Work organization and preferences dynamics

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Abstract

We present a model with intergenerational transmission of preferences providing a joint explanation of preference evolution and of work organization changes in a society. We focus on preference for autonomy defined as individual's degree of initiative and valuation of self direction. We show that the economy has two steady states with different levels of workers autonomy and of coercion degree in the work place. The two-way causality between socialization decisions and work organization induces existence of self-fulfilling beliefs involving multiple perfect foresight paths. Moreover, taking the example of industrial revolution, we show how technological shocks not only impact on the real economy but also on the dominant preference type in a society. This link allows us to highlight the possibility of path dependency in the dynamics of preferences and organizations.

Keywords: Cultural Transmission, Work Organization, Industrial Revolution, Historical Path Depedency

1 Introduction:

This paper focuses on the formation and evolution of preferences for autonomy, defined as individual's degree of initiative and valuation of self direction, and its relationship with the choice of work organization. We relate the old idea (Marx's or Weber's studies) that a link between production organization and people conscience, values or ideas exists, with more recent analysis concerning the preferences evolution. A close issue has been recently consider by Doepke and Zilibotti [8], who highlights the role of intergenerational transmission of patience on class structure transformations. However, the type of altruism retained in our model relates more closely our paper to the growing literature on cultural transmission (Bisin and Verdier [4] and [3], Hauk and Saez-Marti [11], Olcina and Peñarubia [21]).

Empirically, the remuneration of certain preferences, of which preference for autonomy, has been highlighted (Osborne [22] and Nyhus and Pons [20]). From a theoretical point of view Bowles, Gintis and Osborne [5] emphasis on the role of preferences on the incentives to supply effort. However, up to now, macroeconomic implications of these results have not been discussed. Moreover, we can think that if preferences impact on the incentives inside the work place, the organization of the work place can also determines the type of preferences prevailing within the society. Kohn [12] highlights this two way causality between personality features (as self-direction versus conformity to external authority) and occupational choices. The purpose of this paper is to comprehend the interactions between preferences evolution and industrial organization changes. We assume that individuals differ by their degree of autonomy and that different types of organization more or less coercive exist. We show that an economy can converge toward different steady states characterized by different work organizations and different preferences distributions. This framework allow us to account for great shifts of economic history as the industrial revolution or the passage of fordist to toyotist form of production and to set up consequences of these shifts on preferences distribution.

Several recent studies highlight that some preferences are remunerated on the labor market. Osborne [22] shows that adding certain preferences, behaviors or attitudes in the estimation of a wage equation allows a better explanation of the wage variations. Moreover, the remuneration of these preferences seems to vary according to occupation and especially to job status. From a theoretical point of view, Bowles, Gintis and Osborne [5] explain the reward and the punishment of some preferences by introducing the concept of incentives-enhancing preferences, i.e. preferences that allow the employer to elicit workers' effort at lower cost. The results of Osborne [22] show that certain preferences could be incentives-enhancing in one type of occupation but "incentives-weakening" in an other. In another part, Kohn [12] show the role of parents' occupation on the preferences they want transmit to their children. In particular they show that parents having occupation characterized by high level of autonomy value greatly self-direction in their children's' education.

In our model, we focus on the autonomy defined, by Nyhus and Pons [20], as "*a person's propensity to make his or her own decisions and degree of initiative and control*". We assume that a highly autonomous agent will give a high valuation to freedom in his work organization and in determination of his tasks. Conversely a less autonomous agent will be unaffected by the degree of control and the absence of freedom of choice on his tasks. Thus, in our framework, the autonomy is incentives-enhancing in a relatively free form of organization but incentives-weakening in a more coercive form. These characteristics will make profitability of each organization type dependent of the proportion of autonomous agents in the population. In our model, heterogeneous population of workers either autonomous or non-autonomous, is pair-wise matched with a profit-maximizing firm. Both type of agent play a two stage game. First, the firm, which cannot observe the workers type but know the preferences distribution in population of workers, choose its organization. Then, the worker choose his effort level according to the firm's organization and his preferences.

Our mechanism of preferences formation is in line with Bisin and Verdier [4]. Children preferences depend on two levels of socialization: vertical then oblique. The vertical socialization corresponds to a direct parental effort in terms of education. The parents exhibit a paternalistic altruism (Bisin and Verdier), which incites them to transmit their own preference type. The transmission effort will increase with the adequacy between the expected form of work organization and the behavior corresponding to preference type. Hence, autonomous parents may be less incited to transmit their preferences if they anticipate that a coercive form of organization will be dominant. This transmission effort determines the probability for the parents to transmit directly their own preferences. The oblique socialization occurs if the vertical one fails. It corresponds to a matching between the child and a "role model" (i.e. someone whose character, life, behavior... is taken as a good example to follow) randomly chosen in the population which transmit his own preferences.

We obtain a co-determination of preferences distribution (i.e. proportion of each worker type) and form of organization. Indeed, taking the example of autonomy and two alternative production organizations, we show that according to the form of work organization, either one or the other worker's category will choose higher effort. Thus, organizational choices will depend on the proportion of each preference type in the population. Then, via the mechanism of preferences transmission from parents toward children, the parental transmission effort of one preference type will be positively related to the adaptation of this one to the work organization. We therefore obtain a two-way causality between parental socialization decision and organizational form. Under some parameters value, the dynamics of preferences exhibit two stable steady states with a heterogeneous population. The "low equilibrium" is characterized by a low proportion of autonomous workers and a coercive organizational form. The "high equilibrium" is characterized by a high proportion of autonomous workers and a less coercive organizational form.

Clark [6] considers the industrial revolution as a transition from a workshop to a factory-like organization. He claims that it is associated with an increase in the level of coercion on the workplace. Our model is able to reproduce these features. If we consider that the proportion of autonomous workers is initially high, the economy will converge to the high equilibrium. An exogenous shock which increases the relative cost of the workshop-like (less coercive) organization (for instance, through a fall in transportation costs inducing a decrease of production concentration costs) may induce a change in the dynamics and a transition toward the low equilibrium. According to our model, the industrial revolution did not only impact the work organization but also the distribution of preferences and caused a fall in the proportion of autonomous workers. In an other example, we study the conditions and the impact on the autonomy degree of substitution of fordism by toyotism as the dominant production mode. This example allows to illustrate the nature historical path dependent of organizational changes. Indeed, the past changes have transformed the preferences structure which conditioned the adoption of a new organizational form. We also highlight the presence of self-fulfilling beliefs inducing multiple perfect foresight paths and then which could shape both the organization form and the distribution of preferences in the long term.

The paper is organized as follows. Section 2 introduces the model, describing the optimal worker's choice of effort, firm's choice of organization and parent's choice of socialization. Section 3 presents and studies the joint dynamics of preferences and organization. Section 4 illustrates this dynamics with the industrial revolution example. It also analyzes the role of expectations and the impact of technical progress evolution. Section 5 starts from gives another example : the evolution of Fordism and the shift toward Toyotism, which allows to highlight the possibility of path dependency in the dynamics of preferences and organizations. Finally, section 6 concludes.

2 The Model:

We consider two populations, the first constituted of infinitely-lived agents, namely *firms*, the second constituted of short-lived agents, namely *workers*. Both population of agents are a continuum with a measure normalized to one. Workers are risk neutral, live two periods, during the childhood they acquire their personality, during the adulthood they are randomly matched with a firm, work and get a wage.

The population of workers is split in two types of individuals, which differ in their degree of autonomy. The highly autonomous individuals will be indexed by $\bar{a}$ and the weakly autonomous will be indexed by $\underline{a}$. At date t we will note q_t the proportion of workers highly autonomous.

Firms are all identical, risk neutral and maximize the following profit function : $\pi_j = e - c_j$ where e is the level of worker's effort and c_j the organizing cost of production. For this, they can choose between two forms of work organizations[1]. These alternative organizations differ by the level of control and by the level of autonomy they allow respectively for the employers on the employees and for the employees in their work. For simplicity, we use only two archetypal types of organization which are named, following Clark [6] in his descriptions of industrial revolution, *the workshop,* which is more decentralized, leaving more freedom to workers who are less controlled, and *the factory*, characterized by some more precise and repetitive tasks due to division of labor and a more strict work discipline[2].

Moreover we assume that a firm cannot perfectly observe the level of effort provided by the workers nor the workers type. But we assume that it knows the distribution of types inside the workers population (*i.e.* the proportion q_t).

1. We suppose for simplicity that the form of organization is the only available choice's variable of the firm.

2. Clark [6] writes: *''One reason that the Industrial Revolution was greeted with hostility by many was its association with a revolutionary change in the way work life was organized [...] Workers in [the] workshops controlled their own hours, work pace and conduct. They took breaks when they wanted and socialized at work as they wished [...] The second and later change was the imposition on these concentrated workers of ''factory discipline''. With factory discipline the employer dictated when workers worked, their conduct on the job, and that they steadily attend to their assigned task''.*

2.1 Timing

Each date t is divided in two sub-periods *1* and *2*.

In *period 1* firms make their organization choice in order to maximize their expected profit.

In *period 2* workers choose their effort level according to the organization choosing by the firm and their degree of autonomy. Moreover, they chosen the level of education which they invest in their children socialization.

The problem of workers' effort choice and firms' organization choice will be solved by backward induction. Firstly, for *period 2*, we determine effort of workers: $e(i, j)$ with $i \in \{\bar{a}\ , \underline{a}\}$ the worker type and $j \in \{W, F\}$ the organization type. Then, in *period 1*, firms will make their organizations' choice knowing the proportion of autonomous workers and the reaction function of each worker's type. We deduce the best reply (BR) of the firms to the proportion q_t:

$$\mathrm{BR}(q_t) = \mathrm{Arg}\underset{j=\{W,F\}}{\mathrm{Max}}\,[q_t\, e(\bar{a}\ , j) + (1-q_t)e(\underline{a}, j) - c_j]$$

As we will see in the following, education effort τ_t^i will be function of autonomous workers proportion q_t and of expected value of this proportion q_{t+1}^a.

2.2 Choice of Workers

We assume that in a coercive context (the factory-like organization named *F-organization*) effort of autonomous workers ($\bar{a}$-workers) is very painful. The level of effort disutility discourages them to make high effort level despite the higher detection risk linked with a better control. Conversely, if $\bar{a}$-workers enjoy more freedom in the work place (as in W-*organization*) they will choose the highest effort level. Concerning the $\underline{a}$-workers, their effort disutility is unaffected by the discipline degree. Hence their effort choice will only depend on the detection probability if they choose to shrike and then on the control degree in the work place. The set of workers effort levels is assumed to be discrete: $e = \left\{ \bar{e} \ , \ \underline{e} \right\}$ with $\bar{e} \ > \ \underline{e}$. The matrices of expected gain for each worker type given the organizational form are:

	W	F
$\bar{e}$	w	$w-D$
$\underline{e}$	$(1-\underline{s})w$	$(1-\bar{s}\,)w$

$\bar{a}$ -worker

	W	F
$\bar{e}$	$w-d$	$w-d$
$\underline{e}$	$(1-\underline{s})w$	$(1-\bar{s}\,)w$

$\underline{a}$-worker

With $w>0$, $D>d>0$ and $\bar{s}\ >\underline{s}>0$. Where w denotes the worker's reward, D and d denote respectively the high effort disutility of an $\bar{a}$ -worker in the workshop-like organization context and the high effort disutility of an $\underline{a}$-worker whatever the organization type. $\bar{s}$ and $\underline{s}$ denote probabilities of detection of a shirker in respectively an F and W-organization. When a shirker is detected, he is directly dismissed and is not payed[3]. Note that the choice of the low effort level does not induce disutility whatever the type of worker and the organization form are. Hence for the autonomous it is not the work frame which is painful but high effort choice in this frame. We make the following assumptions on the payoff structure:

A1: $D>\bar{s}w>d>\underline{s}w$

Lemma 1. *Under A1:*

- *When employed in a W-organization, $\bar{a}$-workers always choose the level of effort $\bar{e}$ and $\underline{a}$-workers always choose the level of effort $\underline{e}$*

3. Pollard [23] notes that *"dismissal and the threat of dismissal, were in fact the main deterrent instruments of enforcing discipline in the factories"*. It will be the only instrument in our model.

– *When employed in a F-organization, $\bar{a}$-workers always choose the level of effort $\underline{e}$ and $\underline{a}$-workers always choose the level of effort $\bar{e}$*

In this context the autonomy is an ''incentive-enhancing" preference (Bowles, Gintis and Osborne [5]) in a workshop-like form of organization but it is an ''incentive-weakening" preference in a factory-like form of organization[4].

2.3 Choice of Firms

We assume that a firm cannot perfectly observe the level of effort provided by the workers nor the workers type. But we assume that it knows the distribution of types inside the workers population (the proportion q_t). Moreover at date t, the firm chooses its organization before worker begins the production and knowing the reaction function of each worker type given by the lemma 2. We can deduce, in replacing these reaction functions in profit function of the firms the expected profit of a firm under each organization type:

$$\pi_W = q_t\bar{e} + (1-q_t)\underline{e} - c_W \quad \text{and} \quad \pi_F = q_t\underline{e} + (1-q_t)\bar{e} - c_F$$

Further we will assume that: $C_W - C_F < \bar{e} - \underline{e}$

Lemma 2. *There exists a ''proportion threshold" of autonomous workers: $\tilde{q} = \frac{c_W - c_F}{2(\bar{e}-\underline{e})} + \frac{1}{2}$ under which the firm will choose the F-organization and above which it will choose the W-organization. Assumption $C_W - C_F < \bar{e} - \underline{e}$ ensures that this threshold is between 0 and 1.*

4. Pollard [23] highlights that, according to factory's managers at the beginning of industrialization, a proportion of workers was considerably dissatisfied because of absence of autonomy in work organization. Moreover, this dissatisfaction seems often induce by irregular attendance or by shirking. In our framework, this type of individual is $\bar{a}$-worker.

Proof. We merely show that for $q_t > \tilde{q}$, $\pi_W > \pi_F$. □

2.4 Transmission of preferences

The individual preferences are acquired during childhood by a process of socialization. First a process of vertical (parental) socialization occurs. In lines with Bisin and Verdier [4], we assume that parents have a paternalistic form of altruism for their children. They make their educational's choice in order to maximize the well-being of their children but this well-being is evaluated according to the parent's preferences. This assumption implies that parents always try to socialize their children to their own preferences. We will note τ^i the educational effort made by a parent i, with $i \in \left\{\bar{a}\ ,\ \underline{a}\right\}$ the parental type. With the probability τ^i the vertical socialization will be successful and the child will adopt her parent's preferences. With the probability $1 - \tau^i$ the vertical socialization will fail and a process of oblique socialization begins. This oblique socialization consists in the adoption, by children, of an other adult's preferences, that ''role model'' being randomly chosen among the population. Therefore, if vertical socialization fails, a child, whatever its parents type, will be $\bar{a}$ with probability q_t and $\underline{a}$ with probability $1 - q_t$.

We can deduce from this socialization process the probability that a child of a parent with preferences i is socialized to preferences j for each i and j. We will note P^{ij} this transition probabilities:

$$P_t^{\bar{a}\bar{a}} = \tau_t^{\bar{a}} + (1 - \tau_t^{\bar{a}})q_t$$

$$P_t^{\bar{a}\underline{a}} = (1 - \tau_t^{\bar{a}})(1 - q_t)$$

$$P_t^{\underline{a}\underline{a}} = \tau_t^{\underline{a}} + (1 - \tau_t^{\underline{a}})(1 - q_t)$$

$$P_t^{\underline{a}\bar{a}} = (1 - \tau_t^{\underline{a}})q_t$$

2.5 Parental socialization choice

As we have seen, the parents do their education choices in order to maximize their children utility estimated in accordance with their own preferences (the payoff matrix corresponding to their type). Formally the parental problem of socialization can be written as the following:

$$\underset{\tau_t^i}{\text{Max}}\, P_t^{\text{ii}}(\tau_t^i, q_t)V_{t+1}^{\text{ii}} + P_t^{\text{ij}}(\tau_t^i, q_t)V_{t+1}^{\text{ij}} - C(\tau_t^i)$$

Where V_{t+1}^{ij} is the utility of a parent with preferences i if her child is of type j. It is the utility of an individual behaving at the date *t+1* according to the preferences j but evaluated according to the preferences i. $C(\tau_t^i)$ is the socialization cost which we assume to be : $C(\tau_t^i) = \frac{(\tau_t^i)^2}{2k}$. The first order conditions yield:

$$\tau_t^{\bar{a}} = k(1-q_t)\Delta V_{t+1}^{\bar{a}} \qquad \text{and} \qquad \tau_t^{\underline{a}} = kq_t\Delta V_{t+1}^{\underline{a}}$$

With $\Delta V_{t+1}^i = V_{t+1}^{\text{ii}} - V_{t+1}^{\text{ij}}$, this value depends on the work organization at the date *t+1* and therefore on the expectations concerning the organization.

If agents anticipate at the date t that $q_{t+1}^a > \tilde{q}$, they anticipate that the organization at the date *t+1* will be the W-organization. We know that in this configuration, the $\bar{a}$-workers will choose the level of effort $\bar{e}$ and the $\underline{a}$-workers will choose the level of effort $\underline{e}$. $V^{\bar{a}\underline{a}}$ is the payoff of a worker behaving as a $\underline{a}$-worker (choosing the level of effort $\underline{e}$) evaluated with the payoff matrix of a $\bar{a}$-worker. Then we have $V_{t+1}^{\bar{a}\underline{a}}(W) = (1-\underline{s})w$, and by the same way we can deduce,

$$V_{t+1}^{\bar{a}\bar{a}}(W) = w\,,\; V_{t+1}^{\bar{a}\underline{a}}(W) = (1-\underline{s})w,\; V_{t+1}^{\underline{a}\underline{a}}(W) = (1-\underline{s})w \;\text{ and }\; V_{t+1}^{\underline{a}\bar{a}}(W) = w - d$$

and thus,

$$\Delta V_{t+1}^{\bar{a}}(W) = \underline{s}w \qquad \text{and} \qquad \Delta V_{t+1}^{\underline{a}}(W) = d - \underline{s}w$$

If agents anticipate at the date t that $q^a_{t+1} < \tilde{q}$, they anticipate that the organization at the date *t+1* will be the F-organization and this implies:

$$V^{\bar{a}\bar{a}}_{t+1}(F) = (1-\bar{s}\,)w\,,\; V^{\bar{a}\underline{a}}_{t+1}(F) = w - D\,,\; V^{\underline{a}\underline{a}}_{t+1}(F) = w - d \quad \text{and} \quad V^{\underline{a}\bar{a}}_{t+1}(F) = (1-\bar{s}\,)w$$

and thus,

$$\Delta V^{\bar{a}}_{t+1}(F) = D - \bar{s}w \qquad \text{and} \qquad \Delta V^{\underline{a}}_{t+1}(F) = \bar{s}w - d$$

We note that vertical and oblique transmissions are substitute: the greater the proportion of autonomous workers is, the weaker is the autonomous parents effort to transmit their preferences and the higher the effort of non-autonomous parent is. Under *A.1.*, both types of workers choose a positive level of socialization. We will show that, under this condition, any stable steady state is interior.

2.6 Characterization of the temporary equilibrium

We characterized at each date t the firm's choice (organization type) and the workers' choice (work and education effort level for each worker type)[5]. Those choices completely depend on autonomous workers' proportion (q_t) and on expectation on this proportion for *t+1*.

Proposition 3. *Under A1 and A2 the temporary equilibrium period t will be:*

i. if $q_t > \tilde{q}$ *and* $q^a_{t+1} > \tilde{q}$*, firms choose F-organization for period* t, $e^{\bar{a}}_t = \bar{e}$, $e^{\underline{a}}_t = \underline{e}$ *and* $\tau^{\bar{a}}_t = k(1-q_t)\Delta V^{\bar{a}}_{t+1}(W), \tau^{\underline{a}}_t = kq_t\Delta V^{\underline{a}}_{t+1}(W)$.

ii. if $q_t > \tilde{q}$ *and* $q^a_{t+1} < \tilde{q}$*, firms choose W-organization for period* t, $e^{\bar{a}}_t = \bar{e}$, $e^{\underline{a}}_t = \underline{e}$ *and* $\tau^{\bar{a}}_t = k(1-q_t)\Delta V^{\bar{a}}_{t+1}(F), \tau^{\underline{a}}_t = kq_t\Delta V^{\underline{a}}_{t+1}(F)$.

iii. if $q_t < \tilde{q}$ *and* $q^a_{t+1} > \tilde{q}$*, firms choose F-organization for period* t, $e^{\bar{a}}_t = \underline{e}, e^{\underline{a}}_t = \bar{e}$ *and* $\tau^{\bar{a}}_t = k(1-q_t)\Delta V^{\bar{a}}_{t+1}(W), \tau^{\underline{a}}_t = kq_t\Delta V^{\underline{a}}_{t+1}(W)$.

5. We note respectively $e^{\bar{a}}_t$ and $e^{\underline{a}}_t$ the work effort level of $\bar{a}$-workers and $\underline{a}$-workers and $\tau^{\bar{a}}_t$ and $\tau^{\underline{a}}_t$ the education effort level of $\bar{a}$-workers and $\underline{a}$-workers.

iv. if $q_t < \tilde{q}$ *and* $q^a_{t+1} < \tilde{q}$*, firms choose W-organization for period* t, $e^{\bar{a}}_t = \underline{e}$, $e^{a}_t = \bar{e}$ *and* $\tau^{\bar{a}}_t = k(1-q_t)\Delta V^{\bar{a}}_{t+1}(F), \tau^{a}_t = kq_t\Delta V^{a}_{t+1}(F)$.

Proof. These results directly come from the lemmas 2 and 3 and the resolution of the socialization problem □

The temporary equilibrium in t is therefore completely determined by the proportion of autonomous workers in t and the expectation of this proportion for *t+1*.

3 The Dynamics:

We deduce from the transition probabilities given in section 2.4. the dynamics of q_t:

$$q_{t+1} = q_t P^{\bar{a}\bar{a}}_t + (1-q_t) P^{a\bar{a}}_t = q_t + q_t(1-q_t)[\tau^{\bar{a}}_t - \tau^{a}_t]$$

We have also seen that the level of socialization effort of each worker type at date t depends on their expectations concerning the organization form at date *t+1* and then on q^a_{t+1}. From the proposition 3 the dynamics of q_t is :

$$\begin{cases} q_{t+1} = q_t + q_t(1-q_t)k[(1-q_t)\Delta V^{\bar{a}}(q^a_{t+1}) - q_t\Delta V^{a}(q^a_{t+1})] = g(q_t, q^a_{t+1}) \\ \text{Where:} \begin{array}{ll} (F)\ \ \Delta V^i(q^a_{t+1}) = \Delta V^i(F) & \text{if} \ \ q^a_{t+1} < \tilde{q} \\ (W)\ \ \Delta V^i(q^a_{t+1}) = \Delta V^i(W) & \text{if} \ \ q^a_{t+1} > \tilde{q} \end{array} \end{cases} \quad (1)$$

Moreover, from the proposition 3, the temporary equilibrium of each date t is totally determined by q_t and q^a_{t+1}. Then, the trajectory of our economy is also totally determined by the sequence of q_t and q^a_{t+1}. Among these trajectories we will only focus on the perfect foresight paths.

Definition 4. *For a given* q_0*, a perfect foresight path is a sequence of* q_t *satisfying equation (1) and as* $q^a_{t+1} = q_{t+1}$ *for all* t.

Thus the dynamics of q_t given by the equation $q_{t+1} = g(q_t,\ q_{t+1})$ describes completely the evolution of our economy under the assumption of perfect foresights. This dynamics is composed of two trajectories characterized in the following lemma.

Lemma 5. *Both trajectories (F) and (W) of the equation (1) has three stationary states: 0, 1 and* $\hat{q}^j = \frac{\Delta V^{\bar{a}}(j)}{\Delta V^{\underline{a}}(j) + \Delta V^{\bar{a}}(j)}$ *with* $j = \{W, F\}$*. Moreover, for k low enough {0,1} are unstable and* $\hat{q}^j$ *is globally stable for both trajectories.*

Proof. It is easy to see that 0, 1 and $\hat{q}^j$ are solution of the equation (1) on the trajectory *(j)* for $q_{t+1} = q_t$. We note that $(dq_{t+1}/dq_t|_{q_t=0})^j = 1 + k\Delta V^{\bar{a}}(j) > 1$ and $(dq_{t+1}/dq_t|_{q_t=1})^j = 1 + k\Delta V^{\underline{a}}(j) > 1$ therefore (0,1) are locally unstable. Moreover, the functions f^j as $q_{t+1} = f^j(q_t)$, describing evolution of q_t on the trajectory *(j)*, is continuous and is increasing if k is low enough. This implies that the unique interior solution $\hat{q}^j$ for each trajectory *(j)* is globally stable. □

The steady state values of q_t corresponding to each trajectory are $\hat{q}_W = \frac{\underline{s}w}{d}$ and $\hat{q}_F = \frac{D - \bar{s}w}{D - d}$. Observe that $\hat{q}_W > \hat{q}_F$ when $d(\bar{s}w - \underline{s}w) > D(d - \underline{s}\ w)$, this assumption is adopted in the following, in Appendix the other configuration is considered. Finally, notice that the dynamics of q_t exhibits a discontinuity in $\tilde{q}$. To characterize our perfect foresight dynamic for each q_t, we first plug the value of q_t in (2) in the case (F) and obtain a potential value of q_{t+1}. If this value satisfies $q_{t+1} < \tilde{q}$ it is a value corresponding to a perfect foresight path since the expected organization will effectively occur. Then, we plug the same value of q_t in (2) in the case (W) obtaining a second potential value of q_{t+1}. If this new value satisfies $q_{t+1} > \tilde{q}$ it is a value corresponding to a perfect foresight path. These two steps will yield no value for q_{t+1}, a unique value for q_{t+1} or two values for q_{t+1} corresponding to a perfect foresight path.

Define $F(q) = q + q(1-q)k[(1-q)\Delta V^{\bar{a}}(F) - q\Delta V^{\underline{a}}(F)]$ and $W(q) = q + q(1-q)k[(1-q)\Delta V^{\bar{a}}(W) - q\Delta V^{\underline{a}}(W)]$ and $(\bar{q}_W, \bar{q}_F) \in [0,1]^2$ respectively the solutions of equation: $\tilde{q} = F(q)$ and $\tilde{q} = W(q)$. The following proposition discuss existence and multiplicity of q_{t+1} values corresponding to a perfect foresight path in function of the position of q_t relatively to $\bar{q}_W$ and $\bar{q}_F$.

Lemma 6. *Assume A1, A2 and A3 are satisfied and k small enough:*

1. *If $q_t < \bar{q}_W$ and $q_t < \bar{q}_F$: only one value of q_{t+1} corresponding to a perfect foresight path exists.*

2. *If $\bar{q}_W < q_t < \bar{q}_F$: no value of q_{t+1} corresponding to a perfect foresight path exist.*

3. *If $\bar{q}_F < q_t < \bar{q}_W$: two values of q_{t+1} corresponding to a perfect foresight path exist.*

4. *If $q_t > \bar{q}_W$ and $q_t > \bar{q}_F$: only one value of q_{t+1} corresponding to a perfect foresight path exists.*

The proof of Lemma 6 and the study of the full dynamics are given in Appendix.

4 The industrial revolution: rise of the factory and fall of the autonomy

This section describes the shift, following the industrial revolution, from a society characterized by a workshop like form of organization to a society characterized by a factory like one. First, the pre-industrial situation will be considered. Then the focus will be put on the impact of technical shocks on the organizational choices and the evolution of preferences distribution.

4.1 Pre-industrial situation

Clark [6] focus on the work conditions before the industrial revolution in Britain. He argues that most workers were employed in workshops, controlled their pace, timing and conduct at work. The owner of workshop often rents out his material to workers without exercised control or discipline. Clark notes that: *"workers worked when they wished during [the workshop opened] hours [...] workers did not have to produce any minimum output per week"*. Retain a parameter configuration allowing to reach the situation describes by Clark. The following figure represents economy dynamics in the case $\bar{q}_F < \hat{q}_F < \tilde{q} < \bar{q}_W < \hat{q}_W$:

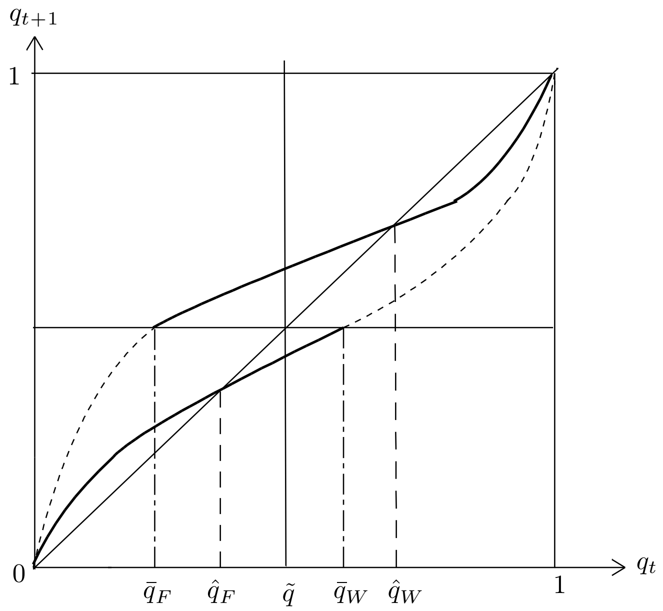

Figure 1.

Proposition 7. *In the configuration of figure 1:*

1. *If* $q_0 \in]0, \bar{q}_W]$, q_t *converges toward* $\hat{q}_F$.

2. *If* $q_0 \in [\bar{q}_F, 1[$, q_t *either converges toward* $\hat{q}_W$.

3. If $q_0 \in]\bar{q}_W, \bar{q}_F[$ *, the dynamics of* q_t *is indeterminated*

Proof. Cf. Study of the dynamics in appendix □

If the initial proportion of autonomous workers (q_0) is higher than $\bar{q}_F$, the economy will converge toward $\hat{q}_W$ and the form of organization remains the workshop. If $q_0 \in [\tilde{q}, \bar{q}_W]$, the two anticipations $q_1^a = W(q_0) > \tilde{q}$ and $q_1^a = F(q_0) < \tilde{q}$ are self-fulfilling, then the dynamics is indeterminated. However, if workers do not expect a shift in the form of work organization, the sequence $\{q_t\}_0^\infty$ will follow (W) trajectory, the proportion of autonomous individuals will increase, go past the threshold $\bar{q}_W$ and then reach $\hat{q}_W$. This configuration, where the dominant organizational form remains the Workshop, could correspond to the pre-industrial revolution situation as described by Clark.

4.2 Industrial revolution

The steam machine has been the emblematic innovation of the first industrial revolution. It has allowed to supply many workers with energy under a same roof. Then it has introduced a first labor division and the birth of the Factory. Mokyr [18] insists on another explanation of transition toward the factory: the decrease of costs of the production centralization (essentially the transport costs) relatively to costs of the production decentralization (essentially the information diffusion costs). Anyway, the technological progress linked with this first industrial revolution has involved a decrease of the costs of factory organization type relatively to workshop organization type. That is, in our framework, an increase of $(c_W - c_F)$ implying an increase of $\tilde{q}$. If the technological shock is large enough $\tilde{q}$ will overtake $\hat{q}_W$. Figure 2 illustrates this case ($\hat{q}_F < \hat{q}_W < \tilde{q} < \bar{q}_F < \bar{q}_W$).

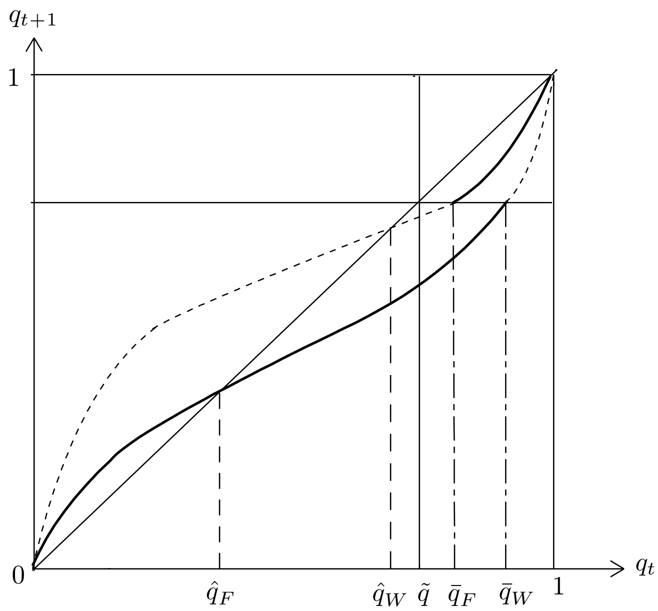

Figure 2.

Proposition 8. *In the configuration of figure 2, for all $q_0 \in]0, 1[$, q_t converges toward $\hat{q}_F$.*

Proof. Cf. Study of the dynamics in appendix □

Then, after the shock, the firms will choose the *F-organization* and q_t will converge toward $\hat{q}_F$. Therefore, a technological shock will not only imply a change in the production structure but also in the preferences distribution. Industrial revolution, making more favorable the *F-organization*, will make the autonomy more penalized for the workers. Then, parents will have less incentives to transmit their preference and so, in the long term, we will converge toward an equilibrium characterized by a smaller proportion of autonomous workers. Note that the adoption of a new organizational form no only depend of the intensity of technological shocks (magnitude of $\tilde{q}$ shift) but also of the prevailling preferences distribution. For a given technological shocks, some countries may not adopt the new organization if the proportion of autonomous workers is it too large.

Finally, Notice that if, following a fall of the information transmission costs, $\tilde{q}$ come back to its initial value, the work organization and the preferences distribution will not be affected. We will converge again toward $\hat{q}_W$ only if the agents coordinate their expectations toward the *W-organization* (in the case of $\bar{q}_F < \hat{q}_F$) or if the decrease of $\tilde{q}$ is large enough to reach $\tilde{q} < \hat{q}_F$. We will see in the following an illustration of the autonomy return.

4.3 Exogenous change in the preferences distribution

We have seen that an exogenous technological shock can induce a shift in the long term distribution of preferences. Obviously, a deep change of q_t will have consequences on the choice of organization and then on the long term equilibrium. If we start from the pre-industrial situation, at the date T, a large fall of the proportion of autonomous workers such as $q_T < \tilde{q}$ will induce the adoption of factory system and a convergence toward $\hat{q}_F$. Coriat [7] gives us an historical illustration of this mechanism. He argues that the wave of immigration toward United States in the first half of Nineteen-Century has provided an unskilled but also a disciplined workforce to American employers. Such a shift in the composition of labor supply having allowed the introduction of Taylorist methods and the rise of Factory[6].

6. Coriat [7] writes that, after this first immigration wave: *"the American capital will dispose of a plentiful workforce almost - concerning Irish people, "tamed" by English capital - disciplined."*

4.4 Self-fulfilling beliefs and the role of ideology

We have noticed the existence of an indeterminacy's area for $q_t \in \,]\bar{q}_F,\ \bar{q}_W[$[7]. In some parameters configuration, equilibriums $\hat{q}_F$ and $\hat{q}_W$ are in this area. For example Figure 3 illustrates the case: $\bar{q}_F < \hat{q}_F < \tilde{q} < \hat{q}_W < \bar{q}_W$.

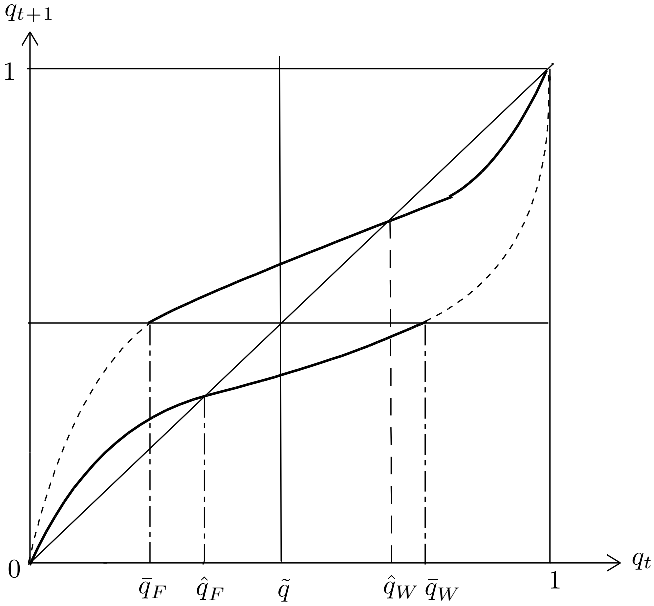

Figure 3.

In the configuration of Figure 3 if we are on equilibrium $\hat{q}_W$ (respectively $\hat{q}_F$), expectation that the firms will switch on the *F-organization* (respectively *W-organization*) is self-fulfilling. Thus if parents coordinate their expectations on *F-organization* (respectively the W one) q_t will join $\hat{q}_F$ (respectively $\hat{q}_W$). Hence, $\hat{q}_W$ and $\hat{q}_F$ are steady states but are unstable according to expectations, and consequently, both work organization and long term distribution of preferences would

7. Notes that the use of adaptative expectations (the organizational form expected for the date $t+1$ is the organization of the date t) allows to get rid of the indeterminacy. Indeed, with this form of expectations, if $q_0 > \tilde{q}$ (respectively $q_0 < \tilde{q}$) the firms will always choose the *W-organization* (respectively the *F-organization*) and the long term proportion of autonomous workers will be $\hat{q}_W$ (respectively $\hat{q}_F$).

be affected by change in agents' anticipations. Bisin and Verdier [3] insist on the role of ideologies on coordination of beliefs. Indeed ideology, providing to agents an image of what should be the state of a future society, allow to coordinate them on one anticipation. Obviously the ideology has to be self-fulfilling. It is the case of the *"belief of industrialization"* if we are at the date t in $\hat{q}_W$. In this case, if a sufficiently large proportion of people believes that the factory will prevail over the future society, they will expect that the behavior of non autonomous workers will be relatively less reward. The preference for autonomy will be less transmitted and the proportion q_{t+1} will be effectively under than $\tilde{q}$. Luke [16], in a study concerning the Soviet Russia, argues that the Russian industrialization has required the transformation of cultural values of the work force. The cultural development of a modern work ethic, basing on disciplined labor, are to be found, in large part, in the mobilization by the radical Russian intelligentsia of Marxism as a culture transforming ideology[8]. Our framework permits to consider the possibility of a transition toward another form of organization allowed by ideology.

4.5 Technical progress

With the example of industrial revolution, we have considered a radical innovation changing the relative cost of different organizations. In this section we set up a technical progress which multiply the level of knowledge by a constant factor and then raise the productivity. Moreover this technical progress lets the work conditions unaffected (d and D remains constant). The next section will illustrate the case of work conditions evolution.

8. One of the role given by Lenin to the communist party cadres is to spread within the Russian people the discipline as value and as necessity to reach a new society. Their mission was "to teach people how to work" and to lead the struggle against "carelessness, untidiness, unpunctuality, nervous haste, the inclination to substitute discussion for action" Lenin ([14] and [13]).

a) Neutral technical progress

The technical progress is named "neutral" if it affects in the same way the productivity of all organizational forms. In order to simplify the analysis, we assume that the productivity (level of effort) of each worker type in each organization is multiplied by a factor $a>1$. Hence the wage becomes aw while the costs of organization (C_F and C_W) are assumed fixed[9]. What is the impact of the introduction of this technical progress on the dynamic of economy?

We assume that the assumption *(A.1.)* remains true in the new configuration, that is: $D > a\bar{s}w > d > a\underline{s}w$. The global effect of the technical evolution could be decompose in a productivity effect (effect of the change in workers productivity on the firm's organizational choices) and an incentive effect (effect of the change of wages on the parent's socialization choices).

Since the technical progress have a multiplicative impact on effort level, its enhances relatively more the productivity of workers choosing the high level of effort ($\bar{a}$*-workers* in a Workshop context and $\underline{a}$*-workers* in a Factory context). Hence, introduction of such a technical progress decreases the proportion of autonomous workers above which firm will choose *W-organization*. Formally, $\tilde{q}(a) = \frac{C_W - C_F}{2a(\bar{e} - \underline{e})} + \frac{1}{2}$ decreases with a. This effect on $\tilde{q}$ is named *productivity effect*.

In the other side the *incentive effect* follows from the rise of wage. Its increases more the of a non shirker worker utility than one of a shirker worker. Consequently, if the expected organization is the workshop, the utility of

9. This increase of wages should involve an increase of production costs. However, in presence of fixed costs ($C_i = w + \sigma_i$) this increase of wage is higher than the increase of production costs ($\Delta w = a > \Delta C_i = a - (a-1)\sigma_i$). Then, it is qualitatively equivalent to consider fixed production costs and existence of fixed costs. In the following the impact of wage increase on costs will be consider as null.

autonomous workers (making the high effort level) increase more with a than the utility of non autonomous workers. Then relative incentives to transmit $\bar{a}$ preferences increase. By this way, the proportion of autonomous workers $\hat{q}_W = \frac{\underline{s}\,aw}{d}$ increase with a. Symmetrically, in a factory context, the $\underline{a}$*-workers* makes the high effort level. After an increase of a, the autonomy is less valuated in the transmission process and the proportion of autonomous workers $\hat{q}_F = \frac{D - \bar{s}\,aw}{D - d}$ decrease with a. The increase of a neutral technical progress will have for consequence an homogenization of the population with a trend of decrease of autonomy in a coercive context and inversely in a more free organizational form. This result comes directly from the the fact that an increase of wage benefits more to non shirker workers.

The global effect of a neutral technical progress introduction, starting from the configuration of figure 1, is sum up in following figures.

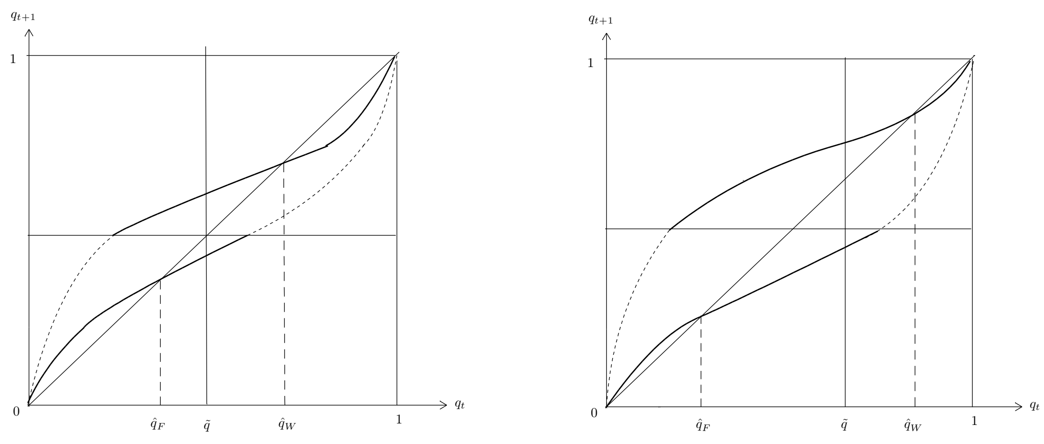

Figure 4.

b) Biased technical progress

The technical progress is biased if it affects differently the different forms of organization. We have seen that industrial revolution has put the machine in the heart of productive process. Then a technical progress improving the quality of capital will increase more the productivity inside the factory, form of production capital intensive, than inside the workshop. In our framework, we assume that productivity and wage in factory is multiplied by a factor $a > 1$ corresponding to technical progress while the efficiency of workshop is unaffected. The global effect of this change could again be decomposed in a *productivity* and an *incentive* effect.

The autonomous workers proportion threshold under which the firm chooses the *F-organization* will be modified in the following way:

$$\tilde{q}(a) = 1 - \left[\frac{C_F - C_W}{(a-1)(\bar{e} - \underline{e})} - \frac{\underline{e}}{\bar{e} - \underline{e}}\right]$$

This threshold is inferior to one only if C_F is sufficiently high with respect to C_W. Indeed, the *F-organization* has an advantage in term of productivity, this for the two worker types. If it has also an advantage in term of costs, the firms will always choose the *F-organization* whatever the proportion of autonomous workers. Consider, first the case where $C_F > C_W + \underline{e}(a-1)$ which ensure that $\tilde{q} < 1$. Look at the effect of an increase of a. The technical progress is a multiplicative factor applied to the effort level. Then its increase, enhances relatively more the productivity of workers providing the high effort level than the productivity of workers providing the low effort level. In a factory context, the workers making the high effort level are the non autonomous, then the valuation of discipline inside the factory rise with technical progress. By this *productivity effect*, $\tilde{q}$ will increase with a. If a increases sufficiently such as $C_F \leqslant C_W + \underline{e}(a-1)$, we obtain $\tilde{q} \geqslant 1$, and thus the *F-organization* is always choose.

Concerning the *incentive effect*, the wage distributed under *W-organization* is not affected by the biased technical progress, then $\hat{q}_W$ remains stable. For the reasons exposed in the neutral technical change section, $\hat{q}_F$ decreases with a.

The increase of a biased technical change carrying on the factory type of organization has two effects on the long term distribution of autonomy. First, it increases the probability of adoption of the *F-organization* and then the probability of convergence toward the low equilibrium ($\hat{q}_F$). Second, through the mechanism of preferences transmission (*incentive effect*), this equilibrium shifts leftward, and then the proportion of autonomous workers, in this configuration, decreases. These two effects are illustrated in the following figures:

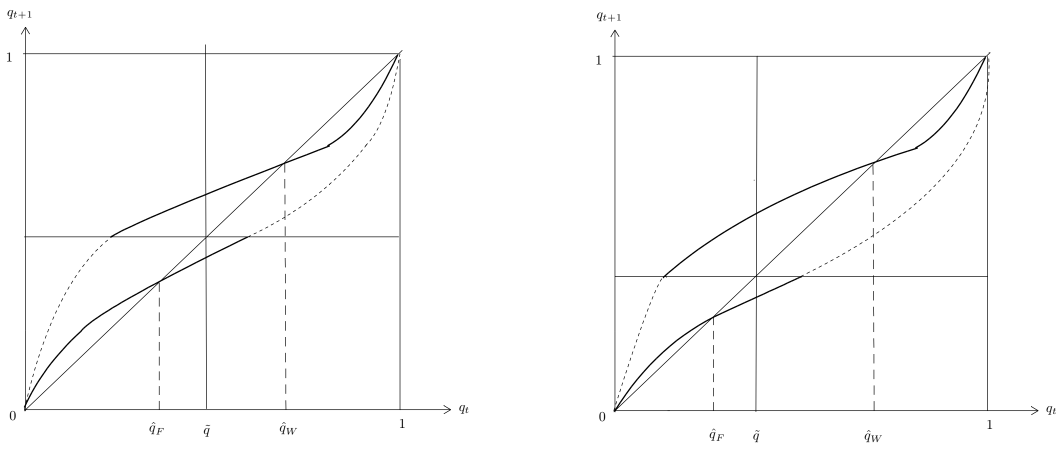

Figure 5.

5 Fordism toward Toyotism

This section starts from the situation following industrial revolution, illustrated by Figure 2. The consequences of application and generalization inside the factory of an organization intensifying the labor division, the Fordism, on the preferences distribution are highlighted. This evolution of *F-organization* allows an increase of labor productivity but imply also contradictions. Finally, we describe Toyotism as a way to resolve Fordism contradictions and we show that the Toyotism adoption is conditioned by changes in the preferences distribution resulting of the previous organization choices and then by the historical path.

5.1 Intensification of labor division

The second industrial revolution with invention of electricity allows a deeper division of labor, specialization and mechanization. Paroxysm of this organization rationalization is reached with the fordist form of production organized around the moving assembly line. The evolution toward Fordism was accompanied with the increase of productivity but also of repetitivity and monotony of industrial work, which corresponds, in our model, to an increase of effort disutility of autonomous workers. Ford [10] himself argued that *"the vast majority of men want to stay up [...] They have never been taught to think; and they do not care to think [...] All of which means that they get to like their monotonous jobs [...] They want to be led. They want to have everything done for them and to have no responsibility"*.

In our framework, we start from the equilibrium $\hat{q}_F$, an increase of D induces a rightward shift of $\hat{q}_F$. Then, the generalization and intensification of factory system will increase the long term proportion of autonomous workers. This paradoxical result comes from the mechanism of preferences transmission. In a factory context, $\bar{a}$*-workers* make the low effort level and $\underline{a}$*-workers* the high effort level. With the increase of D the cost of high effort rises for autonomous workers, then the valuation of non autonomous behavior (to choose $\bar{e}$) decreases. Finally, the incentives of autonomous parents to transmit their own preferences is increased while the transmission behavior of non-autonomous parents is unaffected. Lewchuk [15], in a study dealing with the Ford Motor Company, notes that the new work conditions have effectively raised the proportion of shirker.

However this effect is partly counterbalanced by the increase of productivity which, via the *incentive effect* linked with the wages increase, induces a fall of $\hat{q}_F$ (Cf. section 4.5.).

5.2 Fordism's contradictions and Welfare Capitalism

The application of Fordist methods also increases the inter-dependence of workers. Absence or shirking behavior of one worker along the assembly line can stop the whole production process. Hence, fordism increases the cost of shirking for employers. The extreme workers specialization and the lack of organizational flexibility tend to intensify this effect. In our framework, the rise of shrinking costs could be modelized by a fall of $\underline{e}$. Then, the factory profit (π_F) becomes strongly decreasing with the proportion of shirker, which is q_t (proportion of autonomous workers) when the factory is the dominant form of production. Finally, this fall of $\underline{e}$ imply a fall of $\tilde{q}$.

We have seen in the previous section that the intensification of labor division inside the Fordist firm may rise the proportion of autonomous workers. Then Fordism copes with its contradictions in increasing the autonomy which, on the other hand, disorganize the production. Apparition of these contradictions will involve the other side of Fordism: the welfare policy with the introduction of the "five dollars day". The "five dollar day" has been a symbolic and temporary measure. However the Fordism has effectively been accompanied with Keynesian policy of wages increasing. This demand policy has also an incentive aim that is by mechanism of motivation or efficiency wage to increase the workers efforts. Coriat [7] argues that the main aim of the rate wage increase is to broke the chronicle state of insubordination caused by work's conditions.

We have seen that the increase of wage inside *F-organization* involves a shift toward the right of $\hat{q}_W$. Then, by transmission's mechanisms rather than motivation's mechanisms, this policy success to decrease the proportion of autonomous workers and then the proportion of shirkers. Notes that this result is conform to incentives theory results, the average level of effort increases with w, but the mechanisms are differents. Here, the increase of effort is permitted by the fall of autonomous workers proportion dues to the transmission process[10].

5.3 Consequences of Fordism on preferences dynamics

To sum up, the introduction of fordism imply:

i. An increase of the labor division and the coercion on the workplace which implies an increase of D and induces a rightward shift of $\hat{q}_F$.

ii. An increase of labor productivity which induces an increase of $\tilde{q}$ and a decrease of $\hat{q}_F$ (Cf. Section 4.5.*b)*).

iii. An increase of workers inter-dependence which implies a fall of $\underline{e}$ and induces a decrease of $\tilde{q}$.

iv. An increase of w which induces a decrease of $\hat{q}_F$.

Then the total effect both on $\tilde{q}$ and $\hat{q}_F$ are ambiguous. If the effect of rise of wages, permitted by productivity gains and welfare policies, is higher than the effect of labor division intensification, ‘‘fordist system‘‘[11] induces a fall of autonomous workers proportion ($\hat{q}_F$) in the long term.

10. Notes that another policy of effort incentive can be an increase of the control degree ($\bar{s}$). Thus policy as the same effect than the rise of w (decrease of $\hat{q}_F$). Here too, the positive effect on factory profit is due to fall of autonomy into the workers population.

11. One named ‘‘Fordist system”, the union of the transformation of work organization inside the factory and the welfare policies induced by it.

5.4 Toyotism advent and path dependency

Another characteristic of fordist system is the mass production, that is the production in great quantity of standardized products. The productivity gains come from the great production scale and then from the level of demand. If a shock reduce this demand level, the question become: how rise the productivity when the quantity does not increase ? The toyotist form of production answer to this question. It is adapted to the production in little scale of diversified products thinks to a greater worker's flexibility and capacity of adaptation. To sum up, a greater worker's autonomy. The toyotism avoid also to resolve the fordim's contradictions. Allowing to workers to perform several tasks, it breaks the workers inter-dependence and then decrease the cost of shirking (increase of $\underline{a}$). Although the Toyotist organization is not a return to the pre-industrial workshop, it corresponds to a more flexible form of production than the Factory. Thus, we adopt the same modelization (workers expected payoffs and firms profit function) for the *W-organization* and for the Toyotist organization. In our framework, the ''Toyotism invention'' allow to replace the Workshop as the archetypal alternative organization to the Factory. Let see the condition of Toyotism adoption.

Milgrom and Roberts [17] argues that the development of computer and robotic allowed to reduce a set of costs as the cost of collecting, organizing, and communicating data; and the costs of flexible manufacturing. These changes mades cheaper for the firm to adopt a broader product line and to update its products more frequently. All these changes are complementary with a more flexible organization of work. Then, new technological developments allow to decrease the relative costs of Toyotism $(C_W - C_F)$ and thus to decrease $\tilde{q}$. In what extend such a decrease allows the adoption of Toyotism as dominant organization ? Starting from the equilibrium $\hat{q}_F$ and without shift in expectation, firms adopt Toyotism if the fall of $\tilde{q}$ is large enough for reach the configuration: $\tilde{q} < \hat{q}_F$. In this configuration, the current preferences distribution makes adoption of Toyotism profitable and q_t will converge toward the high equilibrium $\hat{q}_W$. However we have seen in the previous section that this distribution is affected by the application of Fordism. In the following figures, we see that the same technological shock has different impact on the work organization and the long run preferences distribution with regards to the occurrence of a Fordist period.

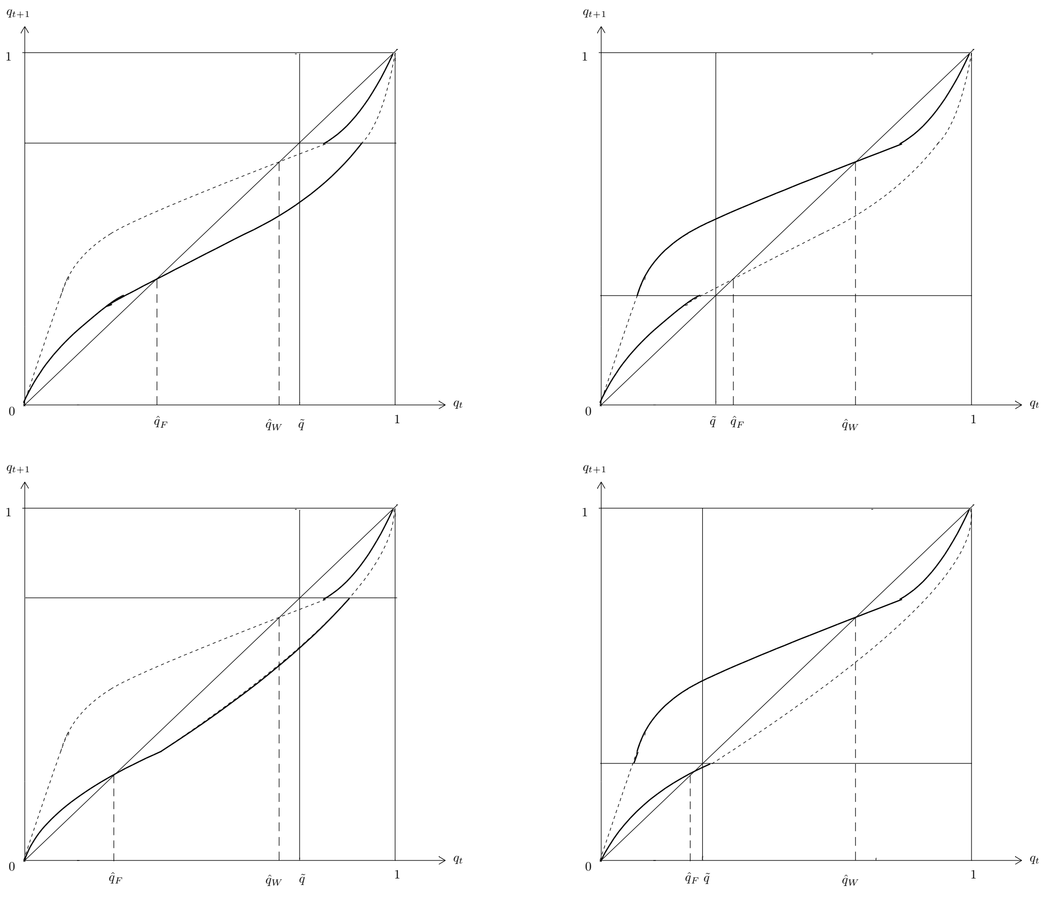

Figure 6.

In the first two figures, no major changes in the Factory form have occurred. Then, the preferences distribution is the same since the industrial revolution. We consider, in a second step, a technological shock in favor of Toyotist organization. In this case, this shock is large enough, the firms choose the Toyotism and the autonomy progressively rise until q_t reach $\hat{q}_W$. In the last two figures, the Fordism consequences (increase of w and $\bar{s}$) have changed the preferences structure. The proportion of autonomous has fall. Here, the same technological shock not allows the adoption of Toyotism and economy remains in $\hat{q}_F$.

Thus, via the impact of organizational choices on the preferences distribution, the trajectory of an economy is path dependent (Atkinson and Stiglitz [1] highlights the possibility of path dependency trough the property of ''localization'' of technical progress on some specifics techniques and not on the whole production function). The evolution of a productive system determines the adoption possibilities of a new system. This historical path dependency allows to explain the international differences in organizational trajectories without have recourse to strictly culturalist explanations (Benedict [2] and Nakane [19] suggests that Japanese organizations derive from cultural factors such as homogeneity, familism, and group loyalty)[12]. Our approach, in endogenizing the ''cultural composition'' of the population, rejects also the adoption of the same dominant organizational model in all places and in all contexts.

6 Conclusion:

In introducing an heterogeneity in the workers preferences we have shown how the work organization and the preferences distribution could be co-determined. In one hand the autonomous workers proportion impact on relative profitability of dif-

12. The validity of cultural explanations was questionned by a wave of Japanese ''transplants'' in various parts of the world (Florida and Kenney [9]).

ferent organizational form and thus on the occurring form. In other hand, the work organization shape the way of which the autonomy is rewarded or penalized and thus parent's incentives in transmission of this trait. The fact that parent's incentives to socialize her children depends on their expectations about the future state of work organization entails the existence of self-fulfilling beliefs. If agents anticipate a coercive organizational form, the autonomy will be less favored in socialization process, population of the next date will be less autonomous and the more profitable organization will be effectively coercive. Thus, beliefs concerning the future state of organization, technology or dominant preference will influence both work organization and the long term preferences distribution. We also highlight that a technological shock, the fall of the transport costs, which has been one of the motors of industrial revolution has also could be at the origin of a fall of autonomous individual proportion in the society. This impact of real shocks on preferences distribution induces the attendance of path dependency. Indeed, the new configuration of preferences structure induces changes in the possibility of an organization adoption.

The consideration of only two simultaneous organization types and the fact that they cannot coexist in a same date is clearly a limit for our analysis. In this line a possible extension could be to take in account a population of firms heterogeneous according to their organizational mode, the dynamic of the organization form could be evolutionary with a process of imitation among the firm for example.

Appendix

Proof of Lemma 6.

From the proof of lemma 5 we can deduce that for k small enough $F(q)$ and $W(q)$ are monotonously increasing on [0, 1]. Since $\tilde{q} \in [0, 1]$, $\exists! \{\bar{q}_W, \bar{q}_F\}$ sub defined as respectively $F(q) = \tilde{q}$ and $W(q) = \tilde{q}$. Moreover:

- For $q_t < \bar{q}_F : W(q_t) < \tilde{q}$, then if at the date t, parents expect that *W-organization* will occur, q_{t+1} will be smaller than $\tilde{q}$ and the *F-organization* will be chosen. Therefore in this case $q_{t+1} = W(q_t)$ cannot correspond to a perfect foresight path. Conversely, if $q_t > \bar{q}_F$: $q_{t+1} = W(q_t)$ corresponds to a perfect foresight path.
- For $q_t > \bar{q}_W : F(q_t) > \tilde{q}$, then in the same way, $q_{t+1} = F(q_t)$ cannot correspond to a perfect foresight path and conversely, for $q_t < \bar{q}_W$, $q_{t+1} = F(q_t)$ corresponds to a perfect foresight path.

We directly deduce Lemma 6.

Study of the dynamics

It follows from Lemma 6 that there are three possibilities to consider in building a complete perfect foresight path $\{q_t\}_0^\infty$ verifying equation (2):

i. If, starting from q_0, the partial path $\{q_t\}_0^T$ come to a step q_T for which equation (2) for both cases (F) and (W) yields no value for q_{T+1} corresponding to a perfect foresight path, there is no perfect foresight path.

ii. If, starting from q_0, equation (2) for both cases (F) and (W) yields exactly one value of q_{t+1} corresponding to a perfect foresight path for each $q_t \in \{q_t\}_0^\infty$, there exists a unique perfect foresight path.

iii. If, starting from q_0, the partial path $\{q_t\}_0^T$ comes to a step q_T for which equation (2) for both cases (F) and (W) yields two values for q_{T+1} corresponding to a perfect foresight path, there are at least two perfect foresight paths and there may be more since other splits may occur.

Lemma 5 describes the behavior of the sequence $\{q_t\}_{T_1}^{T_2}$ on each trajectory: the two trajectories ((W) and (F)) are monotonous increasing and have one interior steady state (respectively $\hat{q}^W$ and $\hat{q}^F$). The position of the dynamics' discontinuity ($\tilde{q}$) determines which trajectory corresponds to a perfect foresight path. Then, the whole sequence $\{q_t\}_0^\infty$ depends of the relative position of $\hat{q}^W$, $\hat{q}^F$ and $\tilde{q}$.

First of all, by properties of functions $W(q)$ and $F(q)$, it is easy to show that the position of $\tilde{q}$ determines the position of $\bar{q}_W$ and $\bar{q}_F$ in the following way:

i. $\hat{q}_F > \tilde{q}$ and $\hat{q}_W > \tilde{q}$ then $\tilde{q} > \bar{q}_W$ and $\tilde{q} > \bar{q}_F$

ii. $\hat{q}_W > \tilde{q} > \hat{q}_F$ then $\bar{q}_W > \tilde{q} > \bar{q}_F$

iii. $\hat{q}_W < \tilde{q} < \hat{q}_F$ then $\bar{q}_W < \tilde{q} < \bar{q}_F$

iv. $\hat{q}_F < \tilde{q}$ and $\hat{q}_W < \tilde{q}$ then $\tilde{q} < \bar{q}_W$ and $\tilde{q} < \bar{q}_F$

Configuration C.1.

First consider that $\hat{q}^W > \hat{q}^F$ (assumption $d(\bar{s}w - \underline{s}w) > D(d - \underline{s}\,w)$ holds) and $\bar{q}_F < \bar{q}_W$[13]. The position of $\tilde{q}$ determines the positions of $\bar{q}_W$ and $\bar{q}_F$.

The following results can be deduced from Lemma 5 and Lemma 6:

i. If $q_t \in [0,\ \bar{q}_F]$: by Lemma 6, only one perfect foresight path exists which corresponds to trajectory (F). By lemma 5, the sequence $\{q_t\}_0^\infty$ converges toward $\hat{q}_F$ if $\hat{q}_F < \bar{q}_F$ or crosses the threshold $\bar{q}_F$ if $\hat{q}_F > \bar{q}_F$.

13. This second condition always holds if $\hat{q}^W > \hat{q}^F$ and trajectories (F) and (W) not crosses.

ii. If $q_t \in [\bar{q}_F, \bar{q}_W]$: two trajectories (F) and (W) correspond to a perfect foresight path. Then between these two thresholds the sequence of q_t can switch from one trajectory to the other. The long term equilibrium is indeterminated. If the sequence of q_t remains on the trajectory (F) (respectively (W)) it converges toward $\hat{q}_F$ (respectively $\hat{q}_W$) if $\hat{q}_F > \bar{q}_F$ (respectively $\hat{q}_W < \bar{q}_W$) or goes below the threshold $\bar{q}_F$ (respectively crosses the threshold $\bar{q}_W$) if $\hat{q}_F < \bar{q}_F$ (respectively $\hat{q}_W > \bar{q}_W$).

iii. If $q_t \in [\bar{q}_W, 1]$: only one perfect foresight path exists which corresponds to trajectory (W). The sequence of q_t converges toward $\hat{q}_W$ if $\hat{q}_W > \bar{q}_W$ or goes below the threshold $\bar{q}_W$ if $\hat{q}_F > \bar{q}_F$.

The following figure illustrates the configuration: $0 < \bar{q}_F < \hat{q}_F < \tilde{q} < \hat{q}_W < \bar{q}_W < 1$.

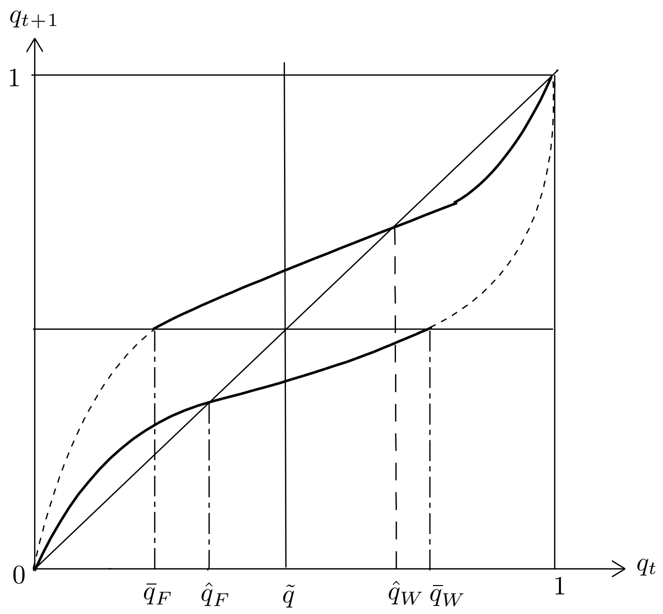

Figure 7.

In this configuration, for all q_0, a date T exists such as $q_T \in [\bar{q}_F, \bar{q}_W]$. The long term equilibrium is then indeterminated. Either $\{q_t\}_0^\infty$ converges toward $\hat{q}_W$ or $\hat{q}_F$ or switch from one trajectory to the other and not converge.

Configuration C.2.

Consider that $\hat{q}^W > \hat{q}^F$ (assumption $d(\bar{s}w - \underline{s}w) > D(d - \underline{s}\, w)$ holds) and $\bar{q}_F > \bar{q}_W$. This case is impossible if $\hat{q}^W > \tilde{q} > \hat{q}^F$[14].

The following figure illustrates the case $\hat{q}_F < \hat{q}_W < \tilde{q} < \bar{q}^W < \bar{q}^F$.

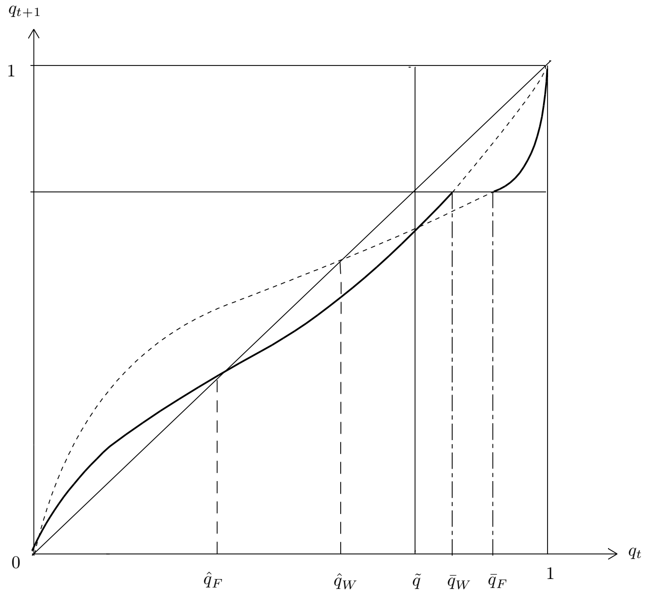

Figure 8.

In this case, the following results held:

i. If $q_t \in [\bar{q}_F, 1]$: by Lemma 6, only one perfect foresight path exists which corresponds to trajectory (W). By Lemma 5, a date T exists such as, following $\{q_t\}_0^\infty$, $q_{T-1} > \bar{q}_F$ and $q_T < \bar{q}_F$. Either $q_T \in [\bar{q}^W, \bar{q}^F]$ or $q_T < \bar{q}^F$.

ii. If $q_t \in [\bar{q}^W, \bar{q}^F]$: by Lemma 6, no perfect foresight path exists. Then if for a q_0 for a date T the sequence $\{q_t\}_0^\infty$ reach $q_T \in [\bar{q}^W, \bar{q}^F]$, no perfect foresight path exists for this initial value of q_t.

14. Indeed $\hat{q}_W > \tilde{q} > \hat{q}_F$ implies $\bar{q}_W > \tilde{q} > \bar{q}_F$.

iii. If $q_0 \in [0, \bar{q}^{\,W}]$: only one perfect foresight path exists which corresponds to trajectory (F). the sequence $\{q_t\}_0^\infty$ converges toward $\hat{q}_F$.

The symmetric results held for the case $\hat{q}_F > \hat{q}_W > \tilde{q} > \bar{q}^{\,W} > \bar{q}^{\,F}$.

Configuration C.3.

Consider that $\hat{q}_W < \hat{q}_F$ and $\bar{q}^{\,W} < \bar{q}^{\,F}$[15].

If $\hat{q}_W < \tilde{q} < \hat{q}_F$ then $\bar{q}_W < \tilde{q} < \bar{q}_F$ and then $\hat{q}^W < \bar{q}^{\,F}$ and $\hat{q}^F > \bar{q}^{\,W}$. Moreover, by proof of proposition 3, $q_t < \bar{q}_W$ implies that $q_{t+1} = W(q_t)$ not corresponds to a perfect foresight path. Then no perfect foresight path will reach $\hat{q}^W$. Symmetrically, no perfect foresight path will reach $\hat{q}^F$. Since $\hat{q}^W$ and $\hat{q}^F$ are the only stable equilibrium, in this configuration no perfect foresight path exist.

The dynamics for $\hat{q}_W < \hat{q}_F < \tilde{q} < \bar{q}^{\,W} < \bar{q}^{\,F}$ and $\hat{q}_W < \hat{q}_F < \tilde{q} < \bar{q}^{\,W} < \bar{q}^{\,F}$ can be directly deduced from the dynamics in the *Configuration C.2.*

Configuration C.4.

Consider that $\hat{q}_W < \hat{q}_F$ and $\bar{q}^{\,W} > \bar{q}^{\,F}$. First, remark that this case is impossible if $\hat{q}^F > \tilde{q} > \hat{q}^W$[16]. The dynamics in the other cases can be directly deduced from the dynamics in *Configuration C.1.*

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15. This second condition always holds if $\hat{q}^W < \hat{q}^F$ and trajectories (F) and (W) not crosses.

16. Indeed $\hat{q}_F > \tilde{q} > \hat{q}_W$ implies $\bar{q}_W < \tilde{q} < \bar{q}_F$.

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