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A comparison between economic systems with an application to transition

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Abstract

This paper develops a general equilibrium theory of endogenous firm and class formation under non-contractibility with heterogeneous individuals. A collectivist economy, a private-ownership economy, and a mixed economy are compared on the basis of identical economic fundamentals (methodological symmetry). Each economic system generates specific inefficiencies so that none dominates the others in general. The main trade-off is between the welfare loss associated with risk-taking in the private-ownership economy and the informational problems in the collectivist economy. We then use this framework to study the political economy of transition between economic systems and provide detailed welfare results.

JEL classification: P51; D51; D72

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1. Introduction

The collapse of planned economies in the late 1980s led to a surge of interest for the economics of transition. A large body of literature has developed analysing many of the problems caused by these major changes in the basic rules governing economic activity.[1] Most of this literature, however, starts with the premise that capitalism is more

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[1] This large literature is summarised in Roland (2000).

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productive than socialism. While this is certainly a valid assumption for many short-run policy issues, this does not help us assess the relative merits of capitalism and socialism. Nor does it explain the enduring interest of many for alternatives to capitalism. In this paper, we take a step towards the development of a unified theory of comparative economic systems.

Our approach is guided by the principle that any analysis of comparative economic systems should proceed on the basis of *methodological symmetry* within a general equilibrium framework. By 'methodological symmetry' we understand that economic systems must be compared on the basis of the same fundamentals, i.e. their representations must rely on *identical initial* conditions regarding individual preferences, endowments, technologies and the information structure.[2] Methodological symmetry is a pre-requisite for isolating the effects of institutional variations on the economy.[3]

As, under methodological symmetry, the differences between socialism and capitalism do not lie in the fundamentals, one has to specify where they lie. We take the approach that the two systems basically differ in: (i) the allocation of property rights, and (ii) the mechanism for the allocation of goods and factors of production. In essence, capitalism is organised around private ownership of the means of production and a decentralised allocation of goods and factors of production, whereas socialism is characterised by public ownership of the means of production and a centralised allocation of goods and factors. More specifically, to compare a prototype capitalist (or, as we will call it here, 'private-ownership') economy with a prototype socialist (or 'collectivist') economy, we develop a static general equilibrium model of endogenous firm creation and class formation.

The fundamentals of the economy which are invariant across systems can be summarised as follows. At stage 1, individuals (of different risk-aversion and managerial talent) must choose between becoming a manager or a worker. At stage 2, each manager sinks her labour endowment to set up a plant. Each plant may be either productive or unproductive, whereby the probability of any plant being productive depends on its manager's talent. Each manager decides whether to learn about her plant's productive status (e.g. by undertaking a market research), or to remain uncertain. At stage 3, workers are allocated across plants. Finally output is produced and distributed. A key

[2] Textbooks on comparative economic systems typically use methodologically completely different models of socialism and capitalism; see, e.g. Gregory and Stuart (1999), part II. Note that methodological symmetry does not necessarily require individual endowments, technology or the information structure to be identical *ex-post*, but that any *ex-post* difference need to be derived endogenously. For example, in the model developed below, the number of production units as well as the information structure vary endogenously across systems. Alternatively, it might be interesting to develop a theory of the comparative evolution of endowments or technologies across economic systems, such as, e.g. Qian and Xu (1998). This, however, is not the issue in this article.

[3] The comparison of socialism and capitalism under methodological symmetry in general equilibrium goes back to the literature developed around the Lange–Lerner debate in the 1930s (see Lange, 1936, 1937; Lerner, 1936; Knight, 1936, and references therein), but it has not made very much progress in this direction since then, particularly when it comes to general equilibrium modelling. Partial equilibrium analysis of institutional variations has experienced more sustained progress with, among others, Weitzman (1974) on optimal planning, Bolton and Farrell (1990) on planned vs. decentralised investments, Dewatripont and Maskin (1995) on soft budget constraints, or Hart et al. (1997) on private vs. public ownership.

assumption is that managerial talent and the input/output of any plant cannot be contracted upon.[4]

Under private-ownership, each plant is owned by the manager (or 'entrepreneur') who operates it. In the (existing and unique) equilibrium under private-ownership (P) all entrepreneurs choose to become informed about the productivity status of their plant and hire an optimal number of workers accordingly (i.e. zero if the plant is not productive). The reason is that with private ownership and a free allocation of factors of production, entrepreneurs, who make their own decisions and bear the un-insurable risks regarding their plants, are rewarded with a high return when successful and a low return when unsuccessful. These low returns act as a disciplining device on entrepreneurs inducing them to become informed and run only productive plants. Despite this productive efficiency, P is characterised by three types of inefficiency related to the absence of full insurance: in general, there are too few entrepreneurs, they have to bear their entrepreneurial risk, and some of the entrepreneurs are less talented than some of the workers, implying a misallocation of talent. Moreover, we show that P is not in general second-best either. Aggregate output in P falls as society becomes more risk-averse and, eventually, falls to zero with infinitely risk-averse individuals. With sufficiently many risk-neutral individuals, by contrast, P achieves first-best.

Our formalisation of P builds on the well-established literature in the tradition of Frank Knight (1921) which has developed a general equilibrium approach to the process of firm creation and the emergence of entrepreneurial and working classes.[5] In effect, our model of P extends Kanbur (1979a) by introducing heterogeneity in managerial talent and risk aversion.[6] Such heterogeneity plays a crucial role when comparing economic systems.

Under public-ownership, all plants are owned by a collectivist institution which hires a manager (or 'director') to operate each one. This institution also allocates workers across plants.[7] We show that the (existing, but not necessarily unique) equilibrium of the collectivist economy (C) does not achieve first-best. In C, the non-contractible output of each plant accrues to the collectivist institution. At the same time, and because directors are indispensable to their plants, the collectivist institution must get each director to agree to operate her plant. As a result of bilateral bargaining, the collectivist institution makes a sure transfer payment to each director. This transfer is based on a sure surplus when the

[4] In this context, we note that non-contractability must play a crucial role in any meaningful comparison between economic systems. Otherwise, it is well-known that under complete contracts, an optimal (possibly second-best) outcome is achieved regardless of the institutional setting in general and the property rights regime in particular (see Williamson, 1975; Grossman and Hart, 1986, and the subsequent literature).

[5] Kanbur (1979a,b and 1981); Kihlstrom and Laffont (1979 and 1983) formalise the Knightian view of the entrepreneur as a risk-taking owner-manager who bears his own business risk. In this series of articles, they develop the general equilibrium framework of occupational choice that we use here as a representation of the private-ownership economy. Entrepreneurs bear the risk of being more or less successful in their business. This view, as Kanbur (1980) argues, is very different from Schumpeter's (1934) view of the entrepreneur as an innovator.

[6] Laussel and Le Breton (1995) introduce workers and entrepreneurs of different abilities to the model of Kihlstrom and Laffont (1979). They analyse the allocation of talent when all individuals are risk neutral.

[7] The collectivist institution, as modelled below, could be either a central planning bureau or a township village council. What matters is that it owns all the production units and that it has the authority to allocate workers to plants.

plant is known to be productive or on an expected surplus when directors have remained uninformed. Hence, the incentives of directors to become informed and to run only viable plants are much weaker than in P, since C provides de facto insurance. On the other hand, the amount of risk-bearing is lower in C, which reduces the inefficiency relative to P. For a sufficiently risk-averse society, C Pareto-dominates P. However, with sufficiently many risk-neutral individuals, C is Pareto-dominated by P. Similarly to P, C is not in general second-best either. While C is characterised by productive inefficiency, public ownership provides *non-contractual* insurance to (uniformed) directors, which is not feasible in P. We believe that this trade-off between productive efficiency and insurance captures one fundamental aspect in the comparison between capitalism and socialism.

The crucial importance of the allocation of property rights and of non-contractibility bridges with the literature on incomplete contracts following Grossman and Hart's (1986) work. In our model, employment in and output of any production plant are not contractible (while, as in Grossman and Hart, transfer payments between individuals or through the state are). Due to this non-contractibility, residual incomes and residual control rights in each production plant come to play an important role.[8] In P, non-contractibility prevents any form of insurance and the allocation of property rights to entrepreneurs makes them the sole decision makers in their respective plants. In C, the necessity for both parties to agree on an allocation of workers at stage 3 and the associated bargaining on this issue has crucial implications on the ex-ante incentives of the manager, as is typically the case in the incomplete contract literature.

We then extend our model allowing for a mixed economy in which the two systems may co-exist. People individually choose whether to move to the P-sector (either as entrepreneurs or as workers) or to the C-sector (as directors or as workers). We show that the equilibrium of the mixed economy (M) exists and is unique. An interesting feature of M relates to a negative pecuniary externality imposed by the P-sector upon the C-sector. Because of higher returns, the P-sector attracts informed and talented managers from the C-sector, leaving the latter with only uninformed and relatively more untalented managers whose marginal product is lower. This, in turn, drives incomes in the C-sector down. If this effect is strong enough, it may even lead to a complete close-down of the C-sector, i.e. to M coinciding with P.

We finally use our model to shed light on some of the forces underlying the democratic choice of economic system. Since managerial talent and risk-aversion differ across individuals, society is not in general unanimous in its choice between economic systems.[9] Our model identifies the losers from a move from C to P as being the failed

[8] Given our general equilibrium focus (and the endogeneity of the surpluses), this aspect of the model remains quite rudimentary: managers in collectivist plants may act inefficiently by choosing not to learn about the viability of their plants in order to bargain on an expected surplus instead of bargaining on a known outcome, which may be unfavourable to them (see Section 5, below). That is, we take non-contractibility as given and explore some of its implications. Thus, we do not address here the debate about the foundations of contract incompleteness (see Tirole, 1999, for a survey on this matter).

[9] In this respect we believe that individual heterogeneity must be an essential ingredient in any meaningful theory of comparative economic systems. Without it, the choice between economic systems would boil down to a comparison of relative efficiency and deprive the debate of much of its content. At the same time, individual heterogeneity leading to inequalities has also crucial political implications.

entrepreneurs together with possibly the new working class (if their wage in P is lower than in C). In a popular referendum under majority rule, P may be preferred to C, even when it is known that there will be a majority worse-off ex-post. This is due to the fact that a majority of people may hope to become part of the new class of successful entrepreneurs.

These results can be related to three key stylised facts regarding recent transition experiences. First, and as predicted by the model, income inequalities in formerly socialist countries have risen substantially (see Flemming and Micklewright, 1999, for a summary of the evidence on this issue). This increase has been more moderate in countries where entrepreneurship has been vibrant, as also predicted by the model. Second and following Fidrmuc's (1998) empirical analysis, the winners and losers from the transition tend to be those identified by the model. That is, the winners consist of the more educated people (accepting education as a proxy for our concept of managerial talent), successful entrepreneurs, and even workers in areas where private entrepreneurial activity is strong. Third, the model offers a possible explanation for the political backlashes observed in several countries (such as Poland, Hungary and other countries in Eastern Europe) where the initial reformist governments were not re-elected and were replaced by coalitions including former communist parties.

The remainder of this paper is structured as follows. After introducing the economic fundamentals, which remain the same in all systems (in Section 2), and characterising the first-best allocations (in Section 3), we develop equilibrium in the private-ownership, the collectivist and the mixed economies (in Sections 4, 5, and 6, respectively). Section 7 is devoted to the political economy of transition between systems. Section 8 concludes and sketches some possible extensions.

2. The fundamentals of the economy

In this section, we present the fundamentals of the economy, which are invariant across the systems. There is a continuum of individuals, indexed by k. Individual preferences are represented by a continuous and piecewise differentiable certainty equivalent function of the form

$$v_k = v\left(\underline{y}, \overline{y}, \pi, R_k\right) \quad \text{with } \underline{y} < \overline{y} \tag{1}$$

where v_k denotes the sure income that an individual k with risk aversion R_k considers equivalent to a lottery offering $\overline{y}$ with probability π and $\underline{y}$ with probability $1-\pi$. The certainty equivalent function (1) satisfies the following set of (rather weak) assumptions:

$$\begin{aligned} &v_\pi > 0 \text{ for } \overline{y} > 0; v_{\overline{y}} > 0 \text{ for } \pi > 0; v_{\underline{y}} > 0 \text{ for } \pi < 1; \\ &v_R < 0 \text{ for } 0 < \pi < 1; \end{aligned} \tag{A}$$

$$v(\underline{y},\bar{y},1,R)=\bar{y};\, v(\underline{y},\bar{y},\pi,0)=\pi\bar{y}+(1-\pi)\underline{y};$$
$$v(\underline{y},\bar{y},\pi,\infty)=\underline{y} \text{ for } \pi<1. \tag{B}$$

Individuals are heterogeneous with respect to risk-aversion. The index of risk-aversion, R, is distributed over the interval $[R^-,R]$, with $R^-\geq 0$. The cumulative distribution of risk-aversion in the population $\Phi(R)$ is assumed to be continuous for $R>0$.

There is a single homogenous good. Each production unit uses one unit of managerial labour and some amount of workers' time. After managerial labour has been sunk, a production unit may turn out to be viable or not, depending on its manager's success. When the manager is not successful, the production unit is non-viable in the sense that it cannot produce any output. When a manager is successful, her production unit is viable in the sense that it can produce according to

$$g(\lambda)=\lambda^{\gamma},\quad \text{with } 1>\gamma>0 \tag{2}$$

where g denotes output as a function of λ, the amount of workers' time being employed in the unit along with the manager's. We assume that γ is the same for all viable production units. Since $\gamma<1$, there are decreasing returns to scale. The closer γ is to 1, the closer the technology is to exhibiting constant returns to scale.

Each individual is endowed with one indivisible unit of labour time. In this respect, there are two types of individuals. Talented individuals are characterised by a higher *ex-ante* success rate in making their production unit viable. The probability of a production unit being viable is π_H if the manager is talented and π_L if the manager is untalented, with $\pi_H>\pi_L$. We further suppose that talent is not correlated with risk-aversion so that $\Phi_H(R)\equiv\Phi_L(R)\equiv\Phi(R)$, where $\Phi_H(R)$ and $\Phi_L(R)$ denote the cumulative distributions of risk attitudes in the populations of talented and untalented individuals, respectively. A proportion α of the population is talented and $1-\alpha$ is untalented, with $0\leq\alpha\leq 1$. We assume that α is common knowledge, so that there is no aggregate risk. As workers, all individuals are equally productive.

The timing is the following. When the economy starts, talent is known but individuals remain unaware of their managerial success. At stage 1, each individual decides whether to become worker or manager. This occupational choice is publicly observable and verifiable. At stage 2, managerial labour is sunk in order to set up production units (e.g. product design, organisation of production, etc.). At the same time, each manager decides whether or not to learn (at no cost) about the viability of her production unit.[10] If a manager decides to get informed, then her information becomes public (e.g. the results of the market research become publicly accessible, although not verifiable). After sinking her labour endowment, a manager becomes indispensable to her production unit. Hence, production units will then be in one of the following states: (i) known to be viable, (ii)

[10] For instance, assume that they can conduct a small market research and check the technical viability of their production process at a negligible cost. Making this process costly would complicate our results without fundamentally changing the main trade-off between the two systems.

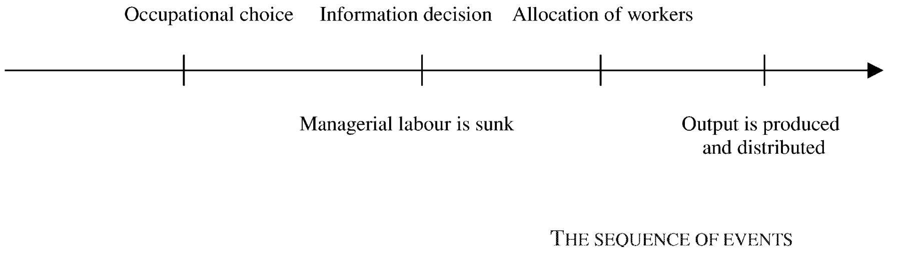

Fig. 1. The sequence of events.

known to be non-viable (and in this case managers may be discarded) or (iii) their productive status may still be unknown. Managers in state (ii) may be discarded and receive zero income. Hence, depending on what happens in state (iii), managers may thus have an incentive not to become informed, although no direct information cost is incurred. At stage 3, workers are allocated across production units. At stage 4, production takes place and output is distributed. The timing can be summarised by the following time line (see Fig. 1).

In addition, we assume that talent, the decision by managers to become informed (about their success) as well as employment and output levels in each production unit, although observable, are not verifiable by outsiders.[11] The motivation behind this assumption is the standard one, i.e. the creation of a production unit involves issues that are too complex for all contingencies to be written in any initial contract between the manager and a third party. Hence the need to allocate property rights in the economy. Our approach to the comparison of economic systems is thus based on the notion of property rights as formalised by Grossman and Hart (1986) and the subsequent literature.

3. The first-best allocations

The first-best (or unconstrained Pareto-optimum) benchmark considered here and denoted F corresponds to the resource allocation that would be chosen by an ideal social planner, which does not face any contractibility constraint. This planner, however, still faces the information constraints described in the fundamentals of the economy in the sense that it does not know in advance the identity of the successful or unsuccessful managers. Thus, the notion of first-best considered here corresponds to interim efficiency. Knowing everyone's talent, the social planner can choose an optimal number of managers and is able to offer each individual full insurance, i.e. a fixed share of total output, but it cannot avoid some managerial labour time being sunk in unproductive projects. Result 1 characterises the first-best:

Result 1. In the first-best, no individual bears risk and workers are allocated to production units so as to equalise their marginal products. Talented individuals are allocated in priority

[11] Note however that non-contractibility of information and output does not prevent non-contingent transfers (see below).

to managerial positions. The more strongly returns to scale are decreasing, i.e. the lower γ, the larger is the optimal proportion of managers, ε_F. The latter is uniquely given by:

Regime I ($\gamma \geq 1-\alpha$) : $\varepsilon_F = 1-\gamma$.

Regime II ($1-\alpha > \gamma > v[(1-\alpha)\pi_L]/[(1-\alpha)\pi_L + \alpha\pi_H]$) : $\varepsilon_F = \alpha$.

Regime III ($[(1-\alpha)\pi_L]/[(1-\alpha)\pi_L + \alpha\pi_H] \geq \gamma$) : $\varepsilon_F = 1-\gamma(1+\alpha(\pi_H/\pi_L - 1))$.

Proof. It is easily checked that any first-best allocation involves the maximisation of aggregate output and its deterministic distribution across individuals. The remainder of the proof characterises the maximisation of aggregate output. Denote ε_H and ε_L the proportion of talented and untalented managers in the total population, respectively. It is of course socially optimal for them to become informed about their productivity. Denote also δ_H and δ_L the proportion of talented and untalented workers in the total population, respectively. Non-managerial labour is only used in viable production units, of which there are $\pi_H\varepsilon_H + \pi_L\varepsilon_L$. Since the production function is strictly concave in non-managerial labour input, every production unit should employ the same amount of labour so that its marginal product is equalised across production units. As the law of large numbers applies, $\pi_H\varepsilon_H + \pi_L\varepsilon_L$ is deterministic. So is total output, which is given by: $G(\varepsilon_H, \varepsilon_L) = (\pi_H\varepsilon_H + \pi_L\varepsilon_L)^{1-\gamma}(\delta_H + \delta_L)^\gamma$. This, consequently, allows for full insurance. The social planner's programme is

$$\underset{\varepsilon_H,\varepsilon_L,\delta_H,\delta_L}{\text{Max}} G(\varepsilon_H, \varepsilon_L) = (\pi_H\varepsilon_H + \pi_L\varepsilon_L)^{1-\gamma}(\delta_H + \delta_L)^\gamma,$$
$$\text{s.t.}\begin{cases} 0 \leq \varepsilon_H \leq \alpha, 0 \leq \delta_H \leq \alpha, \delta_H + \varepsilon_H \leq \alpha \\ 0 \leq \varepsilon_L \leq 1-\alpha, 0 \leq \delta_L \leq 1-\alpha, \delta_L + \varepsilon_L \leq 1-\alpha. \end{cases} \tag{3}$$

The solution of Eq. (3) is characterised differently, depending on the value of γ:

(i) *Regime I* ($\gamma \geq 1-\alpha$). Since talented individuals are on average more productive as managers ($\pi_H > \pi_L$), but equally productive as workers, in the first-best all managerial tasks must be performed by talented individuals, if there are sufficiently many of them. When $\gamma \geq 1-\alpha$, the first-order conditions of Eq. (3) imply $\varepsilon_{HF} = 1-\gamma$ and $\varepsilon_{LF} = 0$. Total output in *regime I* is given by $G_F = \gamma^\gamma(1-\gamma)^{1-\gamma}\pi_H^{1-\gamma}$.

(ii) *Regime II* ($1-\alpha > \gamma > (1-\alpha)\pi_L/[\pi_H\alpha + \pi_L(1-\alpha)]$). In Eq. (3), the constraint $\varepsilon_H \leq \alpha$ is now binding so that $\varepsilon_{HF} = \alpha$. Then, maximising output with respect to ε_L implies $\varepsilon_{LF} = 0$ (i.e. it is not optimal to employ untalented individuals as managers). Total output in *regime II* is given by $G_F = (1-\alpha)^\gamma\alpha^{1-\gamma}\pi_H^{1-\gamma}$.

(iii) *Regime III* ($(1-\alpha)\pi_L/[\pi_H\alpha\pi_L(1-\alpha)] \geq \gamma$). In Eq. (3), the constraint $\varepsilon_H \leq \alpha$ is still binding so that $\varepsilon_{HF} = \alpha$. Then, maximising output with respect to ε_L implies $\varepsilon_{LF} = 1-\alpha-\gamma(1+\alpha(\pi_H/\pi_L - 1))$. Substituting into Eq. (3) yields a total output in *regime III* of $G_F = \gamma^\gamma(1-\gamma)^{1-\gamma}[\pi_H\alpha + \pi_L(1-\alpha)]\pi_L^{-\gamma}$. □

When the technology is close to constant returns to scale, the number of production units can be kept small in order to save on set-up costs. Thus, starting with a large γ (*regime I*), only talented individuals are allocated to managerial positions. As γ decreases, the number of managers increases until all talented individuals work as managers. In an intermediate range of γ (*regime II*), all talented individuals work as managers and all untalented as workers.

Only if returns to scale are very strongly decreasing (small γ, *regime III*) are also some untalented individuals allocated to managerial tasks. In any case, F maximises aggregate output and provides full insurance to all.

Clearly, F is only a hypothetical benchmark, valid only in a world of full contractibility. In the following sections, we explore the consequences of non-contractibility and the role of the allocation of property rights together with that of the allocation of labour.

4. The private-ownership economy

We consider first the implications of the model when the property rights of each production unit are given to its manager and workers are allocated to production units in a decentralised manner. In this case, we refer to managers as entrepreneurs and to their production units as private firms. The sequence of events, as introduced in Section 2, implies that at stage 1, each individual must choose whether to become an entrepreneur or a worker. At stage 2, each entrepreneur must sink her labour endowment and decide whether to become informed about the productivity of her firm. Since the entrepreneur is indispensable to her firm and endowed with all the control rights, she is naturally the sole decision-maker regarding employment in her firm. Thus, at stage 3, the allocation of workers takes place as follows: each entrepreneur must decide how many workers to hire taking the market wage as given. At stage 4, output is produced, wages are paid and the entrepreneur is left with her firm's profit. Given our assumptions, equilibrium in the private-ownership economy, also denoted P, is formally defined as follows:

Definition P. (Equilibrium in the private-ownership economy): P is an income, an occupation and an information decision for each individual such that:

(i) Each individual competitively chooses her occupation (worker or entrepreneur) and whether to become informed (as entrepreneur) or not, so as to maximise her expected utility.
(ii) Each informed entrepreneur competitively demands $\lambda_{\mathrm{P}}^{\mathrm{I}}$ workers so as to maximise her utility.
(iii) Each uninformed entrepreneur competitively demands $\lambda_{\mathrm{P}}^{\mathrm{U}}$ workers so as to maximise her expected utility.
(iv) Labour supply equals labour demand.

Our model of the private-ownership economy is similar to that in Kanbur (1979a) with the difference that here the population is heterogeneous regarding managerial talent.[12] P can be characterised by the following result:

Result 2. P exists, is unique and such that no insurance is offered. The more risk-averse individuals of each type choose to become workers, while the less risk-averse choose to become informed entrepreneurs. Moreover, relatively more talented than untalented individuals become entrepreneurs.

[12] As already mentioned, this heterogeneity plays an important role in the later sections of this paper. Note also that in addition to this literature, the absence of insurance markets is derived from non-contractibility rather than being directly assumed.

Proof. See Appendix A □.

According to this result, under private ownership, entrepreneurs have to bear risks. The absence of insurance markets for business risks, in practice as well as in our model, relies on the difficulties of fully specifying the relevant contracts and verifying them.[13] The assumption that managerial success, output and total employment of each firm are all non-verifiable implies that no risk-sharing contract can be signed ex-ante between the entrepreneur and a third party. Unlike the earlier literature on entrepreneurship in general equilibrium (Kanbur, 1979a,b, 1981; or Kihlstrom and Laffont, 1979), we are emphasising the reason for the absence of insurance markets in P since we know from Kihlstrom and Laffont (1983) that in a private-ownership economy of this type, a competitive equilibrium with complete contracts clearly is first-best. Moreover, we want to compare P to other economic systems (with the same fundamentals) in which managers can reduce their risk exposure.

Result 2 also establishes the existence and uniqueness of P despite heterogeneous agents with respect to their talent and their risk-aversion.[14] Under P, individuals sort themselves depending on their risk-aversion and their talent, according to the traditional Knightian view of entrepreneurship. Entrepreneurs are relatively more prevalent among the most talented and least risk-averse individuals, whereas the others tend to prefer occupations with a sure wage. In addition, entrepreneurs choose to become informed about the viability of their project before starting production and committing more resources.[15]

The remainder of this section deals with the welfare properties of P. Result 3 provides necessary and sufficient conditions for P to be first-best. It states that, if society has sufficiently many risk-neutral individuals, only risk-neutral individuals bear risk, so that P is first-best. The same result also derives weaker conditions under which P maximises aggregate output. It shows basically that, if society is not too risk-averse, the fact that entrepreneurs have to bear risk does not distort production, although it lowers welfare. Result 4 demonstrates that, as society becomes more risk-averse, the inefficiency of P becomes increasingly important. These properties will be used in later sections to compare P to alternative economic systems.

[13] As remarked by Knight (1921, p. 251), 'First, the typical uninsurable (because unmeasurable and this because unclassifiable) business risk relates to the exercise of judgement in the making of decisions by business men'. Another branch of the general equilibrium occupational choice literature derives incomplete capital and insurance markets from asymmetric information (see Banerjee and Newman, 1993).

[14] Kanbur (1979a) and Kihlstrom and Laffont (1979) derive existence and uniqueness with individuals of identical abilities. Laussel and Le Breton (1995) prove existence and uniqueness with heterogeneous talent and with all individuals being risk-neutral. In their framework, individuals are not only heterogeneous as entrepreneurs but also as workers. Their abilities in the latter occupation are assumed to be unobservable. They demonstrate that some highly talented workers may inefficiently choose to become entrepreneurs since they are paid below their marginal product as workers. Lockwood and Manning (1988) also consider an occupational choice model with heterogeneous abilities in general equilibrium. Their model is fundamentally different from ours, though. In their setting with risk-neutral individuals, they show that occupation-specific private information leads to a non-existence result.

[15] For convenience, it is assumed that this information can be produced freely. Having a strictly positive cost for this would just make entrepreneurship less attractive. In addition, if this cost was sufficiently high, it would induce entrepreneurs with a low degree of risk-aversion not to produce this information and to risk bankruptcy.

Result 3. P coincides with F under the following conditions:

- In regime *I*, if and only if there are sufficiently many risk-neutral individuals (i.e. $\alpha\Phi(0) > 1 - \gamma$).
- In regimes *II* and *III*, if and only if all individuals are risk-neutral.

P maximises aggregate output (i.e. $G_{\mathrm{P}} = G_{\mathrm{F}}$) under the following conditions:

- In regime *I*, if and only if there are sufficiently many risk-neutral individuals (i.e. $\alpha\Phi(0) > 1 - \gamma$).
- In regime *II*, if and only if the most risk-averse individual is not too risk-averse (i.e. $R^{+} < R_{\mathrm{PII}}$, where R_{PII} is defined in the proof).
- In regime *III*, if and only if there are sufficiently many risk-neutral individuals (i.e. $\Phi(0) > 1 - \gamma\{1 + \alpha\pi_H/[(1-\alpha)\pi_L]\}$ and the most risk-averse ones are not too risk-averse (i.e. $R^{+} < R_{\mathrm{PIII}}$, where R_{PIII} is defined in the proof).

Proof. See Appendix B. □

Result 4. As society becomes more risk-averse (in the sense of first-order stochastic dominance), the proportions of (talented and untalented) entrepreneurs, total output and wages fall. For an infinitely risk-averse society, the three variables fall to zero.

Proof. See Appendix C. □

Given that markets are incomplete, it is not surprising that P does not reach first-best in general. The allocation in P is inefficient despite the fact that hiring decisions are taken by informed entrepreneurs and that workers' marginal products are equalised across firms. There are three main sources of inefficiency of P. First, private ownership of firms together with the absence of insurance markets makes it necessary for entrepreneurs to bear risk. Since they are risk-averse, such risk lowers expected utility. Second, due to risk-aversion, P is normally characterised by a shortage of entrepreneurs.[16] Third, untalented individuals may become entrepreneurs and crowd out talented individuals from this occupation.

One could argue that the shortage of entrepreneurs in P could be reduced through a subsidy on entrepreneurship. In this line of reasoning Kanbur (1981), under the assumption of CARA utility functions, considers a subsidy to entrepreneurs inversely proportional to their income. The availability of such a subsidy is, however, not consistent with the assumption of non-contractibility which underlies the absence of insurance markets, because, if the state could make transfers contingent on entrepreneurial income, there would be no reason to assume that a private insurer could not. Within the present framework, the only transfer policy that is feasible for the state under P is a non-contingent income transfer between occupations. As the following result shows, an income transfer from workers to entrepreneurs can be Pareto-improving but is not, in general, sufficient to restore first-best.

[16] The proof of this result is available upon request from the authors.

Result 5. P is not in general second-best. Transfers between workers and entrepreneurs can be Pareto-improving. In general, they do not, however, lead to first-best.

Proof. See Appendix D. □

This result is related to that of Black and de Meza (1997). They develop a model of occupational choice with complete contracts. However, the latter are costly to verify, which prevents full insurance. They show that a direct ex-ante subsidy to risky occupations can be Pareto-improving. Similarly, our Result 5 shows that, without interfering with the distribution of property rights nor with the market allocation of workers, there is scope for public policy in P. An income transfer from workers to entrepreneurs increases the entry of untalented entrepreneurs, which alleviates the inefficiency caused by risk-aversion, but it also depresses wages. Thus, public policy can only achieve a better balance between the inefficiencies but cannot suppress any one of them. Note further that a large fraction of the subsidy is ineffective since many individuals would have chosen to become entrepreneurs even without the transfer. It is thus only when $\Phi_{\mathrm{H}}(.)$ is very strongly increasing in the right-hand-side neighbourhood of the marginal entrepreneur, that a transfer away from workers can induce the creation of so many new firms as to raise wages net of the transfer.

5. The collectivist economy

We now turn to the implications of our model when ownership of the means of production is given to a collectivist institution. The objective function of the collectivist institution is to maximise total output. This may seem arbitrary but, as shown in the proof of the result below, it leads to the *ex-post* maximisation of the collectivist institution's income and to the maximisation of the wage of workers. In this system, managers are referred to as directors and production units as collectivist plants.

The timing now implies that at stage 1, each individual must choose whether to become a director or a worker. At stage 2, each director must sink her labour endowment and decide whether to become informed about the productivity of her plant. At stage 3, the collectivist institution assigns workers to production plants. Finally, at stage 4 output is produced and distributed.

Remember that in no collectivist plant, the director can be dispensed with (e.g. because of inalienable human capital). At the same time, the collectivist institution holds the residual rights regarding all plants. Consequently, for each plant, both parties (the director and the collectivist institution) must agree on a number of workers to be employed at stage 3. This bargaining takes place between stages 2 and 3 under symmetric information with either both parties being informed about the plant's viability or both parties being uniformed.[17] Following a standard formulation, we consider a Nash-solution to this bargaining and β denotes the bargaining power of any director. The reservation level for

[17] It is assumed that the collectivist institution can bargain with each director separately and not with a coalition of directors.

directors is 0. The collectivist institution's outside option is to allocate workers to other plants. The equilibrium in the collectivist economy, denoted C, is defined as follows.

Definition C. (Equilibrium in the collectivist economy): C is an income, an occupation and an information decision for each individual such that:.

(i) Each individual chooses her occupation (worker or director) and whether to become informed or not (as director) so as to maximise her expected utility, taking as given the behaviour of all other agents in the economy, including the collectivist institution.
(ii) Any director's income and employment in collectivist plants are determined in a Nash-bargaining process with the collectivist institution whose objective in this negotiation is to maximise aggregate output.
(iii) The collectivist institution distributes the remainder of total output (after having paid all directors) equally between workers.

The fundamentals of the economy remain the same as previously. The only difference between P and C is in the allocation of property rights and labour. Under C, the combination of residual rights being allocated to a third party (i.e. the collectivist institution) and directors not being dispensable for production leads to a hold-up problem. It is assumed that this problem is resolved according to the Nash-solution. This assumption leads to an efficient allocation of the workforce at stage 3. This provides a fair counterpart to the competitive allocation of workers in P, which is also $ex-post$ efficient. C is characterised by the following result.

Result 6. C exists but is not unique in general. Some directors choose to remain uninformed. Only informed directors bear risk. Relatively more talented than untalented individuals become (informed or uninformed) directors and only the less risk-averse individuals (if any) become informed directors.

Proof. See Appendix E. □

C is characterised by the fact that the income of directors is not determined solely by their managerial success but by bargaining with the collectivist institution. As Result 6 shows, this has some important implications.

First, since bargaining takes place before workers are allocated to plants, informed and successful directors can get at most a fraction (corresponding to their bargaining power) of their marginal product and not their full marginal product as in P. Thus, when employment in a plant is the same in P and in C, the distribution of income between the director/entrepreneur and her workers is more equal in C than in P.

Second, uninformed directors have a positive expected marginal product and through the bargaining with the collectivist institution they are able to extract a fraction of it. The expected marginal product of an informed director is of course higher than that of an uninformed director but the latter receives her rent regardless of her managerial success. When they are sufficiently risk-averse, this leads directors to remain uninformed. When choosing not to become informed, directors *de facto* insure themselves against lack of success. This is a fundamental difference from P where entrepreneurs are always better-off informed. Thus, the allocation of property rights to a non-producing party that owns a large number of (or all) production units in C allows more insurance than in P. This, however, happens at the cost of some workers being allocated to unproductive plants.[18] As made clear by Result 9 below, this is of course inefficient and transfers may alleviate this inefficiency but without being able to suppress it in general.

Third, C is not necessarily unique. Since the collectivist institution is able to observe the type of individuals, multiplicity does not stem from any *ex-ante* aggregate uncertainty regarding the composition of talent in the different occupations.[19] To see how multiple equilibria can arise in C, consider the following thought experiment. Assume that there exists an equilibrium such that the income of talented uninformed directors is above the workers' wage, so that all talented individuals choose to become either informed or uninformed directors. Imagine then that the wage is increased. This lowers the rent of successful informed directors as well as that of uninformed directors. Depending on their risk-aversion, it may then be the case that more talented individuals choose to become informed directors instead of remaining uninformed. This improves the productive efficiency of C since a smaller proportion of plants end up unproductive so that the assumed higher wages are actually feasible, thus establishing a new equilibrium.

These features of C replicate some well-known stylised facts of socialist economies operating under public ownership: lower levels of inequalities in earnings, lower levels of risks and the existence of many unproductive plants.[20] A surprising result is the possibility of multiple equilibria in C whereas P was shown to be unique. This result is also reminiscent of von Hayek's (1945) argument of the superior ability of markets to produce information. However, the general superiority of a market system with private property, also advocated by Hayek, is not warranted in our framework as can be seen from the following results that correspond to Results 3 and 4 for P.

Result 7. C coincides with F only in regime *II* when directors have sufficiently strong bargaining power (i.e. $\beta \geq \alpha/(1-\gamma)$) and the whole population is risk-neutral.

C maximises aggregate output only in regime *II* when directors have sufficiently strong bargaining power (i.e. $\beta \geq \alpha/(1-\gamma)$) and the most risk-averse individual is not too risk-averse (i.e. $R^{+} < R_{\mathrm{CII}}$, where $R_{\mathrm{CII}} < R_{\mathrm{PII}}$ is defined in the proof).

Proof. See Appendix F. □

A comparison of this result with the corresponding welfare Result 3 in the previous section shows that the conditions for C to coincide with F and for C to maximise output are more restrictive than the conditions for P to coincide with F and for P to maximise output, respectively. This does, however, not mean that P necessarily dominates C as shown by the following result.

[18] Note that, such an insurance scheme is not feasible under P, despite the fact that the model satisfies methodological symmetry. The only way for a private insurer to offer insurance in P would consist of buying a large number of plants and replicating the collectivist institution, such that P would become identical to C (see Section 6, below).

[19] Making talent unobservable to others would not change anything in P but would increase the inefficiency of C and add more room for multiplicity.

[20] See Flemming and Micklewright (1999) on the first point and Johnson and Loveman (1995) on the second and third.

Result 8. For a sufficiently risk-averse society (in the sense of first-order stochastic dominance), there are no informed directors in C. Further increases in risk-aversion leave output constant and strictly positive.

Proof. See Appendix G. □

A comparison of this result with Result 4 shows that *for a sufficiently risk-averse society, output is larger in C than in P* ($G_C > G_P$). This means that with a sufficiently risk-averse society, C even Pareto-dominates P. As society becomes less risk-averse, P becomes less inefficient, since all its sources of inefficiency are rooted in the missing insurance market. The inefficiency of C, on the other hand, is not so much due to risk-aversion but rather to the difficulty of revealing the true productivity of production units and also to the distribution of property rights making the risky occupation less attractive. Therefore, as society becomes less risk-averse, P approaches F much 'faster' than C does. The next result shows that, as in P, (feasible) income transfers do not in general make C first-best, but also that they can be Pareto-improving. This finding mirrors Result 5 for P.

Result 9. C is not in general second-best. Transfers between workers and directors can be Pareto-improving. In general, they do not, however, lead to first-best.

Proof. Consider a C where the wage is above the income of talented uninformed directors: $w_{\mathrm{C}} > r_{\mathrm{HC}}^{\mathrm{U}}$ and $\alpha = 1$. C is then such that individuals are either informed directors or workers. Such an economy, with respect to its outcome(s), is similar to a P-economy for which the production function is such that $g(\lambda) = \lambda^{\gamma'}$ with $\gamma' = 1 - \beta(1 - \gamma)$. (To put it differently, when C has no uninformed director, it is equivalent to a P-economy where a proportional tax $1 - \beta$ is levied on entrepreneurial income and a matching subsidy is offered on wages). Thus, the first part of Result 5 applies to show that C is not in general second-best. The second part of the same result can be used to show that unconditional transfers between occupations in C do not lead to first-best in general. □

6. The mixed economy

So far, we have considered the collectivist institution and private ownership separately. These two allocation mechanisms may coexist. The mixed economy equilibrium (M) is defined as follows.

Definition M. (Equilibrium in the mixed economy): M is an income, an occupation in one of the two sectors and an information decision for each individual such that:

(i) Each individual competitively chooses her occupation and whether to become informed or not (as director or entrepreneur) so as to maximise her expected utility, taking as given the behaviour of all other agents in the economy, including the collectivist institution.
(ii) Each informed entrepreneur competitively demands $\boldsymbol{\lambda}_{\mathrm{MP}}^{\mathrm{I}}$ workers so as to maximise her utility.

(iii) Each uninformed entrepreneur competitively demands $\lambda_{\mathrm{MP}}^{\mathrm{U}}$ workers so as to maximise her expected utility.
(iv) Any director's income and employment in collectivist plants is determined in a Nash-bargaining process with the collectivist institution whose objective in this negotiation is to maximise aggregate output.
(v) The collectivist institution distributes the remainder of total output in the C-sector (after having paid all directors) equally between workers in the C-sector.
(vi) Labour supply equals labour demand.

This definition formalises the idea of mixed economy where individuals can make a free choice to work either as managers or as workers either in the C- or in the P-sector (see part i). Each of these two sectors (or countries, depending on the interpretation) works essentially in the same way as described in the preceding sections. This is expressed in parts (ii) and (iii) for the P-sector and in parts (iv) and (v) for the C-sector. We are now in the position to state the properties of M.

Result 10. M exists, is unique, is not in general second-best and is such that there are no informed directors in the C-sector.

Proof. see Appendix H. □

Free sectoral and occupational choice, in general, leads to a mixed economy with some individuals in each sector and wages being equalised across sectors (see Newell and Socha, 1998, for empirical evidence on this latter point). Note also that although C is not unique in general, M is unique. Multiplicity in C stems from the interaction between informed and uninformed directors in the collectivist sector. Since there are no informed directors in M, this equilibrium is unique. However, the co-existence of two sectors is uneasy as M can coincide with either C or P:

Result 11. M can coincide with either C or P.

Proof. Consider first the case $w_{\mathrm{C}} > w_{\mathrm{P}}$ and $w_{\mathrm{C}} > v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_{\mathrm{C}}), \pi_{\mathrm{H}}, R^{-}\right)$. In this case, M coincides with C. Consider now the case $w_{\mathrm{P}} \geq w_{\mathrm{C}}$. Then, all workers are better-off in the P-sector than in the C-sector. Consequently, to be viable, the C-sector must pay workers at least w_{P}. With this wage, all potentially informed directors in the C-sector prefer to work as informed entrepreneurs in the P-sector where property rights over their plants give them a higher income (as shown in the proof of Result 10). From Result 6, no C-sector is feasible with a wage $w_{\mathrm{MC}} \geq w_{\mathrm{P}}$ when no director is informed (i.e. $\varepsilon_{\mathrm{HMC}}^{\mathrm{I}} = \varepsilon_{\mathrm{LMC}}^{\mathrm{I}} = 0$). Consider finally the case $v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_{\mathrm{C}}), \pi_{\mathrm{H}}, R^{-}\right) > w_{\mathrm{C}} > w_{\mathrm{P}}$. In this case, a P-sector develops at the expense of the C-sector. Again, all potentially informed directors in the C-sector choose to become entrepreneurs. This is harmful for the C-sector since it is left only with uninformed directors whose marginal product is lower than that of informed directors so that $w_{\mathrm{MC}} < w_{\mathrm{C}}$. When this effect is strong enough, it may even be the case that $w_{\mathrm{MC}} < w_{\mathrm{P}}$ which again implies an empty C-sector. □

The main forces at work here are a negative pecuniary externality with respect to the allocation of talent imposed by the P-sector on the C-sector and an upward wage pressure of the C-sector on the P-sector. The P-sector attracts potential entrepreneurs who are mainly talented individuals with a low degree of risk-aversion, i.e. the same individuals that could have been the directors of the C-sector. Thus under M, when the P-sector is not empty, the C-sector is left with a less talented population in which no one wants to become an informed director. Then the C-sector may become unsustainable. Hence, M can lead to an empty C sector. When society is sufficiently risk-averse, by contrast, M leads to an empty P-sector: no-one wishes to enter the P-sector as entrepreneur at this level of wages (whereas some would for lower wages). In other words, the collectivist sector is harmful for the potential entrepreneurs since it increases the workers' wages and thus reduces entrepreneurial incomes.

These negative pecuniary externalities exerted by the two sectors upon each other may well explain the difficulties encountered by the attempts to set up a mixed economy, be it in India, the former Yugoslavia or even France in the early 1980s. M can also be re-interpreted to emphasise the difficulty of socialist and capitalist economies co-existing when migration is possible. In such a context, externalities of the type prevailing in our (simple) model have long been recognised by socialists thinkers. Leon Trotsky in the 1920s advocated the idea of a European socialist revolution and opposed the New Economic Policy (NEP) to ensure the sustainability of the socialist regime. Stalin also recognised the negative effects of private property on collectivist institutions but chose a different solution: he stopped the NEP and implemented the iron curtain to prevent the departure of the more talented. (See Service, 1997, for developments on these issues and further references).

7. Voting on the economic system

What can be said about society's democratic choice between P, M and C? The answer to this question is important for two reasons. First it will allow us to identify the winners and losers across the different systems. Second, we believe that this type of analysis contributes to our understanding of recent transition experiences.[21]

For simplicity and to make outcomes easily comparable across institutions, assume that the same individual choosing a risky occupation has the same luck (unknown *ex-ante*) regardless of the institution, i.e. a successful entrepreneur in P would have also been a successful director in C.[22] Our first result in this section characterises the outcome of majority voting between P, M and C.

[21] Frydman et al. (2003) and Frydman et al. (1999) give some supportive evidence regarding the crucial role of ownership structures in transition economies. Their results also point at the importance of risk-taking and at the key role of entrepreneurship.

[22] To simplify the derivation of our results in this section, we assume that no redistribution across occupations takes place. In Results 5 and 9, redistribution across occupations was shown not to affect the general nature of the results in P nor in C.

Result 12. Majority rule is always transitive regarding the choice between P, M and C. The democratic outcome under majority voting can be P, C or M. An overall increase in society's risk-aversion leads to an increase in the proportion of individuals preferring C to P. For a sufficiently risk-averse society this proportion exceeds 0.5 and approaches 1.

Proof. see Appendix I for a proof and the precise conditions under which P, M and C emerge as outcomes of majority voting. □

The first part of the result is important since the results that follow would not be very interesting if the political outcome was indeterminate. Turning to the second part of the result, note that – although all three outcomes are possible – M is preferred to C and P only under very restrictive conditions. For M to be preferred, it must first be the case that M is distinct from both P and C, which implies necessarily $w_C > w_M > w_P$. It must also be that talented people are sufficiently numerous and sufficiently risk-averse for a large fraction of them to prefer M to P (and form a majority coalition with the workers who are also against P). At the same time, there must be a shortage of talented individuals in the C-sector for no talented individual to be a worker so that the income of talented uninformed entrepreneurs is strictly higher than that of workers (i.e. they prefer M to C and can form a majority coalition with the entrepreneurs against C). In short, for M to be the result of a democratic process, the pivotal voter must be a talented risk-averse individual who does not want to go to the P-sector as entrepreneur but nor does she want to see entrepreneurs in the P-sector being forced back into the C-sector where they would lower the returns to being a director. When the pivotal voter is either an entrepreneur or a worker, the conflict of interest (or class struggle) leads to a polarisation of political decisions.

We believe that this result helps to understand why in many cases – particularly in some former Soviet Republics – gradual reformers have tended to lose either to the radical reformers or to the conservatives.[23] It is also interesting to note that in both C and P the risky occupations are chosen predominantly by the more able and the less risk-averse individuals. Thus, a large fraction of individuals choosing to become informed directors in C also become entrepreneurs in P. In particular, if $w_C \geq w_P$, all informed directors in C become entrepreneurs in P since the two occupations are equally risky but entrepreneurs receive their full marginal product and employ a larger number of workers in P, whereas informed directors only receive a fraction of their marginal product and employ fewer workers in C. Hence, after transition from C to P has taken place, it is no surprise to see the old elite of C becoming the new post-reform elite. This fact, which has struck many observers of post-transition economies (see, e.g. Bird et al., 1998, or Brixiova et al., 1999), is a natural implication in our model. The members of the old elite become the main supporters of reform since they are the ones who take advantage of the new institutions.[24]

[23] This result may also shed light on the stability of social democracy. This form of mixed economy may survive despite a large majority preferring another system (P or C) because the fraction of the population supporting M (talented individuals in risk-free occupations in the collectivist sector) is able to form a majority against C with the entrepreneurs and against P with the workers. However, this arrangement may easily become politically unsustainable if the P- or the C-sector for some (exogenous) reason becomes more attractive.

[24] An alternative explanation points at the capture of the collectivist assets by the former nomenclatura – an argument which does not apply everywhere.

Finally, from Result 3, we know that P coincides with F when all individuals are risk-neutral. Therefore, if *regime I* applies, in a risk-neutral society individuals *ex-ante* unanimously prefer P to C. This changes when P is characterised by risk-averse individuals taking entrepreneurial jobs. It then becomes subject to the inefficiencies described in Section 4. Any increase in risk-aversion tends to amplify these inefficiencies of P. C, meanwhile, is less affected by the changes in risk attitudes (Result 8). Hence, there comes a point where a majority of (and eventually all) individuals prefer C to P. Our last result shows that despite the transitivity of the majority outcome, political stability is not guaranteed:

Result 13. It is possible (namely under the conditions given in the proof) that a majority of or even all individuals *ex-ante* prefer either P or M to C, even though a majority of individuals is better off *ex-post* with C.

Proof. See Appendix J. □

This result can be discussed in the light of Fernandez and Rodrik (1991). Their main result shows that, if there is a large sector in which a majority of people may lose after some reform (opening the borders to trade, in their case), they can constitute an overall majority of the total population and prevent the reform, although a majority of the population could have gained from the reform (the small sector plus a minority of the large sector). Our Result 13 is precisely the mirror image of their argument.[25] Although a majority of the population will lose (i.e. the unsuccessful entrepreneurs plus all those with a sure income if $w_C > w_P$), there may be a majority of people willing to take the gamble of the market economy due to a gap between prospects and realisations. Potential entrepreneurs can, thereby, impose their choice on a minority who know in advance that they will suffer from it. Although theoretically not extremely surprising, we believe that Result 13 (just as Fernandez and Rodrik's result) has considerable political relevance, in practice. In particular, it provides a consistent explanation of the phenomenon of policy reversals experienced in many transition countries, based on methodological symmetry.[26]

8. Conclusion

The theory developed in this paper satisfies methodological symmetry and offers a general equilibrium perspective on comparative economic systems in an economy with endogenous firm creation and class formation. Due to non-contractibility, managerial incentives to discover the productivity of their firm and to hire workers accordingly

[25] Not surprisingly, the Fernandez and Rodrik result also holds in our context, i.e. although a majority of the population (namely the successful entrepreneurs plus all those with a sure income if $w_P > w_C$) would *ex-post* be better-off with P, there may be a majority of people who are reluctant to take the gamble because of their risk-aversion. Interestingly, however, the analogous to our Result 13 is not highlighted by Fernandez and Rodrik (1991).

[26] See Roland and Verdier (1994) for a related (but not methodologically symmetric) explanation of the phenomenon.

depend on whether managers own their firms or not. When firms are owned by a collectivist institution, managers can limit their risk exposure by remaining uninformed. The marginal product of labour is then not equalised across plants. In turn, no individual needs to bear risk. In P, with owner-managers who have an incentive to become informed, production is efficient. Entrepreneurs, however, inevitably have to bear risk so that the very risk-averse individuals refrain from becoming entrepreneurs. The resulting shortage of entrepreneurs reduces aggregate output so that either economic system may Pareto dominate the other, depending on the distribution of risk-aversion in the population.

Our model of M illustrates the fundamental difficulties associated with the co-existence of socialist and capitalist economies when the people are free to move from one to the other, i.e. 'to vote by their feet'. The systems exert a negative externality on each other. P attracts the talented people and leaves C with a high proportion of untalented individuals. C, in turn, increases the shortage of entrepreneurs by exerting an upward pressure on the wages in P. The model also displays the conflict of interests between workers and entrepreneurs. If anyone prefers C to P, it will be the risk-averse and less talented individuals who chose to be workers. If anyone prefers P to C, it will be those individuals who want to become entrepreneurs, i.e. the less risk-averse and more talented.

This theoretical framework can help us understand various stylised facts of transition economies such as increased inequality after reforms, this inequality being negatively correlated with the amount of privatisation, the identification of winners and losers, and political backlash. Despite the possibility of a vote in favour of reforms, some countries are still governed according to the old rules, often even by the old rulers. This could be simply due to the fact that a majority of the population is extremely risk-averse and, therefore, better-off under a collectivist system than with a market economy, at least in the short-run. Another observation which is consistent with our theory refers to the fact that the political debate in many countries has become polarised on the pro-reform/anti-reform issue. Moderate options are not popular in many countries. Our model proposes an explanation for this since partial reform is the majority's preferred choice only under very special conditions. Instead, partial reform is more likely to be found in countries where reforms are not democratically decided. China and Vietnam offer examples of countries, where a still significant collectivist sector survives despite the presence of some alternative highly competitive institutions.

Of course, our model remains extremely rudimentary and only puts the emphasis on certain aspects of the comparison between economic systems and the transition between them. In particular, our simplifying view of the labour market ignores unemployment. It would also be desirable to relax our extreme assumption of non-contractibility of a plant's input.[27] Among possible extensions, one could also think of the introduction of aggregate risk, since it is difficult to argue that macro-economic risk should not be taken into account during transition.

[27] Grossman et al. (1983) develop a model in a related framework where partial insurance is offered to entrepreneurs, contingent on the amount of labour they hire. Their analysis indicates that, allowing for contracts to be made contingent on a firm's use of labour input, does not fundamentally change the properties of the private-ownership economy.

Based on the Knightian theory of entrepreneurship, we have presented a static comparison of economic systems. Although it is often claimed that capitalism has defeated socialism through its superior ability to produce innovations, we are not aware of many formal dynamic models of comparative economic systems in a general equilibrium framework.[28] It would be relatively easy, though, to develop a dynamic version of our model. One possible way to capture the Schumpeterian role of entrepreneurs as innovators is at stage 2 of our model. If we assume that managers who decide to become informed can use this information to increase the productivity of their plant, the technology available to an informed successful manager becomes

$$g(\lambda) = a \cdot \lambda^{\gamma}, \quad \text{with } 1 > \gamma > 0 \text{ and } a > 1 \tag{2'}$$

instead of Eq. (2). This gives rise to a dynamic version of the model where the production function of a plant in period t depends on the number n of periods it was run by an informed manager, i.e.

$$g_t(\lambda, n) = a^n \cdot \lambda_t^{\gamma}, \quad \text{with } 1 > \gamma > 0 \text{ and } a > 1 \text{ and } n \in N \tag{2''}$$

With this modification, our model is transformed into a simple endogenous growth model that preserves the main features of our comparison of economic systems. Without the need to specify more details of this dynamic model, it is apparent that the growth rate of the economy in period t will depend on the number of informed successful managers. Together with the fact that in P entrepreneurs always become informed while in C directors may chose to remain uniformed, it follows that P's performance, relative to C's, is better in the long run. This would support the view that private ownership is favourable for growth, because it provides better incentives for innovations, while directors of collectivist plants may prefer not to innovate in order to obtain insurance.

But even in this dynamic version of the model, extreme risk-aversion still has adverse effects on the outcomes of P and, to a minor extent, of M and C. Specifically, with an infinitely risk-averse society, output and growth in P both tend to zero forever, while in C the growth rate tends to zero but not the output. This indicates that the qualitative nature of all our results would be preserved in a dynamic version of the model that incorporates the Schumpeterian view of entrepreneurship and innovation.

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[28] See Qian and Xu (1998) or Huang and Xu (1999) for an analysis of finance institutions and innovation.

Appendix A

Proof of result 2

No insurance is supplied because no risk-sharing contract can be signed *ex-ante* between an entrepreneur and any third party. This is a direct consequence of the assumption that the decision by managers to become informed (about their success), managerial talent as well as employment and output in each production unit are not verifiable by outsiders.

From assumption (A), it is clear that $v(0, \lambda^{\gamma} - w\lambda, \pi, R) > v(-w\lambda, \lambda^{\gamma} - w\lambda, \pi, R)$. Thus, for any level of employment, entrepreneurs are better-off when informed about their success. Consequently, parts (i), (ii) and (iii) of definition P imply that there are no uninformed entrepreneurs in equilibrium: $\varepsilon^{\mathrm{U}}_{\mathrm{HP}} = \varepsilon^{\mathrm{U}}_{\mathrm{LP}} = 0$.

We now consider the occupational choice by individuals at date 1. If an individual with risk-aversion R and talent T prefers to become (informed) entrepreneur with expected income $\pi_T r^{\mathrm{I}}_{\mathrm{P}}$ rather than worker with wage w_{P}, then from part (i) of definition P and assumption (A), it must be the case that all individuals with talent T and risk-aversion less than R also prefer to become entrepreneurs for $T = H, L$. Denote $\hat{R}_T$ the risk-aversion index of those individuals of talent T who, in equilibrium, are indifferent between becoming worker and entrepreneur. This threshold $\hat{R}_T$, which may be outside the support $[R^{-}, R^{+}]$, must satisfy

$$w_{\mathrm{P}} = v\left(0, r^{\mathrm{I}}_{\mathrm{P}}, \pi_T, \hat{R}_T\right), \text{for } T = H, L \quad \text{with } {}^{\mathrm{I}}_{\mathrm{P}} = \left(\lambda^{\mathrm{I}}_{\mathrm{P}}\right)^{\gamma} - w_{\mathrm{P}}\lambda^{\mathrm{I}}_{\mathrm{P}} \tag{A.1}$$

From part (ii) of definition P, it follows that $\lambda^{\mathrm{I}}_{\mathrm{P}}(w) = argmax[\lambda^{\gamma} - w\lambda]$. This implies $\lambda^{\mathrm{I}}_{\mathrm{P}}(w) = (\gamma/w)^{1/(1-\gamma)}$ and the equalisation of the marginal product of viable firms. Entrepreneurial income $r^{\mathrm{I}}_{\mathrm{P}}$, is thus such that $r^{\mathrm{I}}_{\mathrm{P}}(w) = (1-\gamma)(\gamma/w)^{\gamma/(1-\gamma)}$. In order to see that there exists a unique wage, w_{P}, which also satisfies part (iv) of definition P, define excess supply of labour as

$$Z_{\mathrm{P}}(w) = 1 - \varepsilon^{\mathrm{I}}_{\mathrm{H}}(w) - \varepsilon^{\mathrm{I}}_{\mathrm{L}}(w) - [\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{H}}(w) + \pi_{\mathrm{L}}\varepsilon^{\mathrm{I}}_{\mathrm{L}}(w)]\lambda^{\mathrm{I}}_{\mathrm{P}}(w). \tag{A.2}$$

It is easy to check that $Z_{\mathrm{P}} < 0$ for $w = 0$, and $Z_{\mathrm{P}} > 0$ for $w = +\infty$. Moreover, $\lambda^{\mathrm{I}}_{\mathrm{P}}(w) = (\gamma/w)^{1/(1-\gamma)}$ and $r^{\mathrm{I}}_{\mathrm{P}}(w) = (1-\gamma)(\gamma/w)^{\gamma/(1-\gamma)}$ are clearly continuous and decreasing in w. From the continuity and monotonocity of the certainty equivalent function in Eq. (A.1), the implicit function $\hat{R}_T(w)$ is also continuous and decreasing in w. Since $\Phi_T(\cdot)$ is continuous in $\hat{R}_T$, $\varepsilon^{\mathrm{I}}_{\mathrm{H}}(w) = \alpha\Phi_{\mathrm{H}}\left(\hat{R}_{\mathrm{H}}(w)\right)$ and $\varepsilon^{\mathrm{I}}_{\mathrm{L}}(w) = (1-\alpha)$ $\Phi_{\mathrm{L}}\left(\hat{R}_{\mathrm{L}}(w)\right)$ are also continuous (and decreasing in w). By straightforward inspection of Eq. (A.2), it follows that $Z_{\mathrm{P}}(w)$ is continuous and increasing for $w > 0$. From Brouwer's fixed point theorem, there is a unique value $w_{\mathrm{P}} > 0$ for which the labour market clears, i.e. for which $Z_{\mathrm{P}}(w_{\mathrm{P}}) = 0$. This wage defines a unique pair $\left(\varepsilon^{\mathrm{I}}_{\mathrm{HP}}, \varepsilon^{\mathrm{I}}_{\mathrm{LP}}\right)$. Finally, since $\pi_{\mathrm{L}} < \pi_{\mathrm{H}}$, it follows from assumption (A) and Eq. (A.1) that $\hat{R}_{\mathrm{H}} > \hat{R}_{\mathrm{L}}$. From this follows $\Phi\left(\hat{R}_{\mathrm{L}}\right) < \Phi\left(\hat{R}_{\mathrm{H}}\right)$. □

Appendix B

Proof of Result 3

From Result 1, there is a unique maximum feasible aggregate output corresponding to a unique allocation of talent. Thus, $\left(\varepsilon^{\mathrm{I}}_{\mathrm{HP}},\varepsilon^{\mathrm{I}}_{\mathrm{LP}}\right)=(\varepsilon_{\mathrm{HF}},\varepsilon_{\mathrm{LF}})$ is necessary for P to maximise aggregate output. Since labour is allocated efficiently across firms in P, it is also sufficient. Then, $\left(\varepsilon^{\mathrm{I}}_{\mathrm{HP}},\varepsilon^{\mathrm{I}}_{\mathrm{LP}}\right)=(\varepsilon_{\mathrm{HF}},\varepsilon_{\mathrm{LF}})$ also implies that $\lambda^{\mathrm{I}}_{\mathrm{P}}=\lambda_{\mathrm{F}}$. From part (ii) of definition P, $w_{\mathrm{P}}=\gamma\left(\lambda^{\mathrm{I}}_{\mathrm{P}}\right)^{\gamma-1}$ since all entrepreneurs are informed. Using all this, we can write

$$\frac{w_{\mathrm{P}}}{r^{\mathrm{I}}_{\mathrm{P}}}=\frac{\gamma\lambda^{\gamma}_{\mathrm{F}}}{\lambda^{\gamma-1}_{\mathrm{F}}-w_{\mathrm{P}}\lambda_{\mathrm{F}}}=\frac{\gamma}{(1-\gamma)\lambda_{\mathrm{F}}}. \tag{B.1}$$

In *regime I*, the maximisation of output requires $\varepsilon_{\mathrm{HF}}=1-\gamma$ and $\varepsilon_{\mathrm{LF}}=0$. From parts (i)–(iii) of definition P, in *regime I* every viable firm must then employ $\lambda^{\mathrm{I}}_{\mathrm{P}}=\lambda_{\mathrm{F}}=\gamma/[(1-\gamma)\pi_{\mathrm{H}}]$ workers. Eq. (B.1) then yields $w_{\mathrm{P}}=\pi_{\mathrm{H}}r^{\mathrm{I}}_{\mathrm{P}}$. On the other hand, in *regime I*, some talented individuals must prefer entrepreneurship, i.e. $w_{\mathrm{P}}\leq v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},R^{-}\right)$. Since $v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},R^{-}\right)\leq v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},0\right)$ from assumption (A) and since, $v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},0\right)=\pi_{\mathrm{H}}r^{\mathrm{I}}_{\mathrm{P}}$ from assumption (B), the necessary condition for P in *regime I* to maximise output is $\hat{R}_{\mathrm{H}}=0$. This condition is equivalent to $\alpha\Phi(0)>1-\gamma$. This condition is also sufficient. Since $\pi_{\mathrm{H}}\geq\pi_{\mathrm{L}}$, $w_{\mathrm{P}}=\pi_{\mathrm{H}}r^{\mathrm{I}}_{\mathrm{P}}$ implies $w_{\mathrm{P}}>\pi_{\mathrm{L}}r^{\mathrm{I}}_{\mathrm{P}}$, which guarantees that no untalented individual wants to become entrepreneur, i.e. $\varepsilon_{\mathrm{LP}}=\varepsilon_{\mathrm{LF}}=0$.

Next, consider *regime II*, where $\varepsilon_{\mathrm{HF}}=\alpha$ and $\varepsilon_{\mathrm{LF}}=0$, implying $\lambda_{\mathrm{F}}=(1-\alpha)/(\alpha\pi_{\mathrm{H}})$. This yields the following expressions for the wage and for the profit of a successful entrepreneur in P:

$$w_{\mathrm{P}}=\gamma\left(\frac{\pi_{\mathrm{H}}\alpha}{1-\alpha}\right)^{1-\gamma}\quad\text{and}\quad r^{\mathrm{I}}_{\mathrm{P}}=(1-\gamma)\left(\frac{1-\alpha}{\pi_{\mathrm{H}}\alpha}\right)^{\gamma}. \tag{B.2}$$

Since $\varepsilon_{\mathrm{HF}}=\alpha$, it must be the case that even the most risk-averse talented individual prefers to become an entrepreneur, i.e. $w_{\mathrm{P}}\leq v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},R^{+}\right)$ or, using Eq. (B.2),

$$v\left[0,(1-\gamma)\left(\frac{1-\alpha}{\pi_{\mathrm{H}}\alpha}\right)^{\gamma},\pi_{\mathrm{H}},R^{+}\right]\geq\gamma\left(\frac{\pi_{\mathrm{H}}\alpha}{1-\alpha}\right)^{1-\gamma}=w_{\mathrm{P}}. \tag{B.3}$$

Define R_{PII} as that value of R^{+} for which $w_{\mathrm{P}}=v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{H}},R_{\mathrm{PII}}\right)$. Then it is immediate that $R^{+}\leq R_{\mathrm{PII}}$ is necessary for P to maximise aggregate output. It is also sufficient when $\varepsilon_{\mathrm{LF}}=0$, i.e. when $w_{\mathrm{P}}\geq v\left(0,r^{\mathrm{I}}_{\mathrm{P}},\pi_{\mathrm{L}},R^{-}\right)$. In *regime II* this condition is satisfied for any $R^{-}\geq0$. Indeed from Result 1, *regime II* is characterised by $\alpha\gamma\pi_{\mathrm{H}}>(1-\alpha)(1-\gamma)\pi_{\mathrm{L}}$. In turn using Eq. (B.2), this condition implies that $w_{\mathrm{P}}>\pi_{\mathrm{L}}r^{\mathrm{I}}_{\mathrm{P}}$, which guarantees that all untalented individuals choose to be workers.

Now, consider *regime III*, where $\varepsilon_{\mathrm{HF}}=\alpha$ and $\varepsilon_{\mathrm{LF}}=1-\gamma-\alpha-\gamma\alpha(\pi_{\mathrm{H}}/\pi_{\mathrm{L}}-1)$. Define the shadow wage, w_{F}, and the shadow profits, r_{F}, as follows:

$$w_{\mathrm{F}}=\gamma^{\gamma}(1-\gamma)^{1-\gamma}\pi^{1-\gamma}_{\mathrm{L}}\quad\text{and}\quad r_{\mathrm{F}}=\lambda^{\gamma}_{\mathrm{F}}-w_{\mathrm{F}}\lambda_{\mathrm{F}} \tag{B.4}$$

For P to maximise aggregate output, w_F must satisfy parts (i) to (iv) of definition P. It is easily checked that it satisfies parts (i) to (iii), if $\lambda_P^I = \lambda_F$. Substituting

$$\lambda_F = \frac{\gamma[1+\alpha(\pi_H/\pi_L - 1)]}{\pi_H\alpha + \pi_L\left[1-\alpha-\gamma-\gamma\alpha\left(\pi_H\big/\pi_L - 1\right)\right]} = \frac{\gamma}{(1-\gamma)\pi_L} \tag{B.5}$$

into Eq. (B.1), yields $w_P = \pi_L r_P^I$. Since in *regime III* the marginal entrepreneur is untalented, equation $\lambda_P^I(w) = \left(\gamma/w\right)^{1/(1-\gamma)}$ determines $\hat{R}_{LP}$. By assumptions (A) and (B), for conditions $\lambda_P^I(w) = (\gamma/w)^{1/(1-\gamma)}$ and $w_P = \pi_L r_P^I$ to hold simultaneously, it is necessary that $\hat{R}_{LP} = R^- = 0$. This condition is, however, not sufficient for $\left(\varepsilon_{HP}^I, \varepsilon_{LP}^I\right) = \left(\varepsilon_{HF}, \varepsilon_{LF}\right)$ in *regime III*, since it does not guarantee that $\varepsilon_{HP}^I = \varepsilon_{HF} = \alpha$. For all talented individuals to become entrepreneurs at the wage given by $w_P = \pi_L r_P^I$, as required for output to be maximised, we need that even the most risk-averse talented individual must prefer the risky occupation, $\pi_L r_P^I < v\left(0, r_P^I, \pi_H, R^+\right)$. Define R_{PIII} as the value of R^+ for which $\pi_L r_P^I = v\left(0, r_P^I, \pi_H, R_{PIII}\right)$. Then, using Eqs. (B.4) and (B.5), we obtain:

$$\pi_L\left(\lambda_F^\gamma - \gamma^{1-\gamma}(1-\gamma)^\gamma \pi_L^{1-\gamma}\lambda_F\right) = v\left(0, \lambda_F^\gamma - \gamma^{1-\gamma}(1-\gamma)^\gamma\pi_L^{1-\gamma}\lambda_F, \pi_H, R_{PIII}\right). \tag{B.6}$$

Thus, the second necessary condition for P to maximise output in *regime III*, is $R^+ < R_{PIII}$.

For P to coincide with F, the maximisation of aggregate output (i.e., $G_P = G_F$) is necessary so that the previous conditions apply. Besides, it is also required no individual bears risk except those who are risk-neutral. In *regime I*, it can be checked that if P maximises output, it is also first-best. In *regimes II* and *III*, the whole population must be risk-neutral since all talented individuals are assigned to managerial positions. □

Appendix C

Proof of Result 4

Suppose that there are only talented individuals in the economy, i.e. $\alpha = 1$. (This only makes the result stronger.) Consider any shift in the distribution $\Phi(R)$ in the sense of first-order stochastic dominance. This results in the indifferent individual being more risk-averse, i.e. in a higher $\hat{R}_H$. Since in equilibrium condition (A.1) must hold, using assumption (A), it follows that $\partial w_P/\partial \hat{R}_H <$. From definition P, ε_{HP}^I is given by

$$\frac{1-\varepsilon_{HP}^I}{\pi_H\varepsilon_{HP}^I} = \left(\frac{\gamma}{w_P}\right)^{1/(1-\gamma)} \Rightarrow \varepsilon_{HP}^I = \frac{1}{1+\pi_H(\gamma/w_P)^{1/(1-\gamma)}}. \tag{C.1}$$

This shows that $\partial\varepsilon_{HP}^I/\partial w_P >$ and thus $\partial\varepsilon_{HP}^I/\partial\hat{R}_H <$. Moreover, we can see that total output $G_P = \left(-\varepsilon_{HP}^I\right)^\gamma\left(\pi_H\varepsilon_{HP}^I\right)^{1-\gamma}$ also falls, i.e., $\partial G_P/\partial\hat{R}_H <$. Also from condition (A.1) and assumption (A), $R_H^- = +\infty$ implies $w_P = 0$, $G_P = 0$ and $\varepsilon_{HP}^I = 0$. □

Appendix D

Proof of Result 5

To see that P is not in general second-best, let us consider the following example where $\alpha = 1$, all individuals are equally risk-averse (i.e. $R(k) = R > 0$) and the certainty equivalent is such that $v(x, x+\bar{y}, \pi, R) = v(0, \bar{y}, \pi, R) + x$. Imagine now that a transfer τ is made to entrepreneurs. Balanced budget implies $\tau\varepsilon^{\mathrm{I}}_{\mathrm{HP}} = \left(1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}\right)\tau'$ where τ' is the tax on workers. P is such that

$$v\left(\tau, \tau + r^{\mathrm{I}}_{\mathrm{P}}, \pi_{\mathrm{H}}, R\right) = w_{\mathrm{P}} - \tau'. \tag{D.1}$$

In equilibrium, $w_{\mathrm{P}} = \gamma[\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}}/(1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}})]^{1-\gamma}$ and $r^{\mathrm{I}}_{\mathrm{P}} = (1-\gamma)[(1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}})/(\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}})]^{\gamma}$. Inserting the previous expressions into Eq. (D.1) yields

$$v\left(0, (1-\gamma)\left(\frac{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\right)^{\gamma}, \pi_{\mathrm{H}}, R\right) - \gamma\left(\frac{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\right)^{\gamma-1} + \frac{\tau}{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}} = 0, \tag{D.2}$$

with (provided R is large enough) $\varepsilon^{\mathrm{I}}_{\mathrm{HP}} < \gamma$ when $\tau = 0$ according to Result 4. Applying the implicit function theorem to Eq. (D.2) implies

$$\frac{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\partial \tau}\Big|_{\tau=0} = \frac{-1}{(1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}})\left(\frac{\partial v}{\partial r^{\mathrm{I}}_{\mathrm{P}}}\frac{\partial r^{\mathrm{I}}_{\mathrm{P}}}{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}} - \frac{\partial w_{\mathrm{P}}}{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\right)} = \frac{1}{(1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}})\frac{\partial w_{\mathrm{P}}}{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\left(1 + \frac{\partial v}{\partial r^{\mathrm{I}}_{\mathrm{P}}}\frac{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\right)}. \tag{D.3}$$

Then observe that

$$\frac{\partial w_{\mathrm{P}} - \tau'}{\partial \tau}\Big|_{\tau=0} = \frac{\partial w_{\mathrm{P}}}{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\frac{\partial \varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\partial \tau} - \frac{\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}. \tag{D.4}$$

Eqs. (D.3) and (D.4) together imply:

$$\frac{\partial w_{\mathrm{P}} - \tau'}{\partial \tau}\Big|_{\tau=0} = \frac{1 - \frac{1}{\pi_{\mathrm{H}}}\frac{\partial v}{\partial r^{\mathrm{I}}_{\mathrm{P}}}}{\left(1 + \frac{\partial v}{\partial r^{\mathrm{I}}_{\mathrm{P}}}\frac{1-\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}{\pi_{\mathrm{H}}\varepsilon^{\mathrm{I}}_{\mathrm{HP}}}\right)} \tag{D.5}$$

Then $R > 0$ and assumption (A) imply $0 < \partial v/\partial r^{\mathrm{I}}_{\mathrm{P}} < \pi_{\mathrm{H}}$. Consequently, expression (D.5) is positive: an arbitrarily small transfer to entrepreneurs financed by a tax on workers is Pareto-improving.

Turning to the second part of the result, consider a situation with $R^{-} = 0$ and $R^{+} = +\infty$. In *Regime II*, no subsidy can make a talented but infinitely risk-averse individual enter entrepreneurship without also attracting untalented but risk-neutral individuals. From Result 1, it cannot be first-best since all talented individuals must enter entrepreneurship before the first untalented one does. □

Appendix E

Proof of Result 6

Denote $\lambda_{\mathrm{T}}^{\mathrm{I}}$ and $\lambda_{\mathrm{T}}^{\mathrm{U}}$ the number of workers per plant with (successful) informed and uninformed directors of type T $(T = H, L)$, respectively. Denote also $\delta_{\mathrm{T}}^{\mathrm{I}}$ and $\delta_{\mathrm{T}}^{\mathrm{U}}$ the number of workers in plants with (successful) informed and uninformed directors of type T $(T = H, L)$ respectively. Aggregate output at date 4 is:

$$\begin{aligned} G_{\mathrm{C}} &= \sum_{T=H,L} \pi_T \varepsilon_T^{\mathrm{I}} \left(\lambda_T^{\mathrm{I}}\right)^{\gamma} + \sum_{T=H,L} \pi_T \varepsilon_T^{\mathrm{U}} \left(\lambda_T^{\mathrm{U}}\right)^{\gamma} \\ &= \sum_{T=H,L} \left(\pi_T \varepsilon_T^{\mathrm{I}}\right)^{1-\gamma} \left(\delta_T^{\mathrm{I}}\right)^{\gamma} + \sum_{T=H,L} \pi_T \left(\varepsilon_T^{\mathrm{U}}\right)^{1-\gamma} \left(\delta_T^{\mathrm{U}}\right)^{\gamma}. \end{aligned} \tag{E.1}$$

After bargaining with the directors and inducing them to operate their plants, the collectivist institution allocates workers across plants so as to maximise aggregate output:

$$\begin{aligned} &\mathrm{Max}_{\delta_{\mathrm{H}}^{\mathrm{I}}, \delta_{\mathrm{L}}^{\mathrm{I}}, \delta_{\mathrm{H}}^{\mathrm{U}}, \delta_{\mathrm{L}}^{\mathrm{I}}} G_{\mathrm{C}} \\ \text{s.t. } &\delta_{\mathrm{H}}^{\mathrm{I}} + \delta_{\mathrm{L}}^{\mathrm{I}} + \delta_{\mathrm{H}}^{\mathrm{U}} + \delta_{\mathrm{L}}^{\mathrm{U}} \leq 1 - \varepsilon_{\mathrm{H}}^{\mathrm{I}} - \varepsilon_{\mathrm{L}}^{\mathrm{I}} - \varepsilon_{\mathrm{H}}^{\mathrm{U}} - \varepsilon_{\mathrm{L}}^{\mathrm{U}}. \end{aligned} \tag{E.2}$$

The solution to Eq. (E.2) implies the equalisation of the expected marginal product of workers across all those plants that are not known to be unproductive.

$$\frac{\delta_{\mathrm{H}}^{\mathrm{I}}}{\pi_{\mathrm{H}} \varepsilon_{\mathrm{H}}^{\mathrm{I}}} = \frac{\delta_{\mathrm{L}}^{\mathrm{I}}}{\pi_{\mathrm{L}} \varepsilon_{\mathrm{L}}^{\mathrm{I}}} = \frac{\delta_{\mathrm{H}}^{\mathrm{U}}}{(\pi_{\mathrm{H}})^{1/(1-\gamma)} \varepsilon_{\mathrm{H}}^{\mathrm{U}}} = \frac{\delta_{\mathrm{L}}^{\mathrm{U}}}{(\pi_{\mathrm{L}})^{1/(1-\gamma)} \varepsilon_{\mathrm{L}}^{\mathrm{U}}}. \tag{E.3}$$

After inserting Eq. (E.3) into Eq. (E.1), maximised total output at date 4 is given by

$$G_{\mathrm{C}} = \Gamma^{1-\gamma} \left(\sum_{T=H,L} \left(\delta_T^{\mathrm{I}} + \delta_T^{\mathrm{U}}\right) \right)^{\gamma} \quad \text{with } \Gamma = \sum_{T=H,L} \left(\pi_T \varepsilon_T^{\mathrm{I}} + (\pi_T)^{1/(1-\gamma)} \varepsilon_T^{\mathrm{U}} \right). \tag{E.4}$$

When (Nash)-bargaining between the collectivist institution and any informed directors takes place, both parties know about the viability of the plants. This implies that unsuccessful informed directors receive 0 whereas successful informed directors receive a fraction β of their marginal product (which at this stage is independent of their talent):

$$r^{\mathrm{I}}_{\mathrm{HC}} = r^{\mathrm{I}}_{\mathrm{LC}} = \beta \frac{\partial G_{\mathrm{C}}}{\partial \pi_{\mathrm{H}} \varepsilon^{\mathrm{I}}_{\mathrm{H}}} = \beta \frac{\partial G_{\mathrm{C}}}{\partial \pi_{\mathrm{L}} \varepsilon^{\mathrm{I}}_{\mathrm{L}}} = \frac{\beta(1-\gamma)G_{\mathrm{C}}}{\Gamma}. \tag{E.5}$$

By contrast, when bargaining between the collectivist institution and any uninformed directors takes place, both parties are ignorant of the directors' individual managerial success. Uninformed directors thus receive a fraction β of their *expected* marginal product:

$$r^{\mathrm{U}}_{\mathrm{TC}} = \beta \frac{\partial G_{\mathrm{C}}}{\partial \varepsilon^{\mathrm{U}}_{\mathrm{T}}} = (\pi_T)^{1/(1-\gamma)} \frac{\beta(1-\gamma)G_{\mathrm{C}}}{\Gamma} = (\pi_T)^{1/(1-\gamma)} r^{\mathrm{I}}_{\mathrm{HC}} \tag{E.6}$$

for $T = H, L$. Since the allocation of workers has to be made before managerial success is known, a fraction $1-\pi_T$ of the plants run by uninformed directors of type T turns out to be unproductive. Consequently, relatively more workers are allocated to plants run by informed directors than uninformed ones so that $r^{\mathrm{U}}_{\mathrm{TC}} \le \pi_T r^{\mathrm{I}}_{\mathrm{C}}$ as can be seen from Eq. (E.6). Since the collectivist institution allocates the remaining output equally across workers, the collectivist wage is given by:

$$w_{\mathrm{C}} = \frac{1-\beta(1-\gamma)}{1-\varepsilon^{\mathrm{I}}_{\mathrm{H}}-\varepsilon^{\mathrm{I}}_{\mathrm{L}}-\varepsilon^{\mathrm{U}}_{\mathrm{H}}-\varepsilon^{\mathrm{U}}_{\mathrm{L}}} G_{\mathrm{C}} = [1-\beta(1-\gamma)] \left[\frac{\beta(1-\gamma)}{r^{\mathrm{I}}_{\mathrm{HC}}}\right]^{(1-\gamma)/\gamma}. \tag{E.7}$$

Note that, since the quantity of directors is exogenous at this stage, maximising G_{C} is equivalent to maximising the collectivist institution's income $[1-\beta(1-\gamma)]G_{\mathrm{C}}$ or maximising the workers' wage. Now, define excess supply of labour as

$$Z_{\mathrm{C}}(w) = 1 - \sum_{T=H,L} \left[\varepsilon^{\mathrm{I}}_{T}(w) + \delta^{\mathrm{I}}_{T}(w) + \varepsilon^{\mathrm{U}}_{T}(w) + \delta^{\mathrm{U}}_{T}(w)\right]. \tag{E.8}$$

Using Eqs. (E.4) and (E.7), Eq. (E.8) becomes:

$$Z_{\mathrm{C}}(w) = 1 - \sum_{T=H,L} \left[\varepsilon^{\mathrm{I}}_{T}(w) + \varepsilon^{\mathrm{U}}_{T}(w)\right] - \Gamma(w)\left[\frac{1-\beta(1-\gamma)}{w}\right]^{1/(1-\gamma)}. \tag{E.9}$$

From Eqs. (E.6) and (E.7) note that $r^{\mathrm{I}}_{\mathrm{HC}}$, $r^{\mathrm{I}}_{\mathrm{LC}}$, $r^{\mathrm{U}}_{\mathrm{HC}}$ and $r^{\mathrm{U}}_{\mathrm{LC}}$ vary continuously with w. Denote $\hat{R}_{\mathrm{H}}$ and $\hat{R}_{\mathrm{L}}$ the risk-aversion of those talented and untalented individuals, respectively, who in equilibrium are indifferent between becoming worker/uninformed director and informed director. For $T = H, L$, $\hat{R}_T$ is such that $v(0, r^{\mathrm{I}}_T, \pi_T, \hat{R}_T) = \mathrm{Max}(r^{\mathrm{U}}_T, w)$. From the continuity of the certainty equivalent function, we obtain that of the implicit function $\hat{R}_T(w)$. Since $\Phi(\cdot)$ is continuous in $\hat{R}_T$, $\varepsilon^{\mathrm{I}}_{\mathrm{H}}(w) = \alpha\Phi(\hat{R}_{\mathrm{H}}(w))$ and $\varepsilon^{\mathrm{I}}_{\mathrm{L}}(w) = \alpha\Phi(\hat{R}_{\mathrm{L}}(w))$ are also continuous. Furthermore, if $w > \Psi\pi_T$ with $\Psi = [1-\beta(1-\gamma)]^{\gamma}[\beta(1-\gamma)]^{(1-\gamma)}$ for $T = H, L$, then $\varepsilon^{\mathrm{U}}_T(w) = 0$. If $w < \Psi\pi_T$ then $\varepsilon^{\mathrm{U}}_{\mathrm{H}}(w) = \alpha - \varepsilon^{\mathrm{I}}_{\mathrm{H}}(w)$ and $\varepsilon^{\mathrm{U}}_{LC}(w) = 1 - \alpha - \varepsilon^{\mathrm{I}}_{LC}(w)$. If $w = \Psi\pi_T$, then $\varepsilon^{\mathrm{U}}_T(w)$ is the interval $[0, \alpha - \varepsilon^{\mathrm{I}}_{\mathrm{H}}(w)]$ if $T = H$ or $[0, 1 - \alpha - \varepsilon^{\mathrm{I}}_{\mathrm{L}}(w)]$ if $T = L$ (individuals of talent T are indifferent between the two risk-free occupations). Thus $\varepsilon^{\mathrm{U}}_T(w)$ is upper semi-continuous, non-empty and convex-valued. From Eq. (E.9), $Z_{\mathrm{C}}(w)$ is thus also upper semi-continuous, non-empty and convex-valued.

Note then that if $w < \Psi\pi_{\mathrm{L}}$ then $w < r^{\mathrm{U}}_{\mathrm{L}}$ and all individuals choose to become either informed or uninformed directors so that $Z_{\mathrm{C}}(w) < 0$. Furthermore, if $w > \Psi$ then $w > \pi_{\mathrm{H}} r^{\mathrm{I}}_{\mathrm{H}}$ so that no-one is willing to become a director. This implies $Z_{\mathrm{C}}(w) > 0$. Consequently by Kakutani's theorem there is at least one value of w for which $Z_{\mathrm{C}}(w) = 0$. This value can be shown to satisfy all the conditions stated in definition C. This establishes the existence of C.

Furthermore, since $r^{\mathrm{U}}_{\mathrm{HC}} > r^{\mathrm{U}}_{\mathrm{LC}}$ and $\pi_{\mathrm{H}} > \pi_{\mathrm{L}}$, it is immediate that more talented than untalented individuals choose to become directors and that only less risk-averse may choose to become informed. Finally, w_{C} is not unique in general. The reason is that $\varepsilon^{\mathrm{I}}_{\mathrm{H}}(w)$ may be increasing or decreasing in w. For instance, if $r^{\mathrm{U}}_{\mathrm{HC}} > w > r^{\mathrm{U}}_{\mathrm{LC}}$, the occupational choice of talented individuals is given by the comparison of $v(0, r^{\mathrm{I}}_{\mathrm{HC}}, \pi_{\mathrm{H}}, R)$ with $r^{\mathrm{U}}_{\mathrm{HC}}$. When w increases, from Eqs. (E.5), (E.6) and (E.7), both $r^{\mathrm{I}}_{\mathrm{HC}}$ and $r^{\mathrm{U}}_{\mathrm{LC}}$ decrease. In the absence of any restriction on the second derivative of $v(\cdot)$, $\hat{R}_{\mathrm{H}}$ may increase or decrease with w so that $\varepsilon^{\mathrm{I}}_{\mathrm{H}}(w)$ may also increase or decrease as w increases. It is then immediate that in Eq. (E.9), $Z_{\mathrm{C}}(w)$ is not monotonic in general. This leaves room for multiple equilibria. □

Appendix F

Proof of Result 7

From Result 1, there is a unique maximum feasible aggregate output corresponding to a unique allocation of talent. Thus, $(\varepsilon^{\mathrm{I}}_{\mathrm{HC}}, \varepsilon^{\mathrm{I}}_{\mathrm{LC}}) = (\varepsilon_{\mathrm{HF}}, \varepsilon_{\mathrm{LF}})$ and $\varepsilon^{\mathrm{U}}_{\mathrm{HC}} = \varepsilon^{\mathrm{U}}_{\mathrm{LC}} = 0$ are necessary for C to maximise output. These conditions are also sufficient, since labour is allocated efficiently across firms in C. In *regime I*, maximised output is such that $w_{\mathrm{F}} = \pi_{\mathrm{H}} r_{\mathrm{HF}}$. If output was maximised in C, from Eqs. (E.5) and (E.7), directorial rents and wages would be: $r^{\mathrm{I}}_{\mathrm{HC}} = \beta(1-\gamma)G_{\mathrm{F}}/(\pi_{\mathrm{H}}\varepsilon_{\mathrm{HF}})$ and $w_{\mathrm{C}} = [1-\gamma(1-\beta)]G_{\mathrm{F}}/(1-\varepsilon_{\mathrm{HF}})$. Since $\beta < 1$, it is easy to see that $\pi_{\mathrm{H}} r^{\mathrm{I}}_{\mathrm{HC}} < w_{\mathrm{C}}$ so that all individuals prefer to become workers. This implies $\varepsilon^{\mathrm{I}}_{\mathrm{HC}} \neq \varepsilon_{\mathrm{HF}}$ and a contradiction with $G_{\mathrm{C}} = G_{\mathrm{F}}$. A similar argument applies in *regime III* where $(\varepsilon^{\mathrm{I}}_{\mathrm{HC}}, \varepsilon^{\mathrm{I}}_{\mathrm{LC}}) = (\varepsilon_{\mathrm{HF}}, \varepsilon_{\mathrm{LF}})$ leads to $\pi_{\mathrm{L}} r^{\mathrm{I}}_{\mathrm{LC}} < w_{\mathrm{C}}$. This implies $\varepsilon^{\mathrm{I}}_{\mathrm{LC}} = 0$ whereas $\varepsilon_{\mathrm{LF}} > 0$, which contradicts $G_{\mathrm{C}} = G_{\mathrm{F}}$. Consequently, in *regimes I* and *III*, C cannot maximise production (nor *a fortiori* be first-best).

In *regime II*, G_{F} is such that $\varepsilon_{\mathrm{HF}} = \alpha$ and $\varepsilon_{\mathrm{LF}} = 0$ so that for $G_{\mathrm{C}} = G_{\mathrm{F}}$ we need $\varepsilon^{\mathrm{I}}_{\mathrm{HC}} = \alpha$ and $\varepsilon^{\mathrm{I}}_{\mathrm{LC}} = \varepsilon^{\mathrm{U}}_{\mathrm{HC}} = \varepsilon^{\mathrm{U}}_{\mathrm{LC}} = 0$. From Eqs. (E.5)–(E.7), $r^{\mathrm{I}}_{\mathrm{HC}} = r^{\mathrm{I}}_{\mathrm{LC}} = \beta(1-\gamma)[(1-\alpha)/(\pi_{\mathrm{H}}\alpha)]^{\gamma}$, $r^{\mathrm{U}}_{\mathrm{HC}} = (\pi_{\mathrm{H}})^{1/1-\gamma} r^{\mathrm{I}}_{\mathrm{HC}}$, $r^{\mathrm{U}}_{\mathrm{LC}} = (\pi_{\mathrm{L}})^{1/1-\gamma} r^{\mathrm{I}}_{\mathrm{HC}}$ and $w_{\mathrm{C}} = [1-\beta(1-\gamma)]$

$[\pi_{\rm H}\alpha/(1-\alpha)]^{1-\gamma}$. Since in *regime II*, $1-\alpha>\gamma>[(1-\alpha)\pi_{\rm L}]/[(1-\alpha)\pi_{\rm L}+\alpha\pi_{\rm H}]$, it is easy to see that $w_{\rm C}>\pi_{\rm L}r^{\rm I}_{\rm LC}>r^{\rm U}_{\rm LC}$ so that all untalented individuals choose to become workers: $\varepsilon^{\rm I}_{\rm LC}=\varepsilon^{\rm U}_{\rm LC}=0$. For C to maximise production in *regime II*, it remains to check under which conditions all talented individuals choose to become informed director. Note first that it is necessary that talented risk-neutral individuals choose to become informed directors: $\pi_{\rm H}r^{\rm I}_{\rm HC}\geq w_{\rm C}$, which implies $\beta\geq\alpha/(1-\gamma)$. It must also be the case that even the most risk-averse talented individual prefers to become an informed director, i.e., $v\left(0,r^{\rm I}_{\rm HC},\pi_{\rm H},R^{+}\right)\geq{\rm Max}\left(r^{\rm U}_{\rm HC},w_{\rm C}\right)$ or, using the above,

$$v\left[0,\beta(1-\gamma)\left(\frac{1-\alpha}{\pi_{\rm H}\alpha}\right)^{\gamma},\pi_{\rm H},R^{+}\right]\geq{\rm Max}\Bigg((\pi_{\rm H})^{1/1-\gamma-\gamma}\beta(1-\gamma)\left(\frac{1-\alpha}{\alpha}\right)^{\gamma},(1-\beta(1-\gamma))\left(\frac{\pi_{\rm H}\alpha}{1-\alpha}\right)^{1-\gamma}\Bigg) \tag{F.1}$$

Define $R_{\rm CII}$ as that value of R^{+} for which $v\left(0,r^{\rm I}_{\rm HC},\pi_{\rm H},R_{\rm CII}\right)={\rm Max}\left(w_{\rm C},r^{\rm U}_{\rm HC}\right)$. Then it is immediate that $R_{\rm CII}\geq R^{+}$ and $\beta\geq\alpha/(1-\gamma)$ are necessary and sufficient for C to maximise aggregate output. Remember that for P to maximise output in *regime II*, it is necessary and sufficient to have $R^{+}\leq R_{\rm PII}$ with $R_{\rm PII}$ such that $v(0,r_{\rm F},\pi_{\rm H},R_{\rm PII})=w_{\rm F}$. Since $r_{\rm F}>r^{\rm I}_{\rm HP}$ and ${\rm Max}\left(w_{\rm C},r^{\rm U}_{\rm HC}\right)>w_{\rm F}$, it follows from assumption (A) that $R_{\rm CII}<R_{\rm PII}$.

For C to coincide with F in *regime II*, it is necessary that it maximises aggregate output so that the previous condition, $\beta\geq\alpha/(1-\gamma)$, has to be satisfied. Besides, no individual should bear risk except those who are risk-neutral. This implies $R^{+}=0$, i.e. the whole population must be risk-neutral. □

Appendix G

Proof of Result 8

No C can be such that $r^{\rm I}_{\rm LC}>[1-\beta(1-\gamma)]^{\gamma}[\beta(1-\gamma)]^{1-\gamma}(\pi_{\rm L})^{-\gamma/(1-\gamma)}$ since from Eqs. (E.5)–(E.7), it would involve $w_{\rm C}<r^{\rm U}_{\rm LC}<r^{\rm U}_{\rm HC}$ and thus $\delta_{\rm C}=0$. From Eq. (E.7), $\delta_{\rm C}=0$ would lead to $w_{\rm C}=+\infty$, a contradiction. Hence, C involves $r^{\rm I}_{\rm TC}\leq\bar{r}\equiv[1-\beta(1-\gamma)]^{\gamma}[\beta(1-\gamma)]^{1-\gamma}(\pi_{T})^{-\gamma/(1-\gamma)}$. From Eqs. (E.5)–(E.7), this is equivalent to $w_{\rm C}\geq r^{\rm U}_{\rm TC}$. Denote $\overline{R}$ the index of risk-aversion of a talented individual such that $v\left(0,\bar{r}^{\rm I}_{\rm HC},\pi_{\rm H},\overline{R}\right)=w_{\rm C}$. If $R^{-}>\overline{R}$, it follows from assumption (A) that all talented and untalented individuals prefer to become workers rather than informed directors. Consequently, if $R^{-}>\overline{R}$, C is such that $\varepsilon^{\rm I}_{\rm HC}=\varepsilon^{\rm I}_{\rm LC}=0$ and no individual bears any risk. Thus, any increase in risk aversion will not change anything, provided the equilibrium is unique. Recall from Result 6 that multiplicity only arises when some directors are willing to bear risks. For a sufficiently risk-averse society this cannot be the case. Hence C is unique here. □

Appendix H

Proof of Result 10

Consider first the P-sector indexed MP. Following an argument similar to that in the proof of Result 2, no insurance can be provided in this sector and entrepreneurs are better-off informed than uninformed so that no individual chooses to become an uniformed entrepreneur: $\varepsilon^{\mathrm{U}}_{\mathrm{HMP}} = \varepsilon^{\mathrm{U}}_{\mathrm{LMP}} = 0$. We no longer need to worry about condition (ii) of definition M. From condition (iii) of the same definition, $\lambda^{\mathrm{I}}_{\mathrm{MP}} = (\gamma/w_{\mathrm{MP}})^{1/(1-\gamma)}$ and $r^{\mathrm{I}}_{\mathrm{MP}} = (1-\gamma)(\gamma/w_{\mathrm{MP}})^{\gamma/(1-\gamma)}$.

Consider now the C-sector indexed MC. Following the same approach as in the proof of Result 6, one finds that conditions (iv) and (v) of definition M imply $r^{\mathrm{I}}_{\mathrm{MC}} = \beta(1-\gamma)\{[1-\beta(1-\gamma)]/w_{\mathrm{MC}}\}^{\gamma/(1-\gamma)}$. From condition (i), the existence of a non-empty C-sector requires $w_{\mathrm{MC}} \geq w_{\mathrm{MP}}$. It is then immediate to see that this implies $r^{\mathrm{I}}_{\mathrm{MP}} > r^{\mathrm{I}}_{\mathrm{MC}}$. Hence in M, no individual chooses to become an informed director: $\varepsilon^{\mathrm{I}}_{\mathrm{HMC}} = \varepsilon^{\mathrm{I}}_{\mathrm{LMC}} = 0$. For a given allocation of workers in the C-sector, the wage w_{CM} and the income of uninformed entrepreneurs of ability T, $r^{\mathrm{U}}_{\mathrm{TMC}}$, are given by expressions similar to Eqs. (E.6) and (E.7). Besides, workers are allocated to collectivist plants so as to equate their expected marginal product: $\lambda^{\mathrm{U}}_{\mathrm{TMC}} = \{\pi_T[1-\beta(1-\gamma)]/w\}^{1/(1-\gamma)}$. Define now excess supply of labour in M as

$$Z_{\mathrm{M}}(w) = 1 - \sum_{T=H,L} \left[\varepsilon^{\mathrm{I}}_{\mathrm{TMP}}(w) + \delta^{\mathrm{I}}_{\mathrm{MPT}}(w) + \varepsilon^{\mathrm{U}}_{\mathrm{TMC}}(w) + \delta^{\mathrm{U}}_{\mathrm{TMC}}(w)\right]. \tag{H.1}$$

Using the above and wage equalisation across sectors, Eq. (H.1) becomes

$$\begin{aligned} Z_{\mathrm{M}}(w) = 1 \quad & - \sum_{T=H,L} \left[\varepsilon^{\mathrm{I}}_{\mathrm{TMP}}(w) + \varepsilon^{\mathrm{U}}_{\mathrm{TMC}}(w)\right] - \sum_{T=H,L} \pi_T \varepsilon^{\mathrm{I}}_{\mathrm{TMP}}(w) \left(\tfrac{\gamma}{w}\right)^{1/(1-\gamma)} \\ & - \sum_{T=H,L} \varepsilon^{\mathrm{U}}_{\mathrm{TMC}}(w) \left[\pi_T \tfrac{1-\beta(1-\gamma)}{w}\right]^{1/(1-\gamma)}. \end{aligned} \tag{H.2}$$

Following an argument similar to those in Appendices A and E, $Z_{\mathrm{M}}(w)$ can be shown to be upper semi-continuous, non-empty, convex valued and monotonic in w over the relevant range with $Z_{\mathrm{M}}(0) < 0$ and $Z_{\mathrm{M}}(+\infty) > 0$. By Kakutani's theorem, there is a unique value w_{M} for which $Z_{\mathrm{M}}(w_{\mathrm{P}}) = 0$, i.e. for which condition (vi) of definition M is satisfied. This unique wage defines then a unique $\left(\varepsilon^{\mathrm{I}}_{\mathrm{HMP}}, \varepsilon^{\mathrm{I}}_{\mathrm{LMP}}, \varepsilon^{\mathrm{U}}_{\mathrm{HMC}}, \varepsilon^{\mathrm{U}}_{\mathrm{LMC}}\right)$. This establishes the existence and uniqueness of M. It is not however second-best following an argument similar to that of Results 5 and 9. □

Appendix I

Proof of Result 12

First, define the median voter m in the following way. As the wage w in P falls from ∞ towards 0, more and more individuals choose to become entrepreneurs. Then, there exists a wage level w_m and an individual m, such that $w_m = v\left(0, r_P^I(w_m), \pi_m, R(m)\right)$ and $\varepsilon_{HP}(w_m) + \varepsilon_{LP}(w_m) = 0.5$. For instance, a majority of individuals *ex-ante* prefers P to C if and only if the expected utility of the median voter is higher under P than under C, that is $v\left(0, r_P^I(w_m), \pi_H, R(m)\right) > \mathrm{Max}\left(r_{HC}^U, w_C\right)$ when $\pi_m = \pi_H$ or $v\left(0, r_P^I(w_m), \pi_L, R(m)\right) > w_C$ when $\pi_m = \pi_L$.

There are two orderings which violate transitivity, namely $M \succ P \succ C \succ M$, and $M \succ C \succ P \succ M$, where $\succ$ stands for 'is strictly preferred by a majority to'. For this, M cannot coincide with either P or C. Then, equilibrium wages must be ranked as follows: $w_C > w_M > w_P$, which implies $r_P^I > r_{MP}^I$ and $r_{HMC}^U > r_{HC}^U$.

Examine first the case $M \succ P \succ C \succ M$. Since $w_C > w_P$, for $P \succ C$, m, the median voter in the contest between C and P must be an entrepreneur in P. Since $r_P^I > r_{MP}^I$, for $M \succ P$, it is necessary that m must not be an entrepreneur in P. Hence a contradiction: $M \succ P \succ C$ is thus impossible.

Examine now the case $M \succ C \succ P \succ M$. For $C \succ P$, we need either m to be a worker in P or m to be an entrepreneur in P such that $\mathrm{Max}\left(r_{HC}^U, w_C\right) > v\left(0, r_P^I, \pi_H, R(m)\right)$ when $\pi_m = \pi_H$ or $w_C > v\left(0, r_P^I, \pi_L, R(m)\right)$ when $\pi_m = \pi_L$. For $P \succ M$, we need m to be an entrepreneur in P such that $v\left(0, r_P^I, \pi_H, R(m)\right) > \mathrm{Max}\left(r_{HMC}^U, w_M\right)$ when $\pi_m = \pi_H$ or $v\left(0, r_P^I, \pi_L, R(m)\right) > w_M$ when $\pi_m = \pi_L$. Since $w_C > w_M$, for $C \succ P \succ M$, we need thus m to be a talented entrepreneur in P such that $\mathrm{Max}\left(r_{HC}^U, w_C\right) > v\left(0, r_P^I, \pi_H, R(m)\right) > \mathrm{Max}\left(r_{HMC}^U, w_M\right)$. For $M \succ C$, M must be such that there is a minority of workers and the income of uninformed directors must be such that $r_{HMC}^U > w_M$ and $r_{HMC}^U > \mathrm{Max}\left(r_{HC}^U, w_C\right)$ which contradicts $\mathrm{Max}\left(r_{HC}^U, w_C\right) > \mathrm{Max}\left(r_{HMC}^U, w_M\right)$. Thus majority rule is always transitive.

If $v\left(0, r_P^I, \pi_H, R(m)\right) > \mathrm{Max}\left(r_{HMC}^U, w_M, w_C\right)$ when $\pi_m = \pi_H$ or if $v\left(0, r_P^I, \pi_L, R(m)\right) > \mathrm{Max}(w_M, w_C)$ when $\pi_m = \pi_L$, then P is preferred to both C and M. It is easy to check that there are some parameter constellations leading to this outcome. If $\mathrm{Max}\left(r_{HC}^U, w_C\right) > v\left(0, r_P^I, \pi_H, R(m)\right)$ when $\pi_m = \pi_H$, or $w_C > v\left(0, r_P^I, \pi_L, R(m)\right)$ when $\pi_m = \pi_L$, and M is such that there is a majority of workers then C is preferred to both P and M. If $\mathrm{Max}\left(r_{HMC}^U, w_M\right) > v\left(0, r_P^I, \pi_H, R(m)\right)$ when $\pi_m = \pi_H$, or $w_M > v\left(0, r_P^I, \pi_L, R(m)\right)$ when $\pi_m = \pi_L$, and M is such that there is a minority of workers and $r_{HMC}^U > w_C$, then M is preferred to both P and C.

The proof of the last part of the result follows directly from Results 5, 7 and 8. □

Appendix J

Proof of Result 13

Consider first the choice between P and C only. Suppose that P is preferred to C by a majority and that m is a worker or an uninformed director, that is $w_P > v\left(0, r_P^I(w_m), \pi_m, R(m)\right)$. As a consequence, we obtain $w_P > \mathrm{Max}\left(r_{HC}^U, w_C\right)$ when $\pi_m = \pi_H$ or $w_P > w_C$ when $\pi_m = \pi_L$, which means that a majority of individuals will vote for P and be better off *ex − post* than with C. Thus, m must be an entrepreneur for a majority to suffer from P when it is voted for.

If $v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_m), \pi_{\mathrm{H}}, R(m)\right) > w_{\mathrm{P}} > \mathrm{Max}\left(r_{\mathrm{HC}}^{\mathrm{U}}, w_{\mathrm{C}}\right)$ when $\pi_m = \pi_{\mathrm{H}}$ or $v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_m), \pi_{\mathrm{L}}, R(m)\right) > w_{\mathrm{P}} > w_{\mathrm{C}}$ when $\pi_m = \pi_{\mathrm{L}}$, P is voted for and all individuals who become workers under P are better-off than under C. In this case, the only individuals who regret their choice are those who under C would have opted for a risk-free occupation but under P become unsuccessful entrepreneurs. (Those who become unsuccessful informed directors in C would have been unsuccessful entrepreneurs in P and thus have nothing to regret). From Results 2 and 6, only the less risk-averse individuals become informed directors in C or entrepreneurs in P so that the quantity of individuals who choose a risk-free occupation in C but become entrepreneur in P is equal to $\mathrm{Max}\left(\varepsilon_{\mathrm{HP}}^{\mathrm{I}} - \varepsilon_{\mathrm{HC}}^{\mathrm{I}}, 0\right)\mathrm{Max}\left(\varepsilon_{\mathrm{LP}}^{\mathrm{I}} - \varepsilon_{\mathrm{LC}}^{\mathrm{I}}, 0\right)$. An overall majority regrets P after it is voted for only when the unsuccessful extra risk-takers in P represent more than a majority of the population. This condition is equivalent to Max $\left(\varepsilon_{\mathrm{HP}}^{\mathrm{I}} - \varepsilon_{\mathrm{HC}}^{\mathrm{I}}, 0\right)(1-\pi_{\mathrm{H}}) + \mathrm{Max}\left(\varepsilon_{\mathrm{LP}}^{\mathrm{I}} - \varepsilon_{\mathrm{LC}}^{\mathrm{I}}, 0\right)(1-\pi_{\mathrm{L}}) > 0.5$.

If $v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_m), \pi_{\mathrm{H}}, R(m)\right) > \mathrm{Max}\left(r_{\mathrm{HC}}^{\mathrm{U}}, w_{\mathrm{C}}\right) > w_{\mathrm{P}}$ when $\pi_m = \pi_{\mathrm{H}}$ or $v\left(0, r_{\mathrm{P}}^{\mathrm{I}}(w_m), \pi_{\mathrm{L}}, R(m)\right) > w_{\mathrm{C}} > w_{\mathrm{P}}$ when $\pi_m = \pi_{\mathrm{L}}$, P is voted for but all individuals who become workers under P are now worse-off than under C. In this case, the losers are all those who opted for a sure occupation in P plus all those who would have opted for a sure occupation in C but become entrepreneurs in P and end up unsuccessful. They form a majority of the population if and only if $1 - \varepsilon_{\mathrm{HP}}^{\mathrm{I}} - \varepsilon_{\mathrm{LP}}^{\mathrm{I}} + \mathrm{Max}\left(\varepsilon_{\mathrm{HP}}^{\mathrm{I}} - \varepsilon_{\mathrm{HC}}^{\mathrm{I}}, 0\right)(1-\pi_{\mathrm{H}}) + \mathrm{Max}\left(\varepsilon_{\mathrm{LP}}^{\mathrm{I}} - \varepsilon_{\mathrm{LC}}^{\mathrm{I}}, 0\right)(1-\pi_{\mathrm{L}}) > 0.5$.

This type of reasoning can be readily extended to account for M. If M is distinct from both P and C and when C for instance is such that $\varepsilon_{\mathrm{HC}}^{\mathrm{I}} = 0$, it suffices to observe $v(0, r_{\mathrm{M}}, \pi_m, R(m)) > w_{\mathrm{C}}$ and $\varepsilon_{\mathrm{HMP}}^{\mathrm{I}}\pi_{\mathrm{H}}\varepsilon_{\mathrm{HMP}}^{\mathrm{I}}\pi_{\mathrm{L}} < 0.5$ (i.e. a minority of winners). □

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