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ORGANISATIONAL CHANGE
AND
HUMAN CAPITAL ACCUMULATION[#]

Eve Caroli[*]
Nathalie Greenan[**]
Dominique Guellec[***]

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[*] INRA and CEPREMAP. INRA: 65 boulevard de Brandebourg, 94205 Ivry cedex, France. Tel : 33 1 49 59 69 95. Fax : 33 1 46 70 41 13. Email : caroli@ivry.inra.fr ; This work has been completed during a one year visit at University College London.
[**] CEE, 29 promenade Michel Simon, Noisy-le-Grand, 93166 Marne-la-Vallee, Tel: (33) 1 45 92 68 44, Fax: (33) 1 49 31 02 44, Email: Nathalie@msh-paris.fr
[***] OECD, 2 rue André Pascal, 75775 Paris cedex 16, France. Tel : 33 1 45 24 93 84. Fax : 33 1 45 24 18 48. Email : dominique.guellec@oecd.org

ORGANISATIONAL CHANGE AND HUMAN CAPITAL ACCUMULATION

We model the links between skills (human capital) and changes in work organisation. As the proportion of skilled workers increases in an economy, it travels through a sequence of organisational equilibria. We show that in developed countries, as the relative supply of skills increases, the organisation of work becomes more decentralised. Both skilled and unskilled workers become more autonomous and perform a wider range of task: decentralisation spreads across firms at the expense of the old centralised organisation based on a strict division of labour. As firms switch to decentralisation, their employment structure becomes more homogenous. When allowing for endogenous skill accumulation, we show that in equilibrium, a high degree of centralisation yields a wider skilled-unskilled wage gap. This gap is also more reactive to knowledge-intensive technical shocks when the economy is initially more centralised. The model hence highlights the importance of organisational factors in explaining the different trends in wage inequality experienced e.g by the United-States, the United-Kingdom and Japan over the past two decades.

Key words: organisational change - human capital - wage inequality

CHANGEMENT ORGANISATIONNEL ET ACCUMULATION DE CAPITAL HUMAIN

Nous formalisons le lien entre qualifications (capital humain) et changement organisationnel. Au fur et à mesure que la proportion de salariés qualifiés disponible dans l'économie augmente, celle-ci chemine le long d'un sentier de changement organisationnel. Nous montrons que, dans les économies développées, l'accroissement de l'offre relative de salariés qualifiés conduit à une décentralisation de l'organisation du travail. Les salariés, tant qualifiés que non qualifiés, deviennent plus autonomes et se voient confier une plus grande variété de tâches: un nouveau modèle organisationnel se développe au détriment de l'ancienne organisation, centralisée et fondée sur une stricte division du travail. Au fur et à mesure que les entreprises adoptent le modèle décentralisé, leur main-d'œuvre devient plus homogène. Par ailleurs, nous montrons que lorsque l'accumulation du capital humain est endogénéisée, à l'équilibre, les économies les plus centralisées sont aussi les plus inégalitaires. L'écart de salaires entre qualifiés et non qualifiés y est non seulement plus élevé, mais aussi plus réactif au changement technique. Le modèle souligne donc l'importance des facteurs organisationnels dans l'évolution différenciée des inégalités, par exemple aux Etats-Unis, au Royaume-Uni et au Japon, au cours des deux dernières décennies.

Mots-clés: changement organisationnel - capital humain - inégalités de salaires

1. Introduction

For several years now, the organisation of work inside firms has been undergoing a tremendous change. The labels given to the new organisational mode are quite diverse: reengineering, delayering, "lean and mean", flexibility, empowerment, outsourcing etc. Beyond the variety of ways taken by firms, and the variety of strategies they carry out, these labels signal a new trend towards more autonomy of workers as middle layers of the hierarchy are suppressed. The organisation of work is becoming more decentralised, as it has been documented in many empirical studies: Osterman (1994) for US manufacturing, NUTEK (1996) for the Swedish economy, Greenan (1996) and Greenan and Guellec (1997) for French manufacturing. This is to be contrasted with the previously dominant scheme, based on a taylorist tradition, which emphasised the advantage of setting precise norms and closely monitoring workers through their specialisation in conception or execution activities (Braverman, 1974).

The literature about organisational change has provided so far four main explanations for this phenomenon. The first one is based on technical change. New technologies allow a more efficient processing of information, both in terms of speed and of cost. It is one key role of hierarchies that is challenged by computers and communication technologies: bosses are increasingly replaced by networks, with direct interactions between workers - Bolton and Dewatripont (1994). A second explanation underlines the role of market instability. In a world characterised by a highly uncertain demand as well as a strong market volatility, firms' competitiveness heavily depends on their ability to react rapidly and costlessly to unforeseen events. In this respect, decentralised work organisations prove more efficient than hierarchical, bureaucratic ones - Aoki (1986). They are more flexible due to their mixing of decision making and implementation. Growing economic instability over the past twenty years, due to macroeconomic forces, has thus led to the diffusion of more decentralised modes of organisation. Third is a shortening in the length of batches, which reduces the economies of scale arising from an organisation based on a strict division of labour. Shorter batches require a high adaptability of the labour force, in order to ensure a quick learning by doing - Greenan and Guellec (1994). Finally, it has been argued - Aoki (1990), Boyer (1991) - that the strengthening of employees' democratic aspirations is challenging hierarchical relationships at the root of the centralised model.

The model presented hereafter puts forward a fifth explanation, namely, human capital accumulation, that is the increase in the skill or educational level of the workforce. The influence of skills upon work organisation has been widely acknowledged in the recent literature - Marsden and Ryan (1991), Soskice (1993)... Our model draws upon this view and accounts for changes in work organisation on the grounds of the share of skilled workers in the labour force. In addition, it tackles two important related issues: the consequences of organisational change on firms' skill mix, and on wage inequality.

Kremer (1993) and Kremer and Maskin (1996) also focus on the relationships between the level of education in the economy, the structure of skills within firms and wage inequality. However, they do not model explicitly organisational change. Changes in productivity affecting wages stem from the properties of the production function they consider (of a o'ring type): efficiency results from the homogeneity of workers employed in the same range of tasks, because tasks are complementary and differentially sensitive to skills, which are assumed to be imperfect substitutes. These characteristics of the production function imply that some cross-matching of skills takes place within firms as long as skill dispersion remains

below a certain threshold, and that relative wages depend on the distribution of skills. Acemoglu (1996) displays similar results, adding that the probability of separating equilibria increases with the proportion of skilled workers in the economy. Our model also generates a higher homogeneity of the skill structure inside firms, but this comes as the outcome of some endogenous organisational change.

Lindbeck and Snower (1996) propose a simple model of organisational change and relate it to increasing wage inequality. The organisational pattern they display is close to ours: taylorist firms specialise workers by occupation, whereas, in holistic firms, workers rotate among multiple tasks. However, one main difference with our approach is that the authors do not consider the content of tasks. They hence draw no link between the nature of tasks and the skills of workers. Their aim is to understand the growing dispersion of wages within occupational, educational and job-tenure groups, more than rising wage inequality between skilled and unskilled workers. As a result, wage inequality arises between workers attached to different types of firms, whatever their skills. Moreover, like in Kremer and Maskin, changes in organisation are fostered by external shocks: advances in production techniques which increase informational task or technological complementarities and advances in human capital which make workers more versatile, thus increasing the return to task diversity. In our approach, workers are allocated to various tasks according to their skills, and organisational change is driven by a long-lasting trend in western economies: the increase in the share of skilled workers - i.e. human capital accumulation - which is ultimately made endogenous.

We propose a simple model based on comparative advantages. Our economy is composed of two types of workers: those who have been through the education system and those who lack any formal education. For convenience in the exposition of the model, we will call "skilled" those workers who have been trained at school and "unskilled" those who have not. Our definition of skills is thus quite narrow: it only encompasses formal knowledge as transmitted through the education system.

Final production requires two parallel activities on the part of workers: knowledge and raw labour production. Knowledge is about the best way to carry out tasks, to sequence them in time and to react to technical hitches or to signals coming from the demand side. It is not given to the firm but produced, on site, through *conception* activities which are time consuming. Once production plans and tasks are designed, some raw labour is required in order to perform them. This is provided through *execution* activities, which consist in the implementation of the whole range of tasks designed through conception activities.

The organisation of work is characterised by the way skilled and unskilled labour combine together in order to produce knowledge and raw labour. Two alternative modes of organisation may be chosen by firms: a centralised mode - the C-model- and a decentralised one - the D-model-[1].

The central feature of the C-model rests on a clear separation between conception and execution activities. The space of activities is closely related to the space of skills. Skilled workers are specialised in task design. Hence knowledge takes the form of norms, orders and assignments which are issued to unskilled workers, specialised in execution activities. Such an organisation makes a full use of the comparative advantage of skilled workers in conception

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[1] This approach is in many ways similar to Greenan and Guellec (1994), although the production functions are quite different.

activities. Indeed, education particularly increases workers' capacity to handle complex information, to abstract, define codes, and take responsibilities.

Firms can also opt for a decentralised organisation, the D-model. In this case, vertical division of labour is replaced by autonomy and self responsibility of workers: whatever their skills, workers have to carry out execution tasks along with conception ones. In this organisational mode, since workers' time is allocated across both activities, the space of activities and that of skills are different.

We opt here for embedding organisation into the production function. The characteristics of work organisation are captured by the functional form itself, rather than - as is usually the case - by a factor added to the production function, the so-called "organisational capital". Such a factor captures the economic value of an organisational pattern, its contribution to productivity, but gives no clue on how the production factors are arranged so as to work together. This is clearly insufficient to reflect the deep structural changes which may occur at a microeconomic or plant level, when the organisation of work is modified. When a firm changes its technology or organisation, this often generates a discontinuity. This discontinuity is not only of a quantitative nature. It is also a qualitative change, involving specific trade-offs: the gains arising from the switch are usually partly outweighed by losses, even though the overall outcome proves positive. There is creative destruction, for organisation as well as for technology. Our approach allows to account for those qualitative - not only quantitative - changes in organisational modes.

Firms choose their organisation in order to maximise profit. This results in an organisational regime, characterised by a distribution of firms over the two modes of organisation - C and D. One key outcome of the paper is that the very nature of the organisational regime which eventually prevails, depends on the supply of both types of labour. In turn, the organisational regime affects the demand for each category of workers, hence their relative price. In the following, we thus study the dynamics of wages and organisational change as skills accumulate in the economy.

A first result is that, as the proportion of skilled workers increases, the dominant form of organisation in the economy changes: when unskilled labour is abundant, unskilled workers are predominantly employed in decentralised organisations where they carry out both conception and execution activities. Skilled workers are more productive than unskilled ones in both activities, but since they are also more costly, firms face a trade-off between greater technical efficiency and a heavier wage bill. As the supply of skilled workers increases, this trade-off softens, which makes it worth for firms to rely on skilled labour in knowledge production. This gives rise to a first phase of increasing centralisation in which cross-matching of skills takes place within firms, skilled workers being specialised in conception activities while unskilled workers provide raw labour. In a second phase, the centralised model dominates in the economy: all workers, whatever their skills, are employed in centralised firms. In a third phase, skilled labour has become cheap enough for firms to start using it both in conception and execution activities. This leads to the spreading of a decentralised mode of organisation at the expense of the old centralised system, with the former finally overtaking in the whole economy.

The pattern of organisational change displayed by our approach is broadly consistent with historical evidence. Over the XIXth century, the taylorist mode of organisation has steadily developed in western countries - Chandler (1962) -, undermining craft production. It

has undoubtedly culminated in the middle of the XXth century with the building up of large hierarchical firms characterised by a strong division of labour. On the contrary, over the past decades, a move towards decentralisation has taken place, leading to a stop in the bureaucratisation process of taylorist firms, and to the development of highly skilled enterprises through outsourcing and firm creation. The shift from decentralised craft production to centralised industrial production induced great changes in the working routines of the unskilled. On the contrary, the shift experienced nowadays implies that skilled workers have to modify the way they work as they progressively loose their hierarchical position: decision making is shared between a greater number of skilled workers who have to handle a wider range of tasks within flatter organisations - Cappelli and Daniel (1996), Aghion and Howitt (1998).

A second result is that, as decentralisation starts to spread in the economy, wage inequality across skilled and unskilled workers stops decreasing. In a centralised regime, the productivity of skilled workers decreases as their number rises, which brings about a steady reduction in the skilled-unskilled wage gap. This is no longer the case as decentralisation develops, so that the reduction in wage inequality is stopped. This is in line with empirical evidence from OECD countries where the downward trend in educational differentials experienced throughout the 1970s got interrupted by the beginning of the 1980s.

A third result is about the nature of the skill mix within firms. In the first organisational phase, the share of skilled workers in the total labour force of centralised firms is constant and decentralised firms employ only unskilled workers. When the centralised model dominates in the economy, the share of skilled workers starts to grow within C firms. In this second phase, cross-matching of skills within firms reaches its highest level. In the third stage, the proportion of skilled workers in centralised firms stabilises at a level which is higher than the one observed in the first phase, and decentralised firms start employing a growing number of skilled workers, who are no longer associated with the unskilled in the production process.

A fourth result arises when allowing for endogenous skill accumulation. In the long-run, the less efficient the education and training system in a country, the more centralised its work organisation and the wider the corresponding skilled-unskilled wage gap. In this view, the higher unit cost of primary and secondary education in the United-States and the United-Kingdom as compared to Japan accounts for the higher degree of centralisation and the wider wage dispersion in the American and British economies. In a more dynamic perspective, we show that, as production becomes more sensitive to knowledge - emergence of "knowledge-based" economies -, wage inequality may increase, with the rise being bigger in those economies which are initially more centralised. This suggests that organisational factors may also be responsible for the diverging trends in wage inequality observed in the US, the UK and Japan over the 1980s and 1990s.

The paper is organised as follows. Section 2 presents the model. Section 3 derives organisational equilibria when skills are exogenous. Section 4 works out the patterns of organisational change under endogenous skill accumulation. Section 5 concludes.

2 - The Model

We consider an economy in which firms produce one homogenous good, consumed by workers. Product and labour markets are competitive. Working population is of fixed size n. Each firm uses two primary inputs: skilled and unskilled workers, and experiments constant returns to scale. Production requires two parallel activities on the part of workers: conception (knowledge production) and execution (direct or raw labour production). The production process combines knowledge (m) and raw labour (l) in the following manner (generic production function):

$$y_t = Am_t^\alpha l_t^{1-\alpha} \qquad (1)$$

where y_t denotes output and A is a technical progress parameter (assumed to be constant in the following).

We assume that skilled workers are more productive than unskilled ones in both knowledge and raw labour production, but that their comparative advantage is bigger at conception activities. Education particularly affects the ability to analyse complex sets of data, as well as to draw synthetic conclusions out of a bulk of various, and sometimes brand new, information. As a consequence, the capacity of skilled workers to conceive and adapt plans of production as well as task designs is higher than that of unskilled workers. Formally:

$$\delta^s > \delta^u \qquad (H1)$$

where δ^s and δ^u denote the respective productivity of skilled and unskilled workers in knowledge production. Because they can better analyse production tasks, skilled workers are also more able in execution activities:

$$\gamma^s > \gamma^u \qquad (H2)$$

where γ^s and γ^u are the respective productivity of skilled and unskilled workers in execution activities. Nevertheless, the related productivity gap between skilled and unskilled workers is assumed to be wider in conception than in execution activities. This builds a relative advantage for skilled workers in knowledge production:

$$\frac{\delta^s}{\delta^u} > \frac{\gamma^s}{\gamma^u} \qquad (H3)$$

We define the organisation of work as an allocation of both types of workers between conception and execution activities. Production can be organised in two ways: one in which workers are specialised in one single activity and one in which they are involved in both types of tasks. In the first model, the workforce is allocated to an activity according to its skills. Work is vertically divided and the corresponding organisational model is said to be centralised. In the second model, work is vertically integrated and its organisation is said to be decentralised.

2.1 The Centralised Model (C model)

In the C model, the combination of knowledge and raw labour depicted by (1) takes place at the level of the firm. Workers are either knowledge processors or raw material processors. Knowledge workers take decisions concerning task design and production plans and monitor their implementation. They are both experts and bosses. Execution workers are in charge of direct production: they provide raw labour and comply to orders issued by the hierarchy.

Each type of worker is specialised in the activity in which her comparative advantage is bigger. So, skilled workers are allocated to conception and unskilled workers to execution activities. It can be argued that, in some circumstances and despite the comparative advantage of both categories of workers in each activity, some mixing could occur: skilled workers performing execution tasks, or unskilled workers performing conception tasks. Taking this possibility into consideration does not modify substantially our conclusions[2], while adding a lot to the analytical complexity of the model. So, we will rule it out in the following. Omitting subscript t, the production function in the centralised model writes:

$$y_c = A m_c^{\alpha} l_c^{1-\alpha} \tag{2}$$

where y_c denotes output, m_c knowledge and l_c, raw labour. Knowledge and raw labour are defined as follows:

$$m_c = \delta^s n_c^s \tag{3}$$

$$l_c = \gamma^u n_c^u \tag{4}$$

where n_c^s and n_c^u are respectively the number of skilled and unskilled workers employed in the C-model. The amount of knowledge that is produced depends on the effectiveness of skilled workers in conception activities (δ^s), while the amount of raw labour available for direct production depends on the effectiveness of unskilled workers in execution activities (γ^u). Finally, the production function writes:

$$y_c = A(\delta^s n_c^s)^{\alpha} (\gamma^u n_c^u)^{1-\alpha} \tag{5}$$

2.2 The Decentralised Model (D model)

In the D model, workers are not specialised in a task. They participate both in conception and execution activities so that the generic production function depicted by (1) is embedded in each worker. Let y_d^i denote the production of an i-type worker (i = u;s) in the D model:

$$y_d^i = A\left(m_d^i\right)^{\alpha} \left(l_d^i\right)^{1-\alpha} \tag{6}$$

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[2] Some calculations have shown that mixing occurs when either skilled or unskilled labour is very scarce. The threshold values of the proportion of skilled labour that trigger a switch in the organisational structure of firms are then slightly modified.

The amount of knowledge produced by a worker of type i (m_d^i) depends both on the fraction of time devoted to conception activities (μ^i ; $0 \le \mu^i \le 1$) and on his effectiveness in knowledge production (δ^i). Formally:

$$m_d^i = \mu^i \delta^i \tag{7}$$

The remaining fraction of time ($1-\mu^i$) is dedicated to execution activities, with productivity γ^i. Hence, the amount of raw labour entering final production is given by:

$$l_d^i = \left(1 - \mu^i\right)\gamma^i \tag{8}$$

Aggregate production in the D model is just the sum of workers' output:

$$y_d = \sum_i y_d^i . n_d^i \tag{9}$$

$$\Leftrightarrow y_d = A\left[\left(\delta^s \mu^s\right)^\alpha \left[\gamma\left(1-\mu^s\right)\right]^{1-\alpha} n_d^s + \left(\delta^u \mu^u\right)^\alpha \left[\gamma\left(1-\mu^u\right)\right]^{1-\alpha} n_d^u\right] \tag{10}$$

where n_d^s and n_d^u respectively denote the number of skilled and unskilled workers employed in the decentralised model. The above specification accounts for two main features of a decentralised work organisation: the autonomy of workers - as opposed to the hierarchical structure of the C-model - and the greater variety of tasks they perform. Whatever their skills, workers decide on their own how to carry out direct production tasks. They do so during the fraction of time allocated to conception activities. In the D-model, knowledge is less formal than in C because it does not need to be translated into norms, orders or assignments. Workers adjust on their own to the situation they face in productive operations. Moreover, since work is vertically integrated, each category of workers performs a wider range of tasks.

Firms allocate workers' time between conception and direct production so as to maximise profit:

$$\begin{cases} \underset{\mu^i}{\text{Max}} \; \pi_d^i = \sum_{i=u,s} A(\delta^i \mu^i)^\alpha \left[\gamma^i (1-\mu^i)\right]^{1-\alpha} n_d^i - w^s n_d^s - w^u n_d^u \\ \text{sc } 0 \le \mu^i \le 1 \end{cases} \tag{11}$$

Solving this program yields: $\mu^i = \alpha \; \forall i$, which implies that time allocation is identical for both skilled and unskilled workers, as it only depends on the elasticity of production with respect to conception activities, α - respectively, to execution activities, ($1-\alpha$). So, the production function in the D-model can then be rewritten as:

$$y_d = A\alpha^\alpha (1-\alpha)^{1-\alpha}\left[\left(\delta^s\right)^\alpha \left(\gamma^s\right)^{1-\alpha} n_d^s + \left(\delta^u\right)^\alpha \left(\gamma^u\right)^{1-\alpha} n_d^u\right] \tag{12}$$

3. Organisational Change under Exogenous Skill Accumulation

As a first step, we assume that the number of skilled workers available in the economy, n^s, is exogenous and growing at a constant pace:

$$n_t^s - n_{t-1}^s = \Delta n^s > 0 \quad \forall n_{t-1}^s < n \tag{H4}$$

In order to determine the corresponding pattern of organisational change, we proceed through a two-step solution. First, we assess firms' organisational choice for given levels of the skilled-unskilled relative wage. Then, we determine market wages under each organisational regime, assuming that both skilled and unskilled labour markets are in equilibrium. This leads to the following conditions:

$$n_c^s + n_d^s = n^s \tag{13}$$

$$n_c^u + n_d^u = n^u \tag{14}$$

$$n^u + n^s = n \tag{15}$$

where n denotes the whole working population.

3.1 Firms' Organisational Choice

A firm can choose to be either centralised or decentralised. It will do so in order to minimise the average cost of production. Under centralisation, this is:

$$AC_c = \frac{1}{A}\left(\frac{w^s}{\alpha\delta^s}\right)^\alpha \left(\frac{w^u}{(1-\alpha)\gamma^u}\right)^{1-\alpha} \tag{16}$$

with the demands for skilled and unskilled labour being:

$$n_c^s = \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}\left(\frac{w^u}{w^s}\right)^{1-\alpha} \frac{y_c}{A(\delta^s)^\alpha(\gamma^u)^{1-\alpha}} \tag{17}$$

$$n_c^u = \left(\frac{1-\alpha}{\alpha}\right)^{\alpha}\left(\frac{w^s}{w^u}\right)^{\alpha} \frac{y_c}{A(\delta^s)^\alpha(\gamma^u)^{1-\alpha}} \tag{18}$$

This mode of organisation is denoted C(u,s) since the organisation of work is centralised and production requires both skilled and unskilled workers.

Under decentralisation, both types of workers are perfect substitutes in the production process - the production function is additive in the output of each category. So, the firm will always choose the cheaper factor, comparing the effective cost of skilled and unskilled labour - respectively $w^s/(\delta^s)^\alpha(\gamma^s)^{1-\alpha}$ and $w^u/(\delta^u)^\alpha(\gamma^u)^{1-\alpha}$. Hence:

i) If the gain in terms of effectiveness brought about by skilled workers is smaller than the additional wage cost they induce ($(\delta^s/\delta^u)^\alpha(\gamma^s/\gamma^u)^{1-\alpha} < w^s/w^u$), the firm employs only

unskilled workers. This mode of organisation is denoted D(u). The corresponding average cost of production is then:

$$AC_{D(u)} = \frac{w^u}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^u)^\alpha(\gamma^u)^{1-\alpha}} \tag{19}$$

with the demand for unskilled labour being:

$$n_d^u = \frac{y_d}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^u)^\alpha(\gamma^u)^{1-\alpha}} \tag{20}$$

ii) When the gain in effectiveness brought about by skilled labour is bigger than the increase in cost $((\delta^s/\delta^u)^\alpha(\gamma^s/\gamma^u)^{1-\alpha}>w^s/w^u)$ the firm chooses to employ only skilled workers and the corresponding organisation is denoted D(s). The average cost of production and demand for skilled labour are then:

$$AC_{D(s)} = \frac{w^s}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^s)^\alpha(\gamma^s)^{1-\alpha}} \tag{21}$$

$$n_d^s = \frac{y_d}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^s)^\alpha(\gamma^s)^{1-\alpha}} \tag{22}$$

iii) Finally, when the increase in cost due to the hiring of skilled workers matches exactly the benefit they bring about $((\delta^s/\delta^u)^\alpha(\gamma^s/\gamma^u)^{1-\alpha}=w^s/w^u)$, the firm is indifferent between both types of labour. The corresponding organisation is named D(u,s) and the average cost of production is:
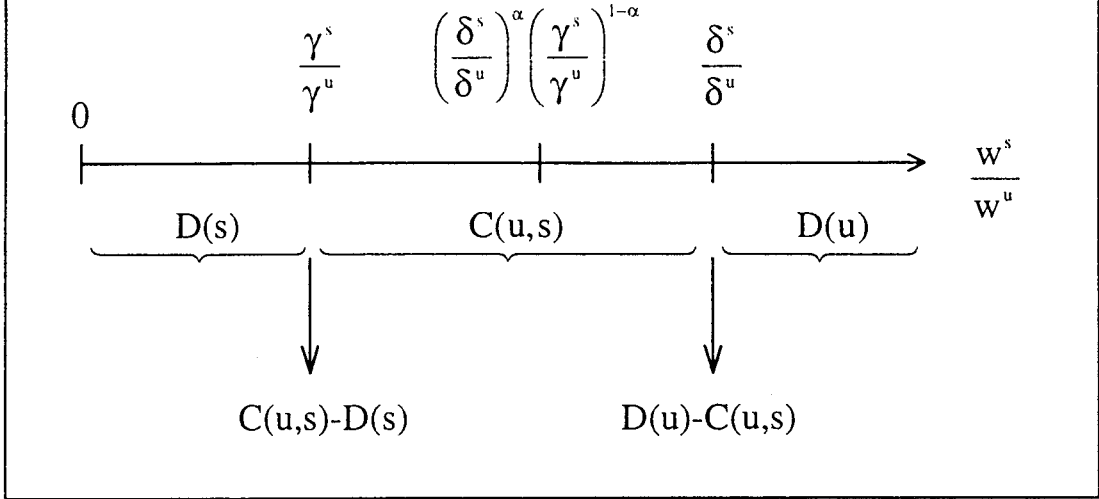
$$AC_{D(u,s)} = \frac{w^u}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^u)^\alpha(\gamma^u)^{1-\alpha}} = \frac{w^s}{A\alpha^\alpha(1-\alpha)^{1-\alpha}(\delta^s)^\alpha(\gamma^s)^{1-\alpha}} \tag{23}$$

D(u) and D(s) are both decentralised organisations, but they differ according to the skill level of their workforce. D(u) can be seen as craft organisation, resting on unskilled workers who carry out the production process from its beginning to its end. In D(u), unskilled workers incorporate some knowledge. However, it does not come from formal education but from practice and experience, acquired during the production process[3]. D(s) is a decentralised organisation of another type as all the workers it employs are skilled, that is they have been through the education system. This type of organisation is to be found in many areas of the service sector: lawyers, consultants, accountants, researchers, software programmers etc.

In order to decide on its work organisation, the firm must compare separately the average cost of production in each of the decentralised modes - D(u), D(s) and D(u,s) - with that under C(u,s). The outcome of this comparison is summarised in figure 1:

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[3] In this case, the terminology "unskilled" may seem improper, but we keep it for the sake of simplicity.

Figure 1 : Firms' organisational choice

$$\frac{\gamma^s}{\gamma^u} \qquad \left(\frac{\delta^s}{\delta^u}\right)^{\alpha}\left(\frac{\gamma^s}{\gamma^u}\right)^{1-\alpha} \qquad \frac{\delta^s}{\delta^u}$$

0

$$\dfrac{w^s}{w^u}$$

D(s)   C(u,s)   D(u)

C(u,s)-D(s)   D(u)-C(u,s)

As far as technical efficiency is concerned, D(u), C(u,s) and D(s) can be ranked as follows: D(u)<C(u,s)<D(s). Skilled workers being more productive in both knowledge and direct production, it is technically more efficient to have them in both activities - D(s) - than in one - C(u,s) -, which is more efficient than employing unskilled workers in both tasks - D(u). However, from an economic point of view, the gain in terms of performance brought about by skilled workers has to be balanced against the additional wage cost they induce. If the additional cost (w^s/w^u) is lower than the gain in both knowledge (δ^s/δ^u) and raw labour (γ^s/γ^u) activities, the firm employs only skilled workers and assign them to both types of activities - D(s). If the additional cost is lower than the gain in conception activities, but higher than that in direct production, the firm will choose to be centralised with skilled workers employed in knowledge production and, correspondingly, unskilled workers employed in execution activities - C(u,s). When gains do not compensate for the cost of employing skilled workers, the firm chooses to employ only unskilled workers and is then decentralised - D(u). Finally, when $w^s/w^u = \gamma^s/\gamma^u$ (resp. δ^s/δ^u), firms are indifferent between D(s) and C(u,s) - resp. D(u) and C(u,s)[4].

The organisational choice of the firm logically depends on relative wages. When skilled labour is relatively cheap as compared to unskilled one, firms choose a skill intensive organisation - D(s) or C(u,s) with a high proportion of s workers - whereas when skills are expensive, C(u,s) - with many unskilled - or even D(u) tend to dominate. In all cases, the skilled-unskilled relative wage is determined by the equilibrium on the labour market.

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[4] No firm ever chooses to be decentralised with both types of workers - D(u,s) - because this mode of organisation is always more costly than a fully centralised one. A firm is ready to hire both skilled and unskilled workers in a decentralised organisation only if $w^s/w^u = (\delta^s/\delta^u)^{\alpha}(\gamma^s/\gamma^u)^{1-\alpha}$. However, if this happens to be the case, C(u,s) is more profitable since the gain in terms of effectiveness due to hiring a skilled worker is δ^s/δ^u in C(u,s) as compared to $(\delta^s/\delta^u)^{\alpha}(\gamma^s/\gamma^u)^{1-\alpha}$ in D(u,s). Given that $\delta^s/\delta^u > \gamma^s/\gamma^u$, $\delta^s/\delta^u > w^s/w^u = (\delta^s/\delta^u)^{\alpha}(\gamma^s/\gamma^u)^{1-\alpha}$. So, whatever the value of n^s, D(u,s) is always dominated by C(u,s).

3.2 Patterns of Organisational Change

As long as $(\gamma^s / \gamma^u) < w^s / w^u < (\delta^s / \delta^u)$ the representative firm chooses a centralised work organisation - see Figure 1. When centralisation dominates in the economy, the relative wage is given by:

$$\frac{w^s}{w^u} = \frac{\alpha}{1-\alpha}\left(\frac{n}{n^s}-1\right) \tag{24}$$

so that any firm chooses to be centralised whenever $n_1^s < n^s < n_2^s$ with:

$$n_1^s = \frac{n}{1+\dfrac{1-\alpha}{\alpha}\dfrac{\delta^s}{\delta^u}} \tag{25}$$

$$n_2^s = \frac{n}{1+\dfrac{1-\alpha}{\alpha}\dfrac{\gamma^s}{\gamma^u}} \tag{26}$$

Proposition 1: For all values of $n^s < n_1^s$, $w^s / w^u = \delta^s / \delta^u$ and the firm is indifferent between $D(u)$ and $C(u,s)$.

Proof

- If $w^s / w^u > \delta^s / \delta^u$, according to Figure 1, the firm would choose $D(u)$. Then $w^s = 0$, so that $w^s < w^u$, which contradicts the above assumption that $w^s / w^u > \delta^s / \delta^u > 1$.

- Accordingly, if $w^s / w^u < \delta^s / \delta^u$, the firm chooses $C(u,s)$. But in this case, for values of n^s smaller than n_1^s, $w^s / w^u > \delta^s / \delta^u$ which contradicts the above assumption.

- Hence, $w^s / w^u = \delta^s / \delta^u \ \forall \ n^s < n_1^s$. QED.

Hence, the employment structure is the following:

$$n_c^s = n^s \tag{27}$$

$$n_c^u = \frac{1-\alpha}{\alpha}\frac{\delta^s}{\delta^u}n^s \tag{28}$$

$$n_d^u = n - n^s\left(1+\frac{1-\alpha}{\alpha}\frac{\delta^s}{\delta^u}\right) \tag{29}$$

When the number of skilled workers available in the economy is smaller than n_1^s, two modes of organisation coexist in the economy: a centralised mode, employing all skilled workers along with some unskilled, and a decentralised one employing only unskilled workers. This regime is labelled $D(u)-C(u,s)$.

Proposition 2: Symmetrically, whenever $n^s > n_2^s$, $w^s / w^u = \gamma^s / \gamma^u$ and a $C(u,s)-D(s)$ regime prevails in the economy. The structure of employment is then:

$$n_c^s = \frac{\alpha}{1-\alpha} \frac{\gamma^u}{\gamma^s}(n - n^s) \tag{30}$$

$$n_c^u = n - n^s \tag{31}$$

$$n_d^s = n^s - \frac{\alpha}{1-\alpha} \frac{\gamma^u}{\gamma^s}(n - n^s) \tag{32}$$

When skills are abundant, the economy is also composed of two sectors: one in which skilled and unskilled workers are employed respectively in conception and execution activities - C(u,s), and one in which the organisation of work is decentralised and all workers are skilled - D(s).

The pattern of organisational choices made by firms can be summarised as follows:

Figure 2 : Pattern of organisational change
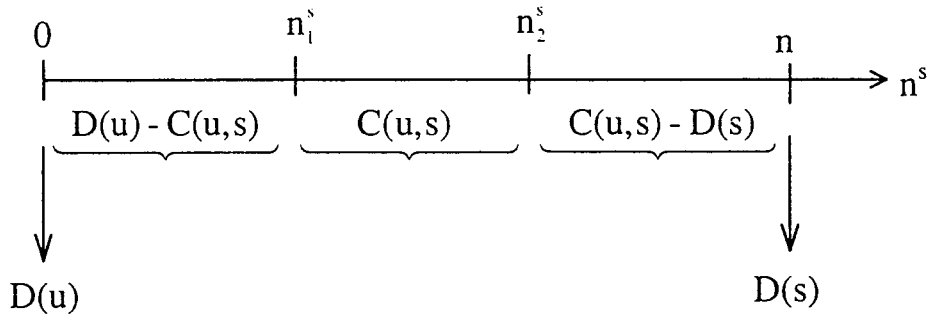
When all workers are unskilled ($n^s = 0$), the firm obviously chooses to be decentralised and the prevailing organisational regime is D(u).

For values of n^s smaller than n_1^s, skilled workers are in such a small number that their relative wage would be extremely high if the whole workforce were employed in the centralised sector. The additional cost induced would not be outweighed by the gain in effectiveness, so that a C(u,s) regime - i.e. all firms being centralised - is inefficient. Hence, two sectors coexist in the economy: a centralised one which hires all skilled workers available along with some unskilled - see equations (27) and (28) - and a decentralised one in which all remaining unskilled are employed. The prevailing regime is then D(u)-C(u,s).

When n^s reaches n_1^s skilled workers are numerous enough for all unskilled to be profitably employed in the centralised sector. There is then one single sector in the economy and the corresponding regime is C(u,s). For all values of n^s ranging from n_1^s to n_2^s, the whole economy remains centralised.

When n^s becomes higher than n_2^s, the unskilled are no longer numerous enough for all workers to be profitably employed in the C model. The situation is then symmetric to D(u)-C(u,s). The economy is composed of two sectors: one in which the organisation of work is centralised and skills are mixed - see equations (30) and (31) - and a second one, which employs all remaining skilled workers in a decentralised organisation. The corresponding regime is C(u,s)-D(s).

Finally, when the entire workforce is skilled ($n^s = n$), all firms shift towards decentralisation. The D(s) regime then prevails.

In summary, according to our theoretical framework, as the supply of skilled workers increases, the economy travels through the following path of organisational change:

$$D(u) \to D(u)\text{-}C(u,s) \to C(u,s) \to C(u,s)\text{-}D(s) \to D(s)$$

In this respect, our model accounts for long-run changes in work organisation. By the time the general level of education was very low all over what is now the industrialised world, most economies were dominated by small businesses, mainly agricultural and craft, organised on a largely autonomous basis. This corresponds to our D(u) regime. As the level of education went up in the XIXth century, vertical division of labour started to develop and gave birth to the modern manufacture, while rural exodus and industrialisation accelerated. Our D(u)-C(u,s) regime provides a stylised account of this transition towards scientific organisation of work, as promoted by engineers like Fayol or Taylor. As economic development went on, and the education level increased in all countries, a wholly centralised organisation started to dominate. This dates back to the first half of XXth century and is sometimes referred to as the "fordist" regime (Boyer, 1991). It was characterised by a sharp cut between conception and execution activities, leading to task specialisation on a large scale. This new step towards centralisation is accounted for, in our model, by the C(u,s) regime in which all firms finally opt for a centralised organisation. Eventually, a new trend in work practices has emerged over the past twenty years which has been characterised by a move towards more decentralisation of responsibility in favour of skilled workers. This is accounted for, in our framework, by the C(u,s)-D(s) regime in which a rising proportion of the skilled labour force is employed in decentralised firms.

Moreover, as the decentralised mode of organisation tends to spread in the economy, wage inequality stops decreasing. In the wholly centralised regime, the relative wage of skilled workers decreases as their number rises which brings about a steady reduction in inequality. This is no longer the case in the C(u,s)-D(s) regime since the proportion of skilled to unskilled workers is now kept constant in centralised firms. As a consequence, the skilled-unskilled wage gap stabilises and wage inequality stops decreasing - see figure 3.

Figure 3 : Pattern of relative wages
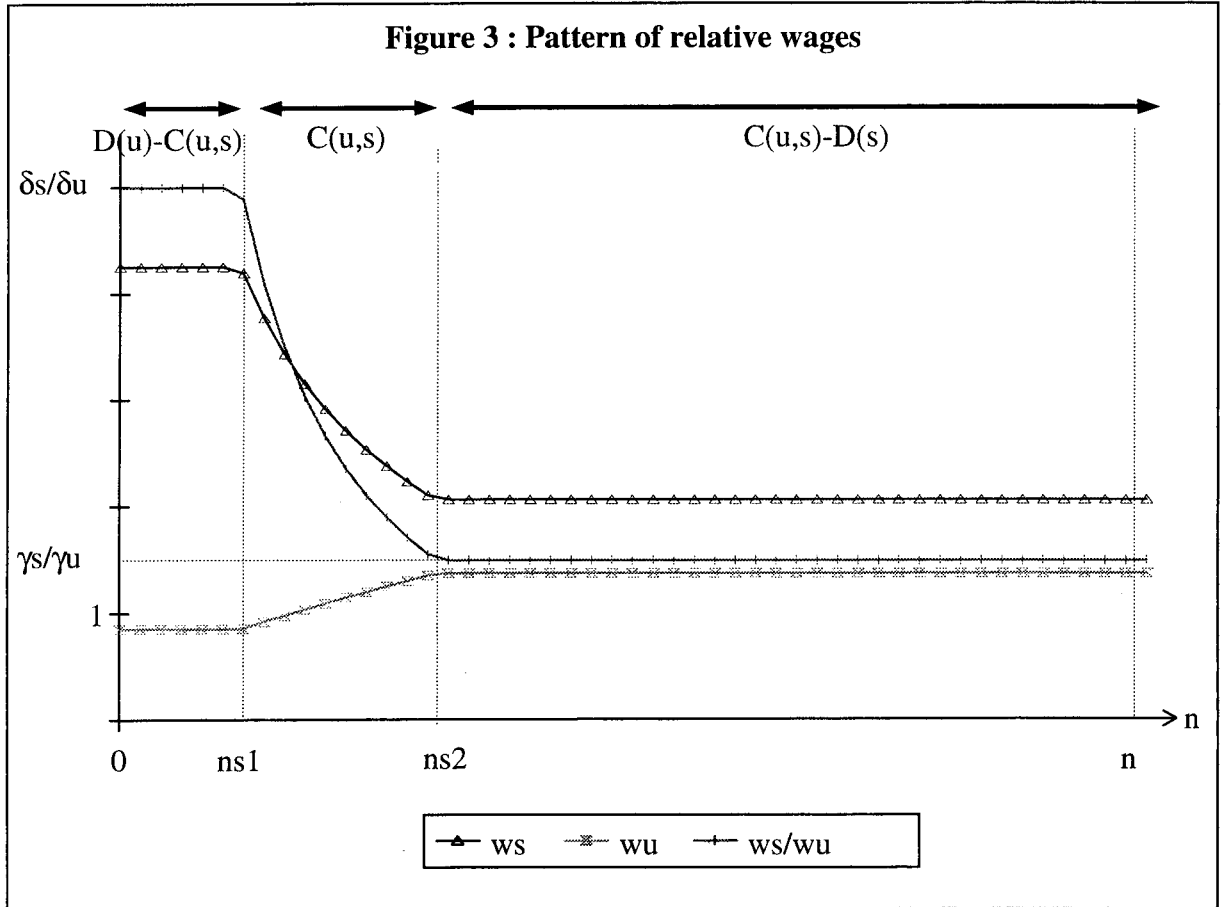
This result is consistent with trends in educational wage differentials experienced by industrialised countries in the 1970s and early 1980s. Between 1970 and 1980, the university/high-school differential decreased in Canada, Sweden, Japan and France, but also in the US and the UK - Machin (1996). These decreases ranged from 5 to 15% according to the countries and stopped by 1980. Between 1980 and the early 1990s, the educational wage gap remained roughly constant in Canada, Japan and France. It increased slightly in Sweden and rose sharply in the US and the UK. So, all major industrialised economies have experienced a stop in the downward trend of educational wage inequality by the beginning of the 1980s. Our model is consistent with this stylised fact since wage inequality stops decreasing as the decentralised mode of organisation starts spreading in the economy. We show below that, if combined with technological changes, it also provides an explanation for the sharper rise in wage inequality experienced by the US and the UK in the 1980s.

In addition to this account of long-run changes in organisation and wage inequality, our model provides some testable predictions.

3.3 Testable Predictions : organisational change, labour force patterns, wages and productivity.

When considering the organisational path displayed by Figure 2 in a cross-sectional perspective and for developed countries - in which D(u) has essentially disappeared -, the model predicts that the more skilled workers available in an economy - the higher the

educational level -, the higher the proportion of the labour force employed in decentralised firms. As stated above, this result deals with cross-country comparisons and should be tested on macroeconomic data. However, a similar prediction can be made at the micro level: the more skilled workers available in its environment, the higher the probability that a firm shifts towards a decentralised work organisation. This prediction has been tested on British data - see Caroli and Van Reenen (1997) - and empirical results definitely support the idea of a positive and significant impact of the supply of skills upon the probability of organisational change.

Second, the organisational path displayed by figure 2 leads to some evolution in the skill mix inside firms - see figure 4.

Figure 4: Labor force patterns
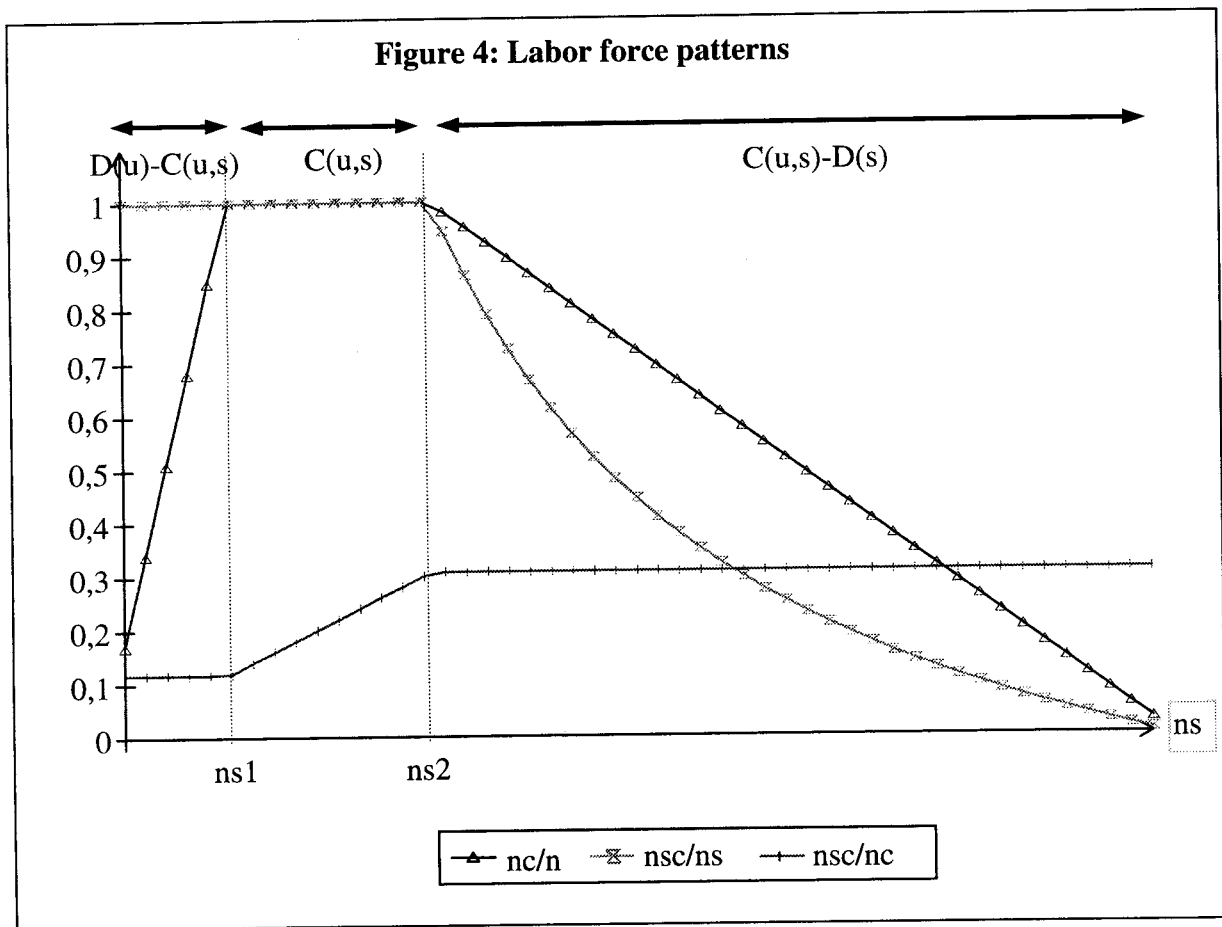
The number of workers employed in the C-model steadily grows while the economy is in the D(u)-C(u,s) regime, stabilises in C(u,s) and starts to shrink when switching to C(u,s)-D(s). Until the end of the C(u,s) regime, all skilled workers are employed in firms organised according to the C-model. The transition from D(u)-C(u,s) to C(u,s) corresponds to a great change in the working conditions of the unskilled: they are progressively excluded from knowledge production and, thus, loose their autonomy. When the economy switches to C(u,s)-D(s), the share of skilled workers employed in centralised firms starts to decrease. In this second phase of transition, while unskilled workers are still specialised in execution activities, skilled workers experience an alteration in the way they work as they progressively loose their

hierarchical position in organisations where they now have to conceive and implement a whole range of tasks.

In the D(u)-C(u,s) and C(u,s)-D(s) regime, the share of skilled workers in the labour force of centralised firms is constant and two sectors coexist in the economy: a sector where the labour force is homogeneous within firms (D(u) in the first regime, D(s) in the second one), and a sector where skilled and unskilled workers are matched together (C(u,s)). In the C(u,s) regime, cross matching of skills is at its highest level (all workers are employed in centralised firms) and the share of skilled workers within firms grows: more skilled workers participate in conception activities whereas less unskilled perform direct production.

On a longitudinal basis, the model predicts that in the C(u,s)-D(s) regime, as the share of educated workers increases in the economy, a growing fraction of the skilled workforce becomes attached to firms which mainly employ educated workers. At the microeconomic level, the corresponding prediction states that, as decentralisation takes place, firms' skill structure should become more homogenous. Our theoretical framework does not tell much about the dynamics of skills at the firm level during the transition from a centralised to a decentralised model. In fact, this transition may undertake two different forms: (i) the creation of new firms organised according to the D(s) model while some C(u,s) firms are destroyed[5] , (ii) a progressive transformation of C(u,s) firms into D(s) ones leading to a sharp drop in the ratio of unskilled to skilled workers. It is rather difficult to measure transition through creation and destruction of firms because newly created, as well as newly destroyed firms, are harder to survey than older ones. However, some empirical evidence on the correlation between organisational change and trend in skill mix within surviving firms is available for France and the UK. For French manufacturing firms in 1987, Greenan and Guellec (1997) show that the autonomy of workers on the shopfloor, as well as the intensity of communication among workers are both negatively correlated with the proportion of unskilled manuals. Using another data source on manufacturing, Greenan (1996) finds that firms which have implemented changes towards more decentralisation and flexibility between 1988 and 1993 have increased their share of skilled workforce. This result is also supported by empirical evidence on British establishments in the 1980s - Caroli and Van Reenen (1997): the proportion of unskilled manuals in 1990 is noticeably lower in those firms which have introduced organisational change over 1981-1984.

Third, the shape of the aggregate production function generated along the path of organisational change is as displayed in figure 5.

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[5] This may happen through the development of start-ups of a D(s) type which challenge old C(u,s) firms on their market, but also through the splitting up of C(u,s) firms into C(u,s) and D(s) firms. Downsizing and out-sourcing of non core functions may witness the latter type of transition.

Figure 5: Agregate production function
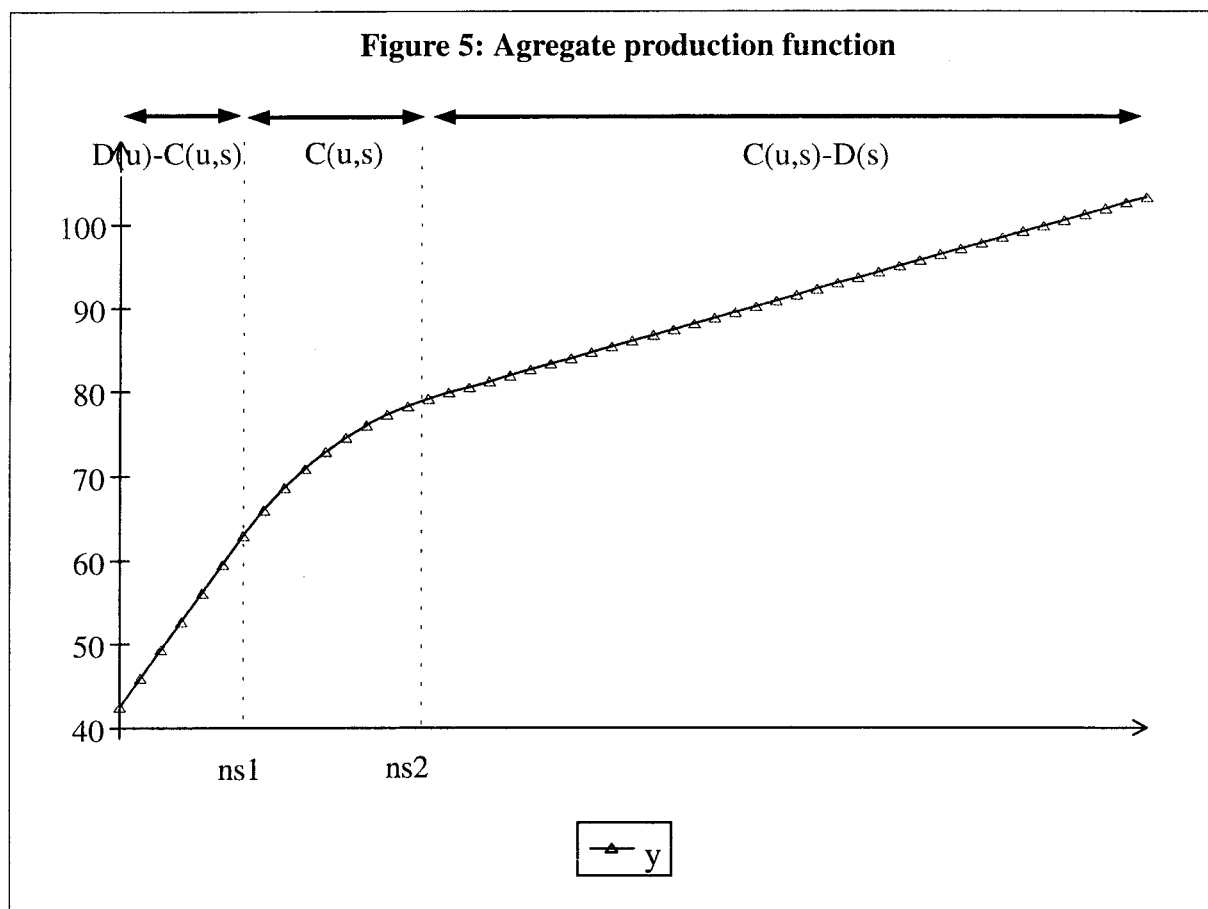
In the D(u)-C(u,s) regime, the productivity of education is higher than in the other two regimes. When the transition to the C(u,s) regime occurs, this productivity starts to decrease, and continues to do so until the C(u,s)-D(s) regime is reached. When shifting to C(u,s)-D(s), productivity stabilises at a lower level than the one observed in the D(u)-C(u,s) regime. This trend suggests that the returns to education are decreasing at a macroeconomic level when organisational change is taken into account. This proposition could fruitfully be tested using cross-sectional macroeconomic data.

4. Organisational Change under Endogenous Skill Accumulation

As a second step, we allow skill accumulation to be endogenous. Workers decide to invest or not in education by comparing the cost of this investment with the gain from it in terms of relative wage.

4.1 Endogenous skill accumulation

We assume here that workers' utility depends both on their current wage (received at the end of period t), and on the effort spent on education (at the beginning of period t). Agents live for one period only and decide whether to train or not before entering the labour market.

The utility of agent i (U_t^i) increases with his wage and decreases with his effort in education (e_t^i).

$$U_t^i = F(w_t^i, e_t^i), \quad (i = u;s),$$
(33)

with : $\dfrac{\partial F}{\partial w_t^i} > 0, \quad \dfrac{\partial F}{\partial e_t^i} < 0$
(H5)

To go one step further in the analysis of the training dynamics, we specify workers' utility as:

$$U_t^i = \frac{w_t^i}{1 + e_t^i}$$
(34)

The education effort is of course nil for those workers who remain unskilled, so that:

$$U_t^s = \frac{w_t^s}{1 + e_t^s}$$
(35)

$$U_t^u = w_t^u$$
(36)

Workers invest in education - n^s increases - as long as:

$$U_t^s \geq U_t^u$$
(37)

So that the dynamic equilibrium of the model is given by[6] :

$$\frac{w^s}{w^u} = 1 + e^s$$
(38)

Workers keep investing in education up to the point where the private benefit from it becomes equal to the related cost.

The precise characteristics of this equilibrium depend on the shape of e^s. It is likely that the cost of educating one pupil increases with the proportion of educated workers in the population. The reason for this is that pupils are heterogeneous: they do not have the same initial level of human capital. As stressed in many pieces of theoretical, as well as empirical work, this is mainly due to the fact that human capital is partly inherited. The microeconometric literature on returns to education shows that the socio-economic background - and in particular, the educational level of parents - strongly influences pupils'

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[6] This dynamical equilibrium can be worked out as the fixed point of a fully specified overlapping generation model in which workers decide to invest or not in skills before entering the labour market. Those who choose to remain unskilled earn w^u during a working life of length p. Those who choose to become skilled have to spend p_s years at school (p_s fixed) and then earn w^s during (p- p_s) years. Such a model exhibits a complex transitory dynamics but its long-run equilibrium is still given by (38) where e^s is interpreted as the fraction of a working life that has to be spent at school in order to become skilled.

performances at school - Coleman (1966), Card and Krueger (1992). This signals some past-dependency in human capital and accounts for persisting heterogeneity, as long as the returns on within-family accumulation are non-decreasing - see Benabou (1996). Heterogeneity is clearly displayed by international test scores: standard deviation in achievement at age 13 ranged from 13% of the mean (for reading) to 32% (for maths) in France in 1991, and from 16% to 38% in the United-States - Bishop (1993). Given this dispersion in the distribution of human capital, the cost of turning one child into a skilled worker varies across children.

As the proportion of skilled workers increases in the population, this cost rises since the schooling system has to deal with children with ever lower initial levels of human capital. For instance, in France 64% of an age group succeeded at the "baccalauréat" in 1995-1996, as compared to only 33% in 1980-1991. Meanwhile, the average cost of a high-school student expressed in 1995 Francs jumped from 31 400 in 1980 to 42 900 Francs in 1995 (see DEP, 1996, 1997).

This assumption writes:

$$e^s = g(n^s) \qquad g'>0 \qquad\qquad (39)$$

### 4.2 Organisational Equilibria and Cross-Country Comparisons

In this simple model, the dynamic equilibrium is unique. The economy converges towards a D(u)-C(u,s), C(u,s) or C(u,s)-D(s) regime according to the level of the cost curve - see Figure 6:

Figure 6 : Organisational equilibrium
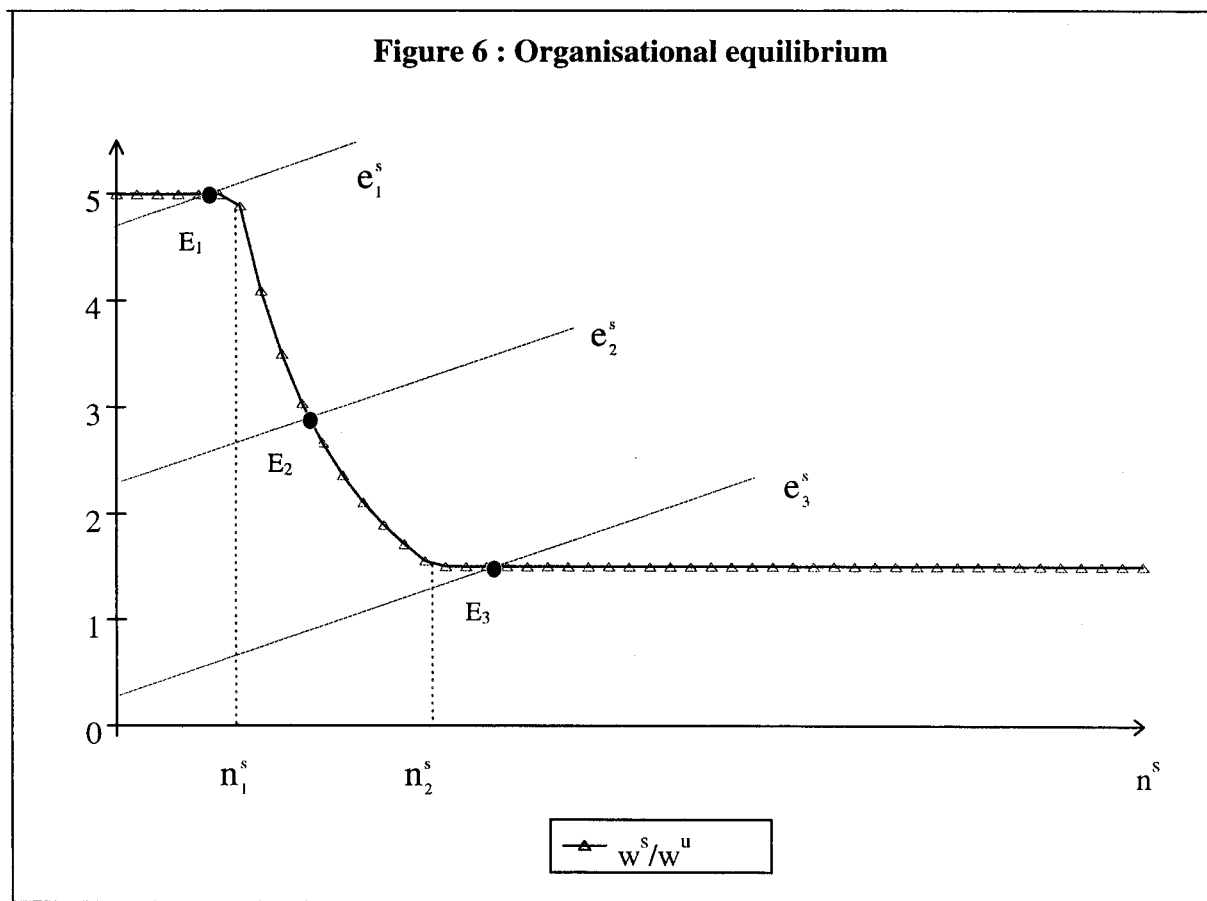
For very high levels of cost (e_1^s), the equilibrium value of n^s is very low and the economy ends up in a D(u)-C(u,s) regime with some firms still decentralised with only unskilled workers, while others are already centralised. For lower values of the cost, the long-run value of n^s is higher and the dynamic equilibrium is characterised by a Taylorist organisation (e_2^s) or even a mixed C(u,s)-D(s) regime (e_3^s).

Overall, the model predicts that, in developed countries, the more efficient the education and training system in an economy - the lower its cost - the more widespread the decentralised mode of organisation and the less unequal the wage structure. In this respect, it provides an explanation for the major differences in work organisation and wage inequality observed, for example, between the US and Japan. Comparisons across national education systems have long pointed to the fact that, at primary and secondary levels, Japanese schools are more effective than American ones - Mishel and Frankel (1991), Marsden and Ryan (1991). This is confirmed by OECD data. For primary and secondary education, expenditure per student amount to 25.2% of GDP per capita in the US (1991) as compared to 18.9% in Japan. The higher cost for the US is not accounted for by a higher output, i.e a higher proportion of secondary graduates in the reference age group[7] . On the contrary, Japanese graduates were 91.1% in the 17-year old age group as compared to 73.9% in the US - OECD (1993). According to our model, this lower cost of education in Japan accounts for the more widespread development of decentralised work organisation in this country - Koike (1988). Symmetrically, the low effectiveness of the education sector in the US allows for the persistence of a highly hierarchical work organisation. This difference in organisational structures across both countries also accounts for the higher level of wage inequality in the US. The ratio of the 9th to the 1st decile of the wage distribution has steadily been higher in the US than in Japan - see Figure 7:

Figure 7: Evolution of wage dispersion: D9/D1

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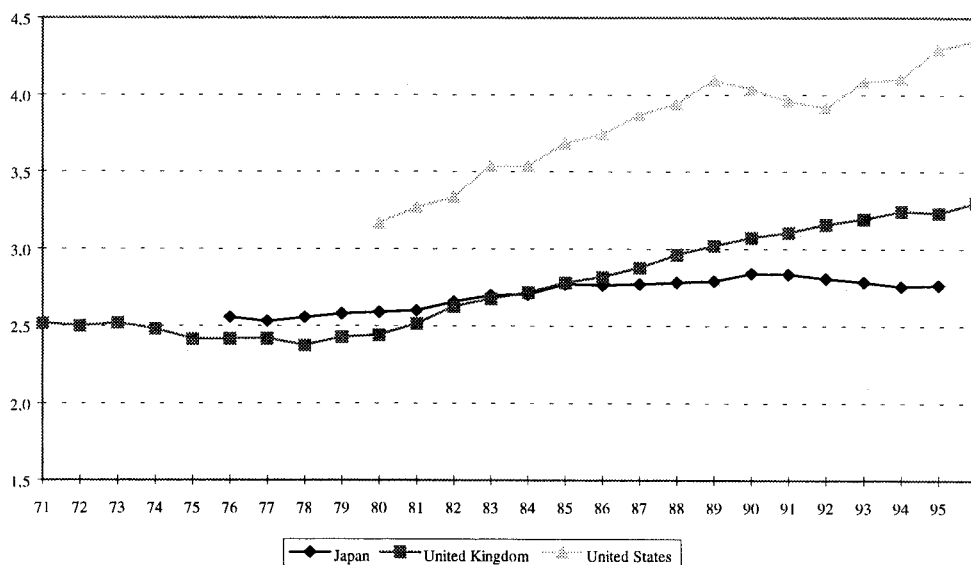
[7] Which could have implied that the US are higher up on the same cost curve as Japan.

This is accounted for, in our model, by the US being further upstream in the process of organisational change. Due to a higher cost of education, the long-run value of n^s is lower in the US than in Japan - see Figure 6, points E_2 for the US and E_3 for Japan -, so that the proportion of centralised firms in the US is higher than in Japan in equilibrium. Though the OECD Educational Outlook (1993) does not report educational expenditure for the UK, the efficiency of British secondary education appears to be quite low - see Keep and Mayhew (1988). So, according to our stylised framework, the US and the UK should be quite similar with respect to the long run value of n^s and, hence, the organisational equilibrium. The proportion of centralised firms in Britain is hence bound to be higher than in Japan.

When taking into account the role of information and communication technologies, the model also accounts for another stylised fact, characteristic of Anglo-Saxon economies in the 1980s, namely the rise in wage inequality - see Aghion et al. (1997). It is widely argued in the literature that information and communication technologies have increased the productivity of knowledge in the production process. This translates, in our framework, into an increase in the elasticity of production to knowledge - α. This assumption summarises the current view that developed economies have recently become more 'knowledge based' (Foray and Lundvall, 1996). The idea here is that thanks to computers and phones, one unit of knowledge produced in conception activities becomes more valuable for the firm for two reasons. First these technologies make the processing, storage and communication of knowledge within the firm more efficient. Second, they allow to benefit more from the knowledge produced elsewhere in the economy, because they make it easier to be connected to other firms or institutions through networks. The return to knowledge may also have increased because, more and more firms compete on their ability to master all dimensions of their own production process (quality, flexibility, diversity) through the rationalisation of their information system. If this is so, according to our model, wage inequality should increase and this rise should be all the bigger that the economy is initially more centralised. This is illustrated by figure 8 - see following page.

If the return to knowledge increases, then the relative wage curve shifts out. As a result, an economy that is initially in an equilibrium such as E_2 will see its relative wage rise from rw_2 to rw_2'. This increase is bigger than the one experienced when starting from a more decentralised equilibrium such as E_4. It can also be noticed that, if the economy is initially largely decentralised (E_3) wage inequality does not change in response to the technological shock.

This result accounts for the very different trends in wage inequality experienced by US or the UK, and Japan over the past 15 years. It is now well documented that information and communication have rapidly diffused in most industrialised countries over the past two decades. In the meantime, wage inequality has increased very fast in the US and the UK while it has remained roughly constant in Japan - see figure 7. Our model explains both trends. All over the world, the diffusion of information and communication technologies has increased the return to knowledge as compared to raw labour. In highly centralised economies - such as the US and the UK - the demand for skilled workers has thus increased, leading in a first step to a jump in their relative price. As supply started to adjust, the relative wage went down. However, since the supply curve is not perfectly elastic to prices, the relative wage did not go back to its initial level - see E_2 and E'_2 on Figure 8: over the last two decades, wage inequality

Figure 8 : Wage inequality in the Knowledge based economy
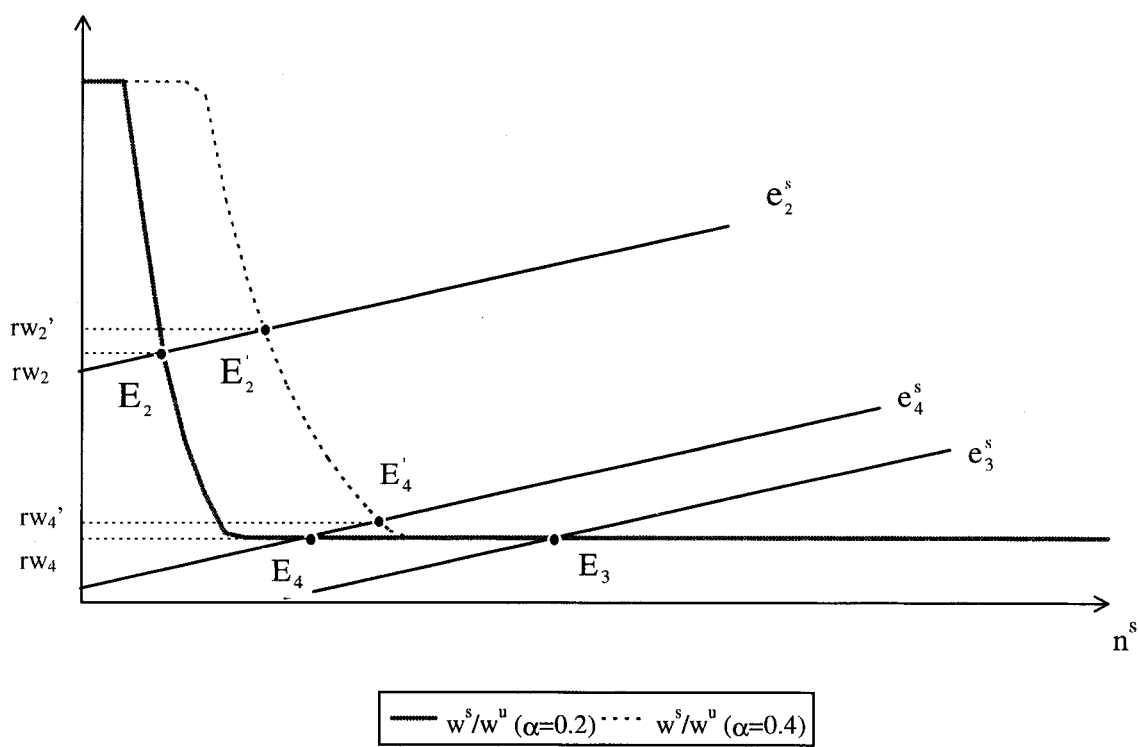
has increased in the US and the UK. In Japan, the organisation of work was already highly decentralised at the beginning of the period so that the diffusion of information and communication technologies has not induce any change in the relative wage - see E_3 on Figure 8. In our framework, its only consequence is to increase the proportion of skilled workers employed in the centralised sector. The reason for this is that their relative advantage in knowledge production is best exploited in centralised firms, while conception becomes more important in the production process.

Our model implies that the development of more knowledge-based economies may have contributed to increase wage inequality through changes in work organisation. It emphasises the role of organisational change in explaining why wage dispersion has increased faster in the US and the UK than in Japan over the past 15 years.

5 - Summary and conclusions

The model presented here exhibits a sequence of organisational equilibria generated by an increase in the share of skilled workers in the labour force. In parallel, a time pattern is generated for skilled and unskilled wages. The model yields four main results.

First, as the proportion of skilled workers increases exogenously in the population, the economy travels through three main organisational equilibria: when skilled labour is scarce the organisation of firms is rather decentralised; as the stock of skills increases, the economy progressively shifts to a more centralised regime, before switching back to decentralisation when skilled labour is abundant. Such a pattern is consistent with historical evidence. In particular, the past two decades have seen the emergence and diffusion of new modes of organisation, characterised by a greater autonomy of workers. The increasing share of independent workers and small firms in the labour force is consistent with this trend. Although many studies have stressed the role of technical change (the changing size of increasing returns to scale) as well as institutional factors (competition policies) in this evolution, our model shows that the accumulation of human capital stands as another candidate.

Second, as a decentralised mode of organisation starts to spread in the economy, wage inequality stops decreasing. This is consistent with evidence from most industrialised countries in the 1970s and early 1980s.

Third, as the economy switches from a centralised to a decentralised regime, firms' skill structure becomes more homogenous. This result is consistent with previous findings in the theoretical literature as well as with empirical evidence - Acemoglu (1996).

Last, when allowing for endogenous skill accumulation, we show that the less efficient the education system in a country, the more centralised its work organisation and the more unequal its wage structure. We also show that, as information and communication technologies develop, the skilled-unskilled wage gap may increase with the sharper rise in those countries which were initially more centralised. This provides an explanation for the rise in wage inequality in the US and the UK and the roughly constant distribution of wages in Japan over the past two decades, with work organisation playing a crucial role.

As underlined earlier, our model suggests some directions for empirical research. At a theoretical level, one interesting research avenue would aim at enlarging our definition of organisation, so as to take into account the communication dimension. We have defined the centralised and decentralised modes of organisation with respect to the degree of autonomy awarded to workers, as well as the range of tasks they performs. This view of organisation is somewhat restrictive and does not allow for any difference in the productive mechanism at work in the D(u) and D(s). However, both organisations differ at least in one respect: when employing a high proportion of skilled workers, a decentralised firm is more able to insert into communication networks. The reason for it is that education enhances workers' ability to formalise and codify knowledge, two conditions required for an efficient communication to take place. Skilled workers are not only more capable in conception activities, they are also more able to benefit from the knowledge of other workers through communication. A general theory of organisational change should aim at combining the approach in terms of autonomy developed here and an approach based on communication. This avenue is still to be investigated.

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