settles into a new (again, temporary) equilibrium, until the next unprecedented vital change of the environment. However, when the outcome of such a social experiment is negative, the pendulum of history swings back, or along a spiral, whose circles constitute a gradation of hard-to-acquire knowledge.

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A Derivation of the Model Solutions

A.1 The von Stackelberg Game under Market Capitalism

Type B agents move first by making a decision on the amount of their savings:

$$\begin{aligned} \max_{s^B_{M,t}} U^B(\cdot) &= c^B_{M,t} + \beta y^B_{M,t+1} - E^B_t(\chi_t) - \frac{\tau^B(\chi_t)^2}{2} \\ \text{s.t. } c^B_{M,t} + s^B_{M,t} &\leq y^B_{M,t}. \end{aligned}$$

We first substitute out: consumption $c^B_{M,t}$ from the budget constraint; income $y^B_{M,t+1}$ from the production function, after taking into account the marginal return to capital; the expected regime-dependent inefficiency $E^B_t(\chi_t)$ from its definition after noting that $\ln \chi_{M,t} = 0$; under a market economy $\tau^B_t(\chi_M) = \tau^B_t(1) = 0$ (since $\chi_M = 1$, see above). Below we omit the M-subscript to savings because under communism individual savings are absent:

$$\max_{s^B_t} \left(y^B_{M,t} - s^B_t\right) + \beta r_M s^B_t - q_{t+1} \ln(\chi_{C,t}).$$

Next, we substitute: $y^B_{M,t} = r_M s^B_{t-1}$ and $r_M = \alpha A_M$ (from the production function, after taking into account the marginal return to capital); q_{t+1} (from its law of motion):

$$\begin{aligned} &\max_{s^B_t} \quad r_M s^B_{t-1} - s^B_t + \beta\alpha A_M s^B_t - \left[q_t + (q_t - q_t^2)\tau^A(\upsilon_t)\right] \ln\left(\chi_{C,t}\right), \\ &\max_{s^B_t} \quad \alpha A_M s^B_{t-1} + (\beta\alpha A_M - 1)\, s^B_t - \left[q_t + (q_t - q_t^2)\tau^A(\upsilon_t)\right] \ln\left(\chi_{C,t}\right). \end{aligned}$$

A.2 The von Stackelberg Game under the Communist Plan

The egalitarian planner as a first mover maximizes utility in the name of the type A agents taking into account aggregate values.

$$\begin{aligned} \max_{S_t} \quad U^A_{C,t}(C_t, Y_{t+1}, \upsilon_t) &= C_t + \beta Y_{t+1} - E^A_t(\upsilon_t) - \frac{\tau^A(\upsilon_t)^2}{2} \\ \text{s.t. } C_t + S_t &\leq H_{C,t}. \end{aligned}$$

Substituting out consumption and savings from (23); the expected regime-dependent inequality $E^A_t(\upsilon_t)$ from its definition after noting that $\ln \upsilon_{C,t} = 0$; q_{t+1} (from its law of motion); $\upsilon_{M,t} = \frac{\alpha}{1-\alpha} s^B_t$ from (8); and $\tau^A(\upsilon_C) = \tau^A_t(1) = 0$ under a centralized economy (since $\upsilon_{C,t} = 1$, see above).

$$\max_{S_t} \quad H_{C,t} - S_t + \beta Y_{t+1} - (1 - q_{t+1}) \ln(\upsilon_{M,t}).$$

Next we substitute: $Y_{t+1} = r_C S_t$ and $r_C = \alpha A_{C,t}$ (present shadow price of capital in a communist system) in his optimization problem.

$$\begin{aligned} &\max_{S_t} \quad A_{C,t}[\alpha K_t + (1-\alpha)L] - (1 - \beta\alpha A_{C,t}) S_t - (1 - q_{t+1}) \ln\left(\upsilon_{M,t}\right), \\ &\max_{S_t} \quad A_{C,t}[\alpha S_{t-1} + (1-\alpha)L] - (1 - \beta\alpha A_{C,t}) S_t \\ &- \left(1 - \left[q_t - (q_t - q_t^2)\tau^B(\chi_t)\right]\right) \ln\left(\upsilon_{M,t}\right). \end{aligned}$$

B Figures

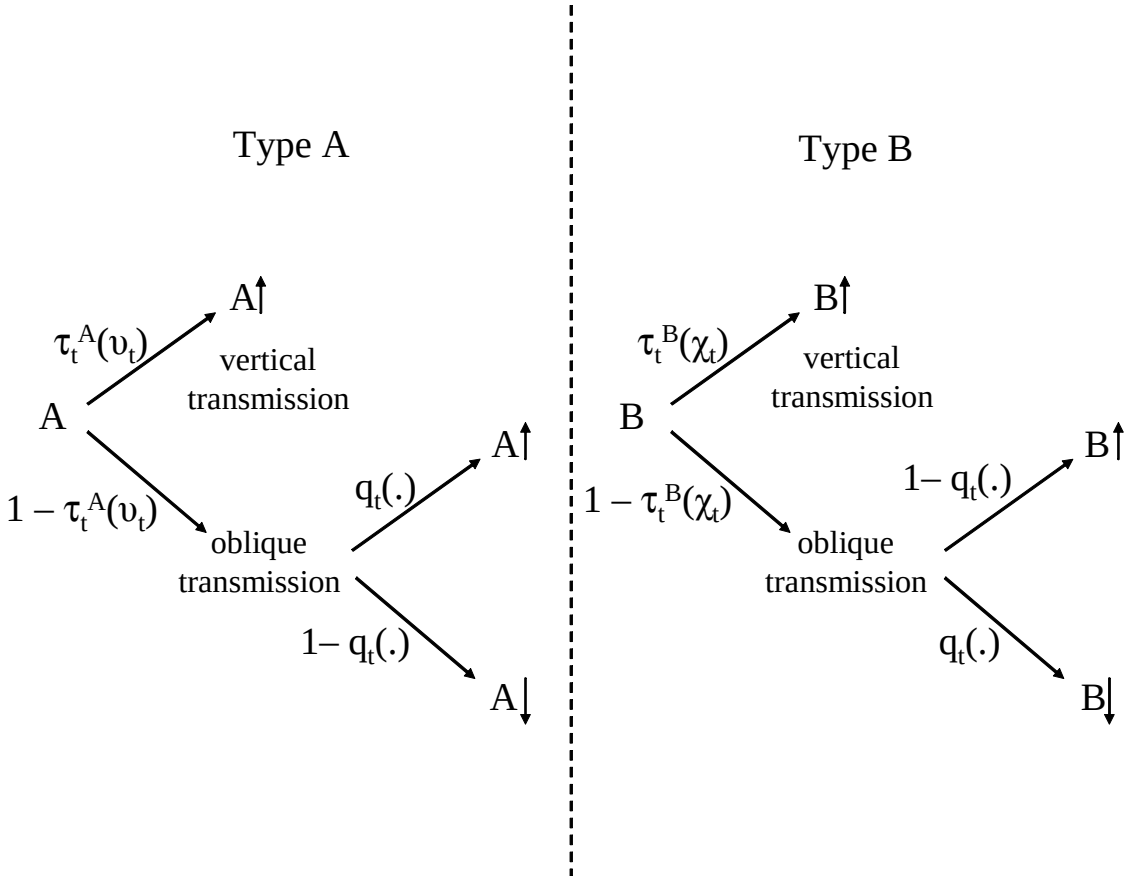

Figure 1: Types of Agents and Socialization

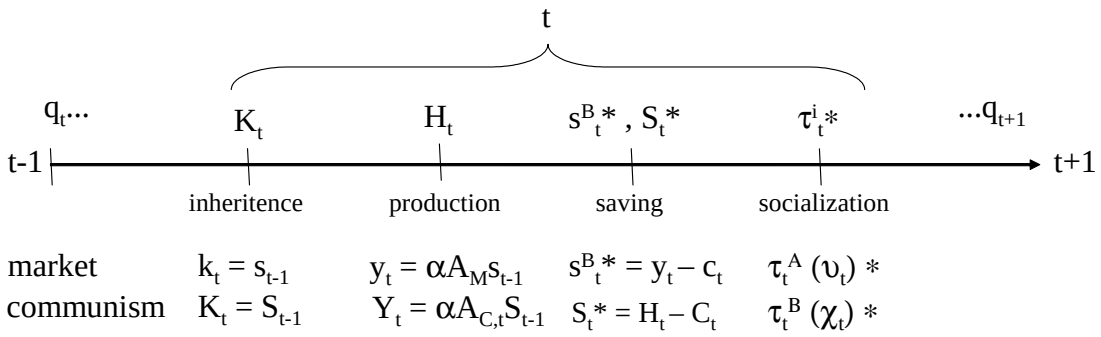

Figure 2: Sequence of Events in Period t

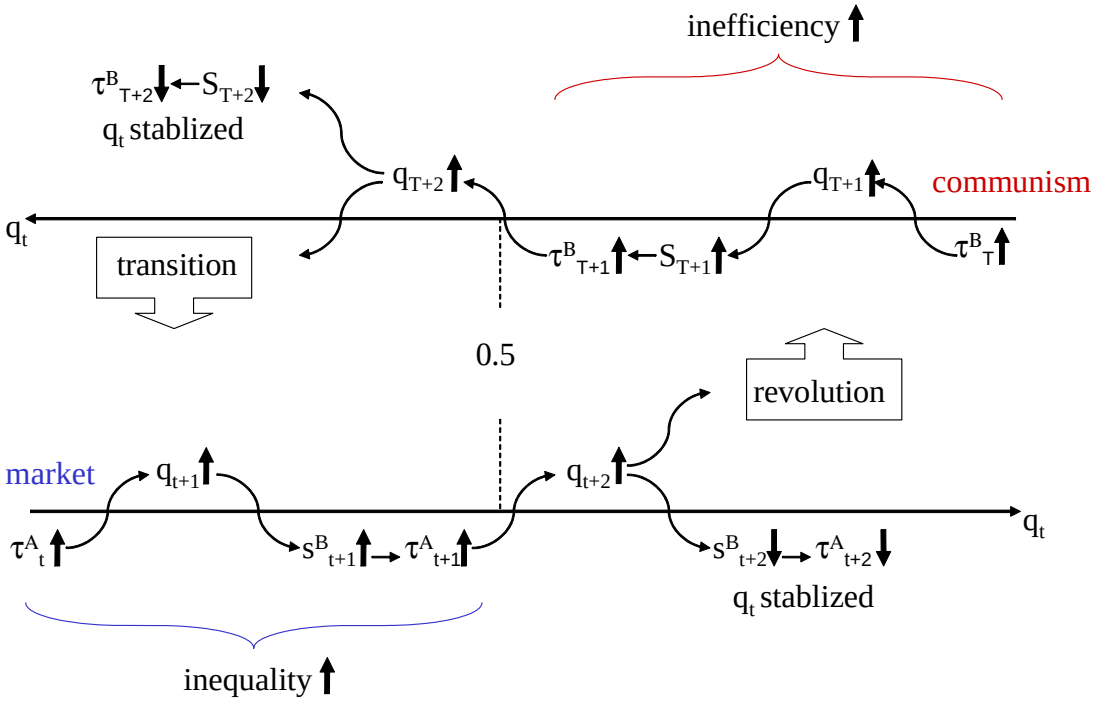

Figure 3: Dynamics of Ideology across Generations

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