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Is A Biased Technological Change Fuelling Dualism?

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(very preliminary version)

I. Introduction : A period of "transition" with lasting effects ?

Over the past two decades major structural changes have affected the economic growth of developed economies. For one, a cluster of radically new technologies centred around information and communication technologies, have emerged. Other notable changes include the (far ranging) internationalization of markets, financial capital and production processes ; and the transformation in work in general and the structure of the labour force in particular. The effects of such major changes are often considered transitory or resulting from uncertainty and risk-adverse reactions that will disappear in time through experience and learning.

Our understanding of the productivity paradox (as ICTs are diffusing at work and in the home we do not seem to notice in official statistics the benefits of these technologies) underlines the many sides and different dimensions of this transitory phase. The productivity paradox appears to encompass learning processes at all levels : at the firm level where efficient uses of new technologies are heavily dependent on other users, be it subcontractors, customers or other firms and partners ; at the level of the technology producers, where producers adjust equipment to different user needs, and are confronted with different technical standards at a world wide level ; and at the consumer level where cultural barriers play their role in slowing down particular "practices" in some cases, while building up barriers to access in other cases. Such a nexus of only loosely related learning processes gives strong credit to the assumption made by authors such as Paul David or Chris Freeman that the so-called transition from one technological system to another may well last a long time, as in the case of the diffusion of the dynamo and electric power (see a.o. David (1991), Freeman, (1987).

Although this new transition obviously presents many new features (e.g. its worldwide nature which is a central characteristic) that may limit the comparison, the particular role of the many learning processes involved points to the importance of analytical studies focusing on the process of technical change currently underway and the many unexpected and complex interactions with other structural changes operating in the economy at large. It is within this broad "appreciative" theorizing

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framework (to use Richard Nelson's (1995) term of past informal research on growth and technology) that we present these first reflections which obviously still require empirical grounding but might stimulate debate and further research.

We are well aware, if only by a Hicksian tradition of the traverse that transitional periods have specificities of their own (Amendola Gaffard (1988), and by the Schumpeterian revival of evolutionary theory (from Nelson and Winter (1982), Dosi et al. (1988) to Arthur, (1989), that the paths taken may be largely irreversible and that the evolutionist nature of our developments could lead to totally transformed or conditioned sets of policy choices at the end of this so called "period of transition". This "risk" is all the more apparent if some internal logic is at play which reenforces itself in deepening some specific bias, acting thus as some cumulative processes of the kind identified on other grounds by Myrdal (1957) and Kaldor (1972)³.

Three stylized facts broadly hint that such internal logic could be applicable and that some of these cumulative processes could further split our societies and limit their ability to offer fair conditions of personal and collective development to their citizens in the future. Without being too emphatic, it seems worthwhile to investigate, even in a very tentative way what these cumulative processes and their order of magnitude might be. The three stylized facts mentioned above can be loosely assessed as follows :

1. Growing income inequalities

Inequalities have increased in nearly all OECD economies over the last two decades. While the situations differ strongly amongst countries and the type of income we consider (family or personal, before or after taxes and specific allowances, etc.), there is a clear general trend within the industrialized world of an increased spread in wage incomes (see and Atkinson et al. (1995), Gottshalk (1993), Freeman and Katz (1993), Sharpe and Zyblock (1996)). As economic growth has slowed down, some past trends in income distribution have been maintained (the life earning cycle of some professionals), some have been curbed down (the income of some middle groups) and some have been reversed (through income redistributive policies or through the maintenance of resources to persons unable to work or find themselves in the work-poverty trap).

These shifts reveal differences in tactical and strategic abilities of public and private agents. Some private agents take advantage of the new labour market situation and access new sources of income (as brought about by financial gains). Other private agents, such as specific social groups, are too weak to do so. Public agents are often unwilling to redistribute income in line with past trends of the welfare state, largely pressed by some latent fiscal revolt (this ranges from the infamous California balanced budget amendment to the fiscal crisis of the Swedish welfare model) as illustrated in the many anti-redistributive tax reforms undertaken at the same time.

³ Somehow the endogenous growth theory, with the seminal works of Romer, has been inspired by this tradition stressing the external effects of increasing returns.

2. A skilled biased technological change

Technological change, which has a broad systemic dimension and involves the reorganisation of many tasks and activities, appears to display a strong skill bias (see Howell and Wolff (1992), Berman, Bound and Griliches (1994), Card, Kramarz and Lemieux (1995), Machin (1996), Nickell (1996)).

Again, there may be numerous reasons for such a skill-bias. It is not always directly linked to the nature of the specific technological change but can be due to some concurrent phenomena. Systematically opting for higher skilled workers can be a way for firms to face uncertainty. In recent years innovators are increasingly prepared to pay for with higher skill level workers as the costs associated with the tangible part of new investments (i.e machinery) are less costly than in the past. Furthermore, the trade effect (the development of trade with low wage countries), although difficult to separate from the technological change effect, also contributes to some skill bias by further specializing developed economies into production activities that require more skilled labour and/or advanced technologies.

3. Unnoticed consumer surplus

Products and services have undergone large and interrelated quality changes in terms of their content and conditions of use. Consumers are not always able to fully appreciate these changes. The debate on the mismeasurement of price indexes and real values (see The Boskin Report, December 1996) shows that this phenomenon has a macroeconomic order of magnitude (price inflation would have been overestimated by some 1.1 percent a year over the last two decades, two thirds of which would directly be linked with the omission of quality improvements). The extent of this underestimation suggests that quality improvements may be perceived in very different ways by different consumers. This is consistent with surveys on consumption that stress the importance of social differences in attitudes towards new technologies. Consumers are in very different positions to organize their time and consumption when this requires specific competencies and information. The extent of the changes also implies that users will need to spend time in learning processes before adjusting their choices in "connaissance de causes".

Our contention is that the dynamics between the three general trends mentioned above can very well be linked in ways that are mutually reinforcing : the technologically driven skill bias puts downward pressures on wages of the less qualified, limits the scope of their on-the-job training and hence reinforces the rising (wage) inequalities, while fueling a dualisation and specialization in consumption patterns. On the other hand, differences in consumption influence the structure of the labour force's qualifications, if only indirectly through some learning "through consumption": using processes in consumption which can effectively be considered as some form of training. Such learning appears then a factor that increases inequalities by limiting the possibilities of some to reap the advantages of more comprehensive consumption patterns. Finally, rising inequalities might itself

further split the qualifications of the labour force through various education and training vicious circles reinforcing effectively the spontaneous bias of technical change.

Although these assumptions seem to be realistic, clarification and empirical findings are needed to appreciate the extent to which the link between the above mentioned issues and their importance can be assessed. To do so we concentrate our investigation on the productivity paradox at the macroeconomic and sectoral levels.

We begin with an overview of the general relationships that may exist among the organization of work (of which the distribution of skills is part), the dynamic of demand (which includes the existence of consumer surplus and its distribution) and the overall growth dynamic of an economy (as assessed by the growth rate of labour productivity at the national level ; section II). We proceed taking a bird's eye view of the productivity paradox and its distribution (section III).

To feature the relationships evoked in section II, we shall sequentially examine the main findings regarding the skill bias effect of technological change (section IV) and the social bias that is likely to affect the aforementioned consumer surplus (section V). We will then be in position to come back to our initial assumptions and to conjecture on how income inequalities can influence the linkages between the above two processes. The main objective of our contribution at this stage is, it should be remembered, to highlight some questions for further investigations and policy perspectives.

II. Investigating the productivity paradox

Our assumptions can be approached in broad terms as follows. Technological change transforms, in related ways, both production and consumption. External economies (or complementarities) link these two transformation processes, which can have positive or negative effects on economic growth. Many types of such cross-linkages can be of many kinds, they are similar to the externalities retained in some endogenous growth models à la Lucas or Romer. Of special interest are the interactions that take place between the internal structures of the two processes. Skill structures influence the changes in patterns of consumption and reciprocally the class structure condition influences the shifts in the skill structure.

In the following section we attempt to select in each process the externalities which are the most relevant to account for the contemporary dynamics of economic growth and the productivity paradox that goes along with it.

It is useful to look at several aspects of the productivity paradox. First, we are concerned with the productivity of labour at the national level which is an indicator of economic growth. Second we assess the part played in this growth process by some learning processes on the production side and on the demand side. Furthermore we suggest that these two processes may be linked ; similar to the way in which learning by doing and learning by using are linked in some activities. Third, the

phenomenons under view have a strong sectoral dimension, whether it concerns skill bias in the reorganisation of work or the distribution of hidden consumer surplus. In effect the productivity slowdown is more marked in some activities and is difficult to measure (according to Griliches (1994) three quarters of the output of the computer industry goes to activities where real output cannot be measured). Fourth the above assumptions do not exclude other contributions to the productivity paradox such as those stemming from some technical problems of measurement (tied to the use of aggregation of detailed items or to the use of some specific indices formulas).

1. Two learning processes

We begin our analyses with a very general approach of what we call the learning processes on the production side and on the demand side⁴. These two "black boxes" have been extensively debated in the economic literature. Numerous studies have looked at the dynamics of production. One could begin with Adam Smith's approach to the division of labour following the extension of markets. Some Marshallian notions of the industrial district are also good illustrations of such "meso" learning processes as well as Allyn Young's (1928) view tying the extension of markets with a division of labour stimulated by the dynamics of product and process innovations. Solow's (1957) work clearly constitutes a very explicit step to account for increasing efficiency on the production side, though this schematization of technical change is an entirely exogenous "learning process". Contemporary endogenous growth theory overcomes this shortcoming by combining the above approaches. Crucial assumptions made by Lucas, Romer and others on the positive external effects of accumulating tangible or intangible capital, of training, and of developing infrastructures and logistics of services, are featured as central representations of the learning processes at work on the production side.

Similar schemes exist on the demand side, although they are treated less frequently in terms of learning or adjustment processes (for example, by referring to a time function affected by the levels of experience, capital, etc, reached at each period). Diffusion processes of new products are evidently taking such perspectives, whether they invoke the imitation effect in the epidemic model or changes in purchasing power as in the probit model of diffusion. More generally, analyses which show consumption patterns of different social groups that are themselves imitating others or differentiating themselves from others as time goes by and prices change or the distribution of wealth evolves, are invoking similar "broad learning processes" on the demand side.

⁴ The use of the term "learning process" is of course metaphorical, as it is rather a combination of various time processes, some of which could be referred to as real micro economic learning processes. The "global" use we make of the term will nevertheless become clearer as we proceed.

2. Linkages

An issue less frequently raised, though important, is the interdependence between the two learning processes. Kaldor (1972), rethinking the cumulative causation model he associated with Allyn Young's approach of the dynamics of production and with Gunnar Myrdal (1957)'s insight of cumulative processes, did stress, along with the role of intermediation as realized in most service activities, the importance of linking the two learning processes. The relationships involved in linking the two rather separate processes can be either functional, institutional or ethical. In effect the above relationship can be functionally embedded in the very structure of the production and consumption processes, as exemplified with the past development of mass production and mass consumption within one country. It implied, for instance, that patterns of consumption of final durable goods were rather similar among social groups. It also refers to the fact that these durable goods freed some labour time from the domestic sphere which could then contribute to the development of scientifically organized lines of mass production. These linkages also have a strong institutional dimension as observed with wage setting and welfare institutions that helped to stabilize demand. Some would add an ethical value dimension, meaning that attitudes towards work, family and consumption were strongly interdependent.

A whole range of linkages could account for the mutually reinforcing development of mass consumption and mass production in one country. This illustrates what we mean by an interdependence between the two learning processes.

3. Contemporary features of learning processes and of their linkages

The search for the main features of the contemporary learning processes and their interdependency can draw upon various stylized facts and the body of literature on economic growth. The internationalization of production and markets, as well as the specifics of the new technological system, transforms the whole issue, bringing back to the growth theory agenda the issue of why growth rates differ.

As previously mentioned, we can list the most acknowledged contemporary dimensions of what we called the learning processes in surveying the development of the literature on endogenous growth⁵. This literature centres its approach on the learning process taking place on the production side and features it in using a broad notion of externality, whereby an activity, internal to the firms or external, has an overall cumulative impact on the dynamics of all firms. Many "factors" have thus been included by various authors separately. The building up of various forms of human capital (or research) has certainly been the factor referred to most frequently. It either underlined the experience gained on the job (which grew as the net capital stock in Romer 1986) or the efforts to develop research activities (as in Romer 1990) or still the positive effect on labour efficiency of the general level of training (as in Lucas 1988).

⁵ It is sometimes unclear however if the objective of these analyses is to account for contemporary growth processes or whether alternatively they aim at taking an ahistorical perspective.

Another related part of the literature on endogenous economic growth focuses on the positive externalities brought about by the successful development of certain activities, such as intermediary services (eg banking, transport, telecommunication, distribution). Ashauer (1989, 1994), Barro (1990) studied the positive impact of public expenditures, Berndt and Hansson (1992), Munnell (1992) and Morrison and Schwartz (1996) of public infrastructures, Röller and Waverman (1996) of telecommunications, and Amable, Chatelain, De Bandt(1997) of the financial system.

These two branches of development in endogenous growth theory are interesting. One focuses on the role of human capital while the other focuses on the benefits of market supports (to include in broad terms the effects of public infrastructures together with the logistics of intermediation services). Considering the skill issue in our analysis will partly refer to the problem of human capital dealt with in the first branch of work. Taking into account the sectoral dimension will aim to recall the positive network externalities attached to public and private intermediation services.

However, this starting point, following the developments of endogenous growth theory, presents many shortcomings. First, nothing is said on the way in which all of the above factors are combined. They may well counter each other's effects or affect their impact (for instance, the way in which telecommunications are organized conditions the effect of education). Second, there is no parallel development on the demand side, which also implies that no linkage has been assumed.

One can only partly respond to the first shortcoming in considering simultaneously a "logistic" factor and a human capital factor. Which indicator is more difficult to decide; it depends on what we assume to be the greater determinant of growth and employment. As for the second shortcoming, namely, the featuring of some learning processes on the demand side, it can be overcome, but once again in a number of ways where it is difficult to pick up the more interesting features ; in a rather similar way it could be the diffusion process of some goods (ICTs goods versus standard traditional goods, the equivalent of a sectoral dimension with external effect : status, network, structuring impact on other consumption activities) but it could also be the impact on human capital of some consumption activities (with human capital becoming more marketable in the process). The debate around the development and distribution of the consumer surplus will help us to feature some crucial characteristics of the learning process at work on the demand side.

Even at this very preliminary stage we can try to clarify our stand within a crude model encompassing all possible effects, at a rather macroeconomic level, although with sufficient sectoral dimensions and details at the production and consumption level so as to help to schematize the structure of the learning processes and the forms of their interdependence. We do so in the following section.

3. A general scheme

Let $i = 1, 2$ be the two sectors of the economy under view, where sector 1 broadly corresponds to manufacturing, and sector 2 to intermediation services also broadly defined to include most business services and social services. Sector 2 thus concentrates activities with strong external effects.

The link between the dynamics generating the productivity gains in each sector can be expressed as follows :

$$(E1) \quad z_i = f_i(x_i, y_j, c)$$

where z_i and x_i represent respectively the growth rates of productivity and production in sector i over a mid-term period of time to be consistent with this type of stylized approach.

y_j is an indicator of the external effect of production j on the productivity in production i , while c is an indicator of the impact of some characteristic of consumption on the production processes. (E1) means that the magnitude and/or efficiency of production in sector j has an impact on the link between market expansion and productivity growth in sector i . Such hypotheses are not that uncommon in the economic literature.

Thus, when manufacturing was a key sector in terms of employment and productivity growth, one could have read (E1) as a way to stress how the success of manufacturing in terms of productivity increases brought about by a scientific (Taylorian) organisation of work influenced the organization of work in the sector 2 of services :

$$\begin{aligned} z_1 &= f_1(x_1) \\ z_2 &= f_2(x_2, y_1) \end{aligned}$$

where y_1 equals accordingly the growth rate z_1 or the level Z_1 of productivity in sector 1.

In the contemporary period of diffusion of information and communication technologies, however, one could very well argue that the effects occur the other way around, with the network externalities brought by services stimulating the efficiency in sector 1.

$$\begin{aligned} (E2) \quad z_1 &= f_1(x_1, y_2) \\ (E3) \quad z_2 &= f_2(x_2) \end{aligned}$$

where y_2 equals accordingly to the growth rate z_2 or the level of productivity Z_2 in sector 2.

However, it is difficult to retain such a symmetric move of externalities between the periods of sustained growth and slow growth. We know that the dynamic of productivity in services is far from replicating the one experienced previously in manufacturing. The fact that employment and work organization in services may be strongly influenced by the general structure of the supply of

labour (in terms of wealth, education, values) leads us to suggest that this is where the externality of the consumption structure c is most likely to have an impact, leading to the following formalization :

$$(E4) \quad z_2 = f_2(x_2, c)$$

Equations E2 and E4 would then constitute the production side of our preliminary model. We add the dynamics on the side of distribution and demand wage rates w_i and profit margins r_i linked to the efficiency of the sector :

$$(E5) \quad w_i = g_i(z_i)$$

$$(E6) \quad r_i = k_i(z_i)$$

Demand for the commodity depends on prices and incomes. It may also imply the organisation of work and the distribution of skills which ensues.

$$(E7) \quad x_i = l_i(w_i, w_j, r_i, r_j, y_j)$$

Prices, which are presumed to be defined by a mark-up over direct production costs, are not explicit in the above definition.

The external effects on demand and production that are expressed in the above equations are crude and tentative assumptions. Still, they help to question some of the empirical findings that can be found in the literature, which we shall do hereafter when looking at the debate on skill bias and on the consumer surplus.

The above formulations give an account of the productivity slowdown which is useful to confront with a straightforward estimation of its sectoral composition. In effect our arguments insist on the new sectoral dimension of the problem of economic growth that developed countries are facing.

III. The sectoral composition of a slower growth

Before looking at studies that attempt to further specify the above mentioned effects presented in our model, we emphasize the new sectoral dimension of the problem that we are addressing. Since the "golden years" of the 1950's and 1960's to which we referred when discussing a productivity slowdown, the sectoral composition of our economies has dramatically changed. The overall weight of the manufacturing sector (the key engine of growth in the previous regime) has strongly declined. A large part of this decline is linked to the external development of many service activities which are concurrent with the production and distribution of goods. It is interesting to estimate such service activities contribution to the slowdown. This is especially interesting given that these service sectors are the main consumers of the new ICTs and are thus taking a direct part in

shaping these technologies. One can think not only of telecommunications activities but also of banking, distribution, and transport, where new techniques have strong spillover effects in shaping usage and blurring the frontiers between activities.

To estimate the contribution of the various sectors to the overall slowdown in productivity (which is also the slowdown in economic growth at national level, the important issue of participation rates and population changes are set aside for the moment) we have, in Table 1, calculated the average growth rate of productivity at various levels for a number of countries, over two extended time periods.

(insert table 1 around here)

Comparing the 60's and the 80s the slowdown in productivity gains appears across the board of all sectors. All countries are concerned despite the large diversity of gains. The contribution of services to overall productivity growth is quite noticeable in the two periods. Financial and business services for nearly the same amount as manufacturing. The contribution of distribution trades neighbours half the one of manufactures while social services and communication have a minor impact. The share of these service activities in total value added explains much of the size of their contribution to the overall productivity growth. In effect their productivity gains are generally weak.

IV. On the skill biased nature of technological change.

In the early 1990's it has been widely observed that investment in new ICTs has been accompanied by a marked substitution in favour of skilled labour (see Howell and Wolff (1992), Berman, Bound and Griliches (1994)). Such bias seemed even more characteristic of the impact of ICTs on the labour market than its overall impact on employment. In effect, the shedding of unskilled labour at the sectoral level has occurred in most countries in the last decade, as illustrated in table II.

(insert table 2 around here)

1. On the complementarity between new capital and skill.

The above observation is in accordance with the thesis that stresses a complementary relationship between capital and skill (both being a substitute for unskilled works). In Griliches (1969), this complementary relationship was largely due to the relative decline of the price of capital, while Denny and Fuss (1983) attribute this more directly to the specific effect of technical change. If such a relationship has reached a stage implying such a drop in demand for unskilled labour, then it raises many questions concerning the characteristics of the new technologies. For one, what are the implications, in terms of work organization, that led to a parting with the old model, where new capital equipment was essentially seen as a substitute for labour of all skill levels and where shifts in skill structure remained a secondary effect (at least in manufacturing) ? Moreover, if the new technologies possess such strong characteristics, why are the situations so different from one firm

to the other⁶, from one country to the other and even from one sector to the other (especially from manufacturing to services) ?

A third line of reasoning stresses that technological change is endogenous and that technological change and its effects may follow from some other changes, such as increased competition from abroad (the trade effect) or at home (as expected from the experience gained within a market by all actors - from suppliers to customers and including intermediate agents). This explanation is not necessarily, therefore, a straightforward one : the source of the apparent complementarity between new technologies and skilled labour needs to be questioned. In the next section we briefly review some of the issues raised above and some empirical findings which are relevant.

2. A trade effect ?

The trade effect has been at the centre of the debate since both trade and technological change are linked. If technological change is endogenous, then its skill bias may well be the indirect effect of trade specialization whereby developed countries with high wages are forced to specialize in activities that are more skilled labour intensive. Although this certainly encompasses part of the phenomenon, it does not explain it entirely. For example, most sectors are affected by technological change regardless of their exposure to trade (see Berman et alii (1994), Machin (1996)).

The trade effect argument can, however, be enlarged to include any change in demand, be it internal or external. Some studies insist that shifts in competitiveness on all markets, giving more weight to non-price factors (such as incremental innovations, delivery and after sales servicing improvements, as well as minor upgrading in the quality of the various goods and services consumed by richer countries) effectively promote production and thus make more use of qualified labour (see for instance (Goux and Maurin (1995))). At this stage it is difficult to separate the two issues : an effect specific to the technology and a broad consequence of a general shift in demand (as have been acknowledged for the trade and technology effects by Nickell (1996), and Cotis et alii (1995)).

To investigate whether there is still a specific technology effect one could examine surveys at the sectoral or firm levels for such changes in competition. However at the sectoral level there is an aggregation risk that may mask part of the effect while at the firm level it has been widely observed that the variance of all effects (whether on the skill structure or on productivity, or on profitability) was large. Other routes may therefore be more conclusive to assess the magnitude and nature of the specific impact of new technologies. Systematic differences between sectors and countries is one such alternative to complement our investigation. Before doing so, it is useful to consider the eventual effect of an excess supply of qualified labour.

⁶ sometimes tied to the business cycle of the branch (see Leonard (1987), Davis and Haltiwanger (1992) for the US, Lagarde, Maurin and Torelli (1994), (1995) for France), and sometimes not (see Konings (1995) for the UK. The divergence is always less marked for tertiary activities.

3. The effect of an excess supply of qualified labour ?

Part of the skill bias may be the result of an increase in demand for education in developed economies. This increased demand could be stimulated by slacks in labour markets which induce longer stays in initial formal education to delay entry into the labour market and by individuals trying to improve their chances of finding employment. Such an effect has been underlined by, amongst others, Howell and Wolff (1992) for the US and by Goux and Maurin (1995) for France. The increased demand for education is certainly a part of the explanation for the skill bias and the trends increasing the average levels of education and the number of schooling years as apparent in all OECD countries. Shifts in unemployment rates where the unqualified labour rates of unemployment are rising more quickly than rates of unemployment of qualified labour confort this opinion.

Such effects should not, however, be over-exaggerated. The unemployment rates of those with diplomas have increased so that schooling at even high levels does not provide full protection against unemployment or poor jobs. Conversely, and strangely enough, the average yield on education investment has risen (at least in the US for the college level and in the UK ; in both countries the wage distribution increased its range). In essence, if the supply effect had been the main cause of the skill bias one would have expected a lowering of the yields on educational investment.

These points stress that the over-supply of qualified labour effect was intertwined with some changes in the functioning of the labour market (a rather relative premium for education attainment, no absolute advantage) and in the process of wage formation where the range extended on both ends. Looking at the issue of wage formation has indeed been a classic way to investigate the meaning of the skill bias.

4. Are firms paying for the skill bias ?

For firms the skill bias trend could well represent an extra cost. The skilled workers maintained in an existing position or hired to serve the new technologies could well increase the average cost of skilled workers. This, combined with the shift towards a higher ratio of skilled workers, would increase the average wage. An examination of the changes in wages in the case of technical change could thus bring interesting insights into firms' strategies.

Numerous studies have attempted to analyze the impact of investment and usage of new technologies on wages. Such analyses can clearly be executed at various levels (firms or sectors) and can concern a specific type of worker or the average work force. This distinction is crucial for the skill bias issue. In one case we look at the premium to users of the new technologies, in the other case we look at the overall sharing of the benefits of the new technologies amongst workers. We can expect that investment in new technologies, when it substitutes capital for labour, will end up increasing the average wage rate (which is coherent with the general structure of wages by sector). At the individual level, however, the expectations are less clear.

The debate at this level has been open by Krueger (1993) who showed that indeed the use of computers brought US workers surveyed a wage premium of some 15% at the end of the 1980's. Such a premium could be attributed either to an increase in productivity or to user's personal characteristics which led them in all cases to receive higher wages in the end. Krueger favours the first explanation, even though the cross sectional data used do not really allow conclusions to be drawn. Recent studies tend to counter Krueger's view : for France Entorf and Kramarz (1994), (1996a and b)) show that in effect workers using computers are paid more but that they were more paid before the introduction of the new technologies ; for the US, Doms, Dunne, and Troske (1996) reached the same conclusions as did Chennels and Van Reenen (1995) for the UK. For Germany Di Nardo and Pischke (1996) show that the use of computers have similar returns for individuals... but so does the use of pencils. Only Bell (1996), using a sample of one thousand individuals, born in 1958 and surveyed in 1981 and 1991, found a net increasing effect on wages for those using computers at work in 1991, thus supporting Krueger's view (on the assumption that no one used computers in 1981).

For the most part, these empirical findings nevertheless suggest that the use of a computer does not necessarily lead to an "extraordinary" wage increase, meaning, in other words, that individuals would have received a higher wage based on their personal characteristics. Still it is a signal and has some role in the introduction of new technologies, which are spontaneously handed over to people who somehow inspired confidence according to the usual criteria. It also explains that the use of computers seems to be a protection against being fired.

These empirical findings show that firms tend to select potential users of ICTs along criteria belonging to a world "preexisting" the new technologies. Preferences for skilled workers means in this context, preferences over on-the-job training in the new organization of work. The analyses also raises questions on the content of the skills referred to and on the broader context of work organisation in which these changes are taking place. Such issues are often missing in the debate among economists on skill bias technology. One reason for this is the difficulties associated with handling these issues/categories with statistical tools and surveys. A more profound reason for this lack of debate is that the determinants in question are often tacit, country and/or sector specific and are therefore difficult to generalize. Having said that, we will see that enough observations have been made to make some challenging conjecture on the issue.

To conclude, firms do not seem to pay specifically for this skill bias but to use some pre-existing ideas of skill and personal competence to organize the implementation of the new technologies. The problem is to distinguish which part of the skill bias is the result of actual competencies and which part is the effect of some sort of "prejudice"⁷.

⁷ The word is in no way pejorative, it simply implies that firms are making their organizational choices with preconceived ideas on the abilities or basic skills required to fill jobs that are partially defined by the personal equipment available.

5. Are there specific sector or country biases in these skill bias trends ?

We proceed in this brief investigation by establishing whether or not the phenomenon of a skill biased technical change is more marked or of a different nature according to countries or sectors. Among countries the level of state intervention and welfare provision may play a role⁸. On the sector side, the service industries, most of which are by definition strong users of ICTs as they are large information "handlers", may well present distinctive features in the adjustment of their skill structure⁹.

We begin by verifying the casual importance of sectoral specificities. In effect most studies we referred to have concentrated on manufacturing industries. As two thirds of employment and ICTs are concentrated in services, it is not very relevant to draw any conclusions from the debate above without verifying that most arguments effectively apply to services. Even investigating the size and nature of the reduction in the demand for low skilled workers becomes problematic. In some cases the skill distinction cannot be straightforwardly compared between manufacturing and services. This discrepancy may explain why, the features are at times strikingly different. The evolution of low skilled workers displayed in table 2 just show how contrasted are the evolutions in manufacturing and overall services. Looking at the evolution of employment by skill at a more detailed level for services in France over 1982-1991 (OECD 1994), we observe that in activities like social services, public administration and household services, the increase in unskilled workers outpaced the growth of skilled workers¹⁰. In most other services the number of unskilled workers continually rose, though at a lower rate than for the skilled workers. Only in finance and communication do we observe a net decrease of the unskilled labour force as observed in all manufacturing sectors (as well as in agriculture, mining and construction).

One should not conclude that the debate centred on manufacturing industries is not relevant for service industries.

For one, certain sectors, such as finance and telecommunications, have invested more in ICT equipment and are the sectors where the decrease in the demand for unskilled labour is more noticeable. Second what we can learn on skill and work organization in the case of technological change in manufacturing industries is likely to be telling of the issues that will increase competition and product differentiation in the service industries. This does not imply that work organization in services does not have specificities, but only that among the many issues that can be raised with respect to manufacturing some will concern service activities.

⁸ At a minor level a non English speaking country could also be a distinctive feature regarding the use of a technology largely instrumented in English.

⁹ Another criteria could have been to distinguish sectors in accordance to their exposure to international competition. Still as we noticed previously, while checking the trade issue, this exposure ratio does not make any real distinction amongst manufacturing industries which all experienced similar shifts in their skill structure.

¹⁰ A similar result is observed in most large OECD countries (see OECD 1996)

As for the country bias, the sources of divergence are a priori numerous. Many institutional factors, which are rather country specific, are shaping the way in which national industries are defining skilled labour in their work organization. It involves in broad terms the educational system, the type of industrial relations prevailing in each industry and the kind of welfare system implemented at the national level¹¹. Furthermore, industrial relations contribute to some co-evolution of the wage and the skill structures, thus implying that the skill issue is indirectly linked to the overall distributional issue between wages, profits and taxes. Clearly these contexts have continued to differ from one country to the other over the 1980s and 1990s despite decades of economic convergence. It is all the more surprising to observe similar evolutions on some issues such as the general decline in the demand for unskilled labour. Similarities are less marked or totally non-existent for related issues as the changes in wage structure (spreading in the US, more or less unchanged in continental Europe) or in the returns to education (increasing in the US, rather declining in continental Europe). Nevertheless one cannot distinguish a European model from an American model, as Europe remains very diverse at this level. (education, training, wage structures, participation rates, forms of interventions on the labour market, etc.)

Because of these differences in institutional contexts and also as a result of broad cultural differences, countries do differ in the skills they have and the way in which these skills are used. Examining the content of the skill notion will help in assessing the basis for these cultural and institutional differences.

6. Revisiting the content of skill

a. At an individual level

We have not yet discussed the content of the skill notion used thus far. In many of the studies we refer to, a crude distinction between production and non-production workers, which is readily available in some countries, is often used. This is definitely correlated with a number of alternative criteria based on some broad characteristics of educational attainment or of occupational category (Berman, Machin, and Bound (1995) do check these strong correlations for the US). Still jobs require a multitude of different skills and even the best dichotomy may well blur the issue of significant changes in skill structures. Taking this into account Howell and Wolff (1992) distinguish three major dimensions of skill : cognitive (analytic and synthetic reasoning, numerical and verbal facilities), motor (physical abilities, coordination, dexterity) and interpersonal (supervisory, leadership). Using a Dictionary of Occupational Titles the authors have constructed three skill scales on which they have graded employment occupations by sector, and their change over the period 1970-1985. Wolff (1995) repeats the investigation for a longer period and adds an educational attainment variable. The evolution of skills, as illustrated by these two studies, gives a more complex figure of the evolution of the skill structure in various sectors of the US economy. They do confirm a significant break in

¹¹ This specifically refers to criteria for social transfers and social contributions. In some welfare systems the category of skilled workers plays a role independently of the wage level.

the evolution of the skill structure in the 1980's and a general decline in the demand for unskilled labour. This last shift combines an increase in the demand for higher cognitive and interactive skills with a general drop in the demand for motor skills. These studies also suggest that the effects on the skill structure of investment in general equipment as opposed to a specific investment in computers, may differ. Investment in ICTs is still only a small fraction of total investment (as extensively recalled in Oliner and Sichel (1995)). It follows that the specific effects of ICTs may sometimes be hindered by overall standard capital/labour substitution. The composition effect, that is to say the shift towards service activities, is also a major cause of the decrease in demand for motor skills. Wolff (1995) emphasizes that the continual increase in the supply of educated labour may well bias measures of skill bias which look at years of school attainment.

These studies not only indicate that the demand for unskilled labour has declined but also that the very structure of skilled work itself has changed with an increase in the number of "high-level" jobs and in the number of jobs requiring higher cognitive skills. This highlights that the change in the job structure may have to be analyzed at the firm level, including the work organisation of a firm.

b. An organisational issue

Most of the studies discussed have analyzed the skill bias of technology as if it were a set of individual issues, disregarding the fact that the primary concern of a firm is the work organisation as a whole. These organisational issues are certainly difficult to typify in times of structural change where diverse reactions by firms is most frequently observed (see Attewell 1994). This explains the lack of statistics on organisational structures in general and in particular of studies exploring the skill bias and the productivity paradox as extensively as in the case of the more individual aspects of employment.

A variety of quantitative studies do, however, by looking at the level of either the firm, the sector or of individuals, indicate that the explanation may be of an organisational nature. Such is the case when studies fail to link certain roles, such as being responsible for a specific type of equipment, with some personal incentives such as a wage premium or a skill grade. In effect these studies stress the importance of signalling but could as well invoke organisational structure issues. The same applies to the studies by Howel and Wolff(1992) and Wolff (1995), distinguishing several kinds of skills, does indirectly, however, consider work organisation.

Questions on work organization could be addressed by referring to some basic structures, as Aoki (1988) did when comparing the information structure embodied in work organization in Japan and in the US. It could have been all the more relevant to consider such information structures in that these structures for Aoki displayed rather different capacities in facing and organizing technological change, with the Japanese horizontal structure of information (in its work organisation) being more fit to diffuse and implement incremental innovations in products or processes. US firms with their more vertical structures of information (as shown by its more hierarchical work organisation) should

be more adaptive in facing radical technical changes¹². It must be noted, nevertheless, that such a perspective has not been frequently applied in studies on the skill bias of technical change or the productivity paradox.

Beyond statistical reasons, the lack of quantitative studies on work organization may demonstrate that the issue is not yet well developed for a large number of firms. This assessment is in accordance with studies that insist on the diversity of work organisation to adapt to technical change. Here we are confronted with two hypotheses. One, that firms undergo a standard process of trial and error before one best practice of work organisation imposes itself and diffuses to a majority of firms. The current period would be explained as a standard period of transition. Two, that the new technological environment of the firm is such that there is no dominant model, but specific applications that are only relevant in a certain context of competition and cooperation¹³. In such a rapidly changing work organization environment, skills are bound to become obsolete more quickly than before. The relative instability which leads firms to opt for organisations which can be continuously transformed and adapted, is also related to the increasing number of linkages that have developed between firms (as surveyed in many contributions of the book edited by Harris (1994)).

If a significant change in the perspective of work organization has in fact occurred and become a chronic issue with diverse solutions (as may be illustrated by the continuous spread of new organizational forms and actions such as : re-engineering, merging, networking, externalizing, work-flow processes, groupware, etc.) then it is likely that the relationship between the two spheres of work activities and home activities will be transformed as well. The fact that skills are becoming obsolete more quickly will be an important factor in the evolution of this relationship. The conclusions drawn from this survey on the skill issue will lead us to review how the new technical system can be viewed from the "other" sphere, e.g. from the point of view of the consumer and the worker.

7. Some provisional conclusions on the skill bias

We summarize some of the points made in this brief survey of the skill bias issue.

The increase in skill requirements does not appear to be strictly linked to the role given to workers using some types of new equipment. Their wage or qualification premium seems rather to reward personal characteristics. This has brought attention to the broader issue of work organisation. No clear work organization perspective seems to have emerged that could direct the choices made by imitating firms. The issue of work organisation itself seems to have taken a new direction - firms are more open to continuous change and to organisational linkages with other firms. This puts new emphasis on certain personal qualities, which are often not very explicit. Although these individual

¹² The higher demand for cognitive skills as well as the strong demand for interactive/supervisory skills could have been read as a combination of the two models of information structure.

¹³ A change that Attewell (1994) seems to illustrate when questioning whether or not the work reorganization process is becoming chronic.

characteristics may partially overlap with the number of years of formal education, they do not coincide with it. It is strongly indicated that the relationship between the sphere of work and the sphere of personal life (including all aspects that affect the structure of life) has been deeply transformed in the process. In the case of services, some of the above issues may well be exacerbated as many service providers are large employers, large users of new information technologies and large providers of services to firms and to the general public¹⁴.

To consider these above issues the next section will first look at the behaviour of consumers when faced with the opportunity to consume new goods and services. We then re-evaluate the skill issue looking at consumers' perspectives in general and their strategies in developing skills (and employability) through education and training.

V. New consumers and the distribution of the consumer surplus.

We now turn to activities outside the work sphere and the pattern of consumer demand. As previously discussed, technology and structural change have led to a change in work organisation. This change was difficult to characterize in terms of collective organization principles. In effect the trial and error learning process in which firms seemed to be engaged ultimately relied heavily on selecting workers with some personal characteristics, close to educational skills, but with marked differences. We attempt to complete this picture by looking at consumption patterns and lifestyles. The assumption is that the divisions which are occurring in our societies in terms of the desire and ability of individuals or families to use the new technologies will also be telling on what is happening within work organisations. This broad learning process occurring outside the firm is not only concerned with the ways in which consumers fill their baskets of goods and services but also is concerned with the way in which these commodities incorporate the new technologies. This is especially relevant for those services organised in networks. The linkage between the two broad learning processes (in work and out of work organisation) that we outline may be transitory and may correspond to a classic ordering of access to ways of life and consumption which remain similar. But it may also be a more lasting and structural drift which could hinder economic growth and have detrimental effects on the cohesion of our societies. The last section will come back to this assessment. We shall try here to present some of relevant features which help to ground the above thesis. Nevertheless, the debate on the "consumer bias" is by no way as elaborate as the debate on skill bias, especially in the economic literature¹⁵.

¹⁴ Marketing research on the quality of services and how to measure it takes into account some of these individual characteristics (see the Servmam method analysed in Kunst, Lemmink and Prins (1996).

¹⁵ Such debate seems more active in other disciplines of social sciences : sociology, political science, geography or business and management sciences. Most interesting economic studies of the consumer surplus are dealing with very narrowly defined products(see Fischer, Griliches (1995) with two prescription drugs, Trajtenberg (1990) with CAT scanners, Hausman (1994) with a new breakfast cereal, as outlined by Nakamura (1995)).

1. The CPI debate and sources of consumer surplus

The current debate over the CPI can be helpful in illustrating some of our concerns. In effect questioning the accuracy of measures of a consumer price index raises questions on the measurement techniques and on how able consumers are to appreciate the changes not only in the content of goods and services but also in the way they are provisioned. We will not discuss the techniques of CPI measurement by the national institutions in charge. This part of the debate is important due to the role that price indexing plays in fixing wages, public transfers and contracts but is not directly linked to our topic. On the other hand, all aspects of this debate that are concerned with the difficulties involved in comparing the real value of two baskets of goods and services at different points in time when a large systemic technological change is occurring, are critical for the discussion of our topic.

When change has such far reaching aspects as the change induced by ICTs, the meaning of a cost of living index as "the minimum expenditure to be at least as well off" is questionable in such absolute terms. It is all the more questionable given that the changes have affected mainly actions, such as the way in which the commodities are provisioned, that have always been difficult to measure even though they are important. Nevertheless, we assume that the objective of a cost of living index is feasible and look at the main difficulties encountered to measure, in real terms, the changes as outlined in the debate over the measurement of the CPI. National institutions measuring the CPI are said to have an upward bias basically because they tend to follow the behaviour of an average consumer who would buy new products (or enjoy a sizeable quality improvement in some goods or services) when a sizeable share of consumers have already done so¹⁶. At this stage the price of the innovated or new product has significantly decreased¹⁷. The quality change, as measured by the price level when the new good is put on the market, and ensuing price decreases, have disappeared. In such a world consumers will develop different strategies and obtain very different welfare gains. Some consumers will be characterized (in marketing studies) as early adopters, some others will wait (although not too long) to take advantage of a price decrease. Still others will be late adopters, not as a result of price levels, but due to a lack of information and knowledge about the characteristics of the new good or service. Finally some will never adopt (and there is no way to channel information and knowledge which would make adoption of any interest to them). It must also be considered that the provision of goods and services also makes up a part of the product and that "shopping" patterns are submitted to the same process of innovations and strategies¹⁸. Altogether

¹⁶ The Boskin report (1996) which gives some examples of this delayed registration (p.39) thus mentions that cellular phones (over 36 millions users in the US) is not yet in the CPI list.

¹⁷ The reason for such a price decrease may be manifold and depends on the time horizon. In a rather long run one can invoke a product cycle à la Vernon ; in a shorter time horizon the production of new goods (it is less the case for services) enjoys increasing returns because of standard economies of scale and strong learning by doing effects.

¹⁸ We shall come back on the fact that innovations and strategies involve each time both the producers and the consumers.

with the provisionability dimension one should take into account the welfare gains brought by the availability of a large variety of products.

The debate over the CPI has the great advantage for our perspective to point at the areas where all these diversified changes are the most difficult to appreciate and to try to give an order of magnitude to the underassessment of quality change.

The Boskin report (1996) gives a rather detailed account of the reasoned "guesstimations" that the commission realized for the various components of the CPI on the basis of a large number of more or less directly related econometrics works. The report concludes that overall underestimation of quality change may have led to an upwards bias of 0.6 % per year of the CPI. The impact of increasing ability to shift from one type of outlet to the other has been accounted for 0.1 % bias upwards¹⁹. Overall the unmeasured consumer surplus, net of the technical drawbacks brought by the measuring procedure, amounts to 0.7% a year²⁰. This net bias is already quite sizeable if one compares it with the average growth rate of large OECD economies (1.6% yearly over 1989-1993). Still looking in the report at the detailed discussion by product category of the bias does not convey the impression of overestimation. In particular the category Housing encompasses all sets of issues which are not given much weight in the correction such as housekeeping services (despite the ever increasing variety of services on offer), while the external effects of all the new appliances (included electronic ones) can have on the domestic economy are just counted for their direct effect on the subcategory and thus weighted for 0.8% of total consumption while total housing weights 41%.

Medical care which benefits from a lot of background studies is granted a relatively high unmeasured rate of technical change, as expected. By contrast, entertainment and education services, although similar arguments would apply because of the deep structural changes brought about by ICTs, are given very low "marks". By and large it appears that this net unmeasured technical change has been underestimated. More exactly the areas where the magnitude of unmeasured technical change is uncertain remain rather important. These are mainly service areas. Nakamura (1995), who did a similar exercise on the BEA national accounts, estimates that the net unmeasured technical change in personal consumption would be as high as 2.5% per year over the period 1984-1993. The main differences between the two estimations just mentioned do precisely bear on recreation services, education and housing. The question is not to choose between the two estimates but to outline that the phenomenon under view is of a real magnitude beyond the uncertainty that surrounds the issue.

The next step is to consider how this affects differently the social groups and what it says about the dynamics of consumption and of the learning process which is shaping it. This could be one way to reduce the uncertainty surrounding the issue.

¹⁹ On the basis of Reinsdorf (1993)

²⁰ altogether the bias in measuring CPI in the US amounts to 1.10 % a year, with all the technical improvements in measuring made by the BLS from 1996 onwards accounted for.

2. The distribution of the consumer surplus

The debate over the unmeasured consumer surplus has two backgrounds. One is a fiscal issue ; a lot of public transfers, pensions and revenues are indexed on the basis of a CPI index and overestimation of this index has a sizeable effect if only on the public budget deficit. The other background is the distribution of income ; inequalities in income distribution have been growing in most developed countries over the last two decades.

It is relatively easy to get a rough estimation of the impact of mismeasurement on the budget deficit or on the balance of taxes and transfers to various social groups. It is much more complex to get an idea of the effect on the distribution of welfare. One can argue that gains and losses to different groups balance out. The groups with less income, education and culture will certainly miss part of the advantages of the unmeasured quality change but will gain by having special access and prices to the goods and services concerned. Such hypothesis underestimates the fact that we start from an already very unequal situation (regarding the distribution of income and education) and that the very existence of an unmeasured quality change underscores some opacity and inequality in the access to and diffusion of new commodities.

People will differ in how they access new goods and new services and in what they get out of them. Many authors have stressed the large increase in the variety of goods on offer (see Gordon 1990) as well as the increase in the range of services at their disposal. This variety goes together with numerous ways of provision of these goods and services, be it the different outlets or the diverse ways to finance these transactions. Consumption in such an environment has become more complex and has broadened the opportunities for smart behaviour. The pressure of smart consumers (on their own or organized in associations and through the media) plays a major role in a general increase in competition and, more generally, in more demand oriented market economies. Conversely, large numbers of people in the lower part of the income distribution find it hard to escape some quality change they can not avoid, varieties they can not afford or improvements that are of no use. Specially crucial in that respect is the consumption of financial services leading to unbearable endebtmnts (which in many countries had to be severely regulated). Similar increases in the range of capabilities to use efficiently services can be observed in education, health, communication, transport and public services. In other words, one can talk of skills to describe the various types of "smart consumers" and one could compare a lot of people getting into trouble in their attempt either to take advantage of the quality improvement on offer or even just to keep unchanged their old basket of goods and services.

ICTs are not to blame for this increased complexity and potential of consumption: they may even constitute a solution to overcome some of the drawbacks of this new potential. But the efficient use of ICTs is itself complex as it requires many coordinations and contains opportunities for a great number of misuses (as largely exemplified in Landauer (1996)). Still at this early stage of a trial and error process, repeated in all spheres of activities, these technologies may well accentuate the difficulties met by some social groups to take advantage of quality improvement. Observations of

cultural and financial barriers to access the new facilities or to make full use of new equipments lead us to express some fears that our societies could develop in a two tier Information Society. Elites and professional classes would constantly increase what the ICTs can effectively offer²¹, while those at the margins, with low income, little education and limited social connection, will find it increasingly hard to keep "in touch" with the ICTs. Policy statements have clearly outlined the role of domestic use to avoid a widening of the gap (see amongst others Group of Prominent Persons (1994) and the EU's High Level Experts Group on the Social Aspects of the Information Society (1996, 1997)).

The existence of such a range of domestic skills to make use of ICTs leads one to presume that the "unmeasured quality improvement" is in terms of welfare rather unequally distributed. The statistical evidence to support such a presumption (more directly stemming from case studies and general observations) is, however, limited²². But to substantiate the argument, one will have to take into account the structuring character of ICTs on the modes of consumption. Therefore looking at purchases of goods and services by social groups is not enough and one has to investigate how effective the combined use of the equipments and services ordered, is likely to be. Such requirement to assess "domestic skills" may seem sometimes futile if one has in mind differences in practices in "home automation". In effect intelligent homes (such as "Machines for Living in") are much more part of the symbolic of ICTs than of its reality even in the first-tier group (see e.g. Haddon and Silverstone, 1996)²³. Still an area where the discrimination can already be more effective is in the provision of services via large networking systems. Such social differentiation of use could originate from two factors : the abilities of users to take advantage of these modernizing systems ; the tendencies for large systems to develop their organisations in taking for granted this differentiation.

Examples could be found regarding education, health, financial and communication systems. Education is a classic case, even if it has not been yet thoroughly transformed by ICTs. The fact that an increased number of schooling years goes together with rising illiteracy and other poor results (importance of drop outs, of unqualified school leavers, of poor scoring at general and specialized tests, see OECD, 1994), is enough to illustrate the widening of the range of achievements. Communication is still a field where the differences in aptitudes to use information highways and cheap channels of communication have not yet significantly developed or been tracked down. We shall retain the examples of health systems where the shaping of a major technological transformation is on its way and financial systems where automation has already gone a long way.

The development of telecommunications between the various agents and phases of treatment in health system is still in an early phase but it raises already the main issues regarding the path of its technological development. In all cases this development implies an active interface between professionals of the health system and patients. The design of this interface presents a standard trade

²¹ which does not rule out difficulties of dead locks and lock-in even at this level.

²² which led the Boskin Report to set aside the issue of such social bias.

²³ Notwithstanding the importance of symbolic dimensions to shape projects of consumption.

off: the larger its scope, the more useful and beneficial will be its operation in terms of the range of interventions covered. Conversely the more complex the interface, the higher will be the barriers to access, depending on the general "skill level" of the population. Modernization of treatment centers such as the HMOs did improve the quality of the system but was accompanied by some orderings of access, which in contexts of high inequalities in education or income may end up in exclusions (see Boulier (1994)).

Financial services and especially retail banking have already experienced various phases of computerization of their network facilities. Increased competition and quality improvement of the equipments finally pressed towards some reorganization of networks, with changing rules of orderings and list and level of treatment. These re-engineering of networks and operations led to some exclusions of access to services. Banks in the US and in the UK thus closed some local branches to be replaced by the limited service of automated tellers (see Prat, Leyshon and Thrift 1996 for the UK and Dymski and Veitch 1992 for the US) all of which had detrimental or alienating effects on local communities. In the case where new equipments allowed consumers to reap benefits of minimum service, they often excluded for a long time the extension of the spectrum of services for locals. These two examples suggest that the scope for development of ICTs much depends on the distribution of consumers skills.

This leads us to conclude that consumption and unmeasured surplus are both unevenly distributed and that specific skills acquired through educational achievements as well as by the facilities brought by higher income, determine the allocation. Still a crucial issue remains to precise the content of these skills and especially which component can act as a substitute for the more standard educational or income criteria.

3. Consumers skills and workers skills.

We can draw some parallels between what could be in a time of intense technological change the personal requirements for a skilled consumer and the similar requirements for a skilled worker. In both cases a skilled person will be expected to respond positively to external challenges induced by these ongoing structural changes as well as to find ways to constantly improve the internal efficiency of their actions (the ability to develop a learning by doing process). In worlds of bounded rationality and limited information one privileged way to balance these internal and external learning processes is to have access to various groups or networks, more or less formal, where you can get information and support. These networks or reference groups can be diversified, but the expected support of each one could be less committed, or more concentrated but then less able to face all the challenges.

Two illustrations of these properties are telling.

Gollac (1996) looking at how computers users at work managed their work found that those who were using in the most innovative ways the computers (programming or able to use several software programmes) were referring in most cases to relations outside the firm, referring to

colleagues in remote positions within their own firm was listed second and close colleagues third. By contrast, for people using computers in limited ways (using e.g. always the same software for definite operations) the order was the opposite.

Similar hints are given by investigations on the best mean of protection of individuals against unemployment : the most effective protection was given to people with a good range of diverse connections. It follows that having strong links with a network or a community may not be as valuable as the possibility provided by a portfolio of connections²⁴.

How these links are established, how they are renewed, and developed largely depends on individual histories, cultural backgrounds and experiences. The diversity of this training and its accumulation evokes to some extent Bourdieu (1984)'s notion of "capital culturel". Still the standard social forces shaping the preferences of individuals have also their say (see amongst others Galbraith (1958), Packard (1957)) but a characteristic of the current period certainly can be found in the stronger endogenous change in these structuration. As mentioned many times, the old patterns which structured the "skills of consumers" have become much more dynamic, evolving along time with the experience and the restructuring brought about, in short, by ICTs. In fact ICTs do transform the ways markets are operating in changing the ways in which most intermediation services operate (distribution, transport, communication, banking, etc.). The room left for this restructuring is itself largely dependent upon the institutional framework (the importance of which is illustrated by the contemporary deregulation-reregulation changes).

We shall just retain from this short discussion the similarities in the abilities required in both kind of skills at work and out of work, their greater flexibility which implies capacity to learn and to adapt to new contexts. These characteristics also imply a strong rate of obsolescence as well the existence of hazards, with lasting or irreversible consequences (poverty and unemployment can act as traps in some cases). There is also uncertainty on the specificities of the selection of portfolios of connections. ICTs have developed their own rules in that respect, leading to new problems²⁵ which in turn impact on the ways they are shaped and implemented (see Goodman et al., (1994)).

Though giving only a partial insight on the skill issue, broadly perceived as an ability to take advantage at work and at home of the potential brought about by ICTs, we can try to round up our argument and to identify from the points we have made in the last two sections some key issues in the productivity paradox discussion and in particular how they interact.

²⁴ We use the word portfolios in reference to studies in industrial organisation (see Dunning) stressing that the new large firms are engaged in a series of alliances, joint ventures and the like which they try to manage in an optimal way to face rapid changes in competition and technologies on various markets.

²⁵ Thus Attewell (1994) suggests that they have considerably increased the number of cases with asymmetric information, as schematized in principal-agents problems.

VI. Conclusions : on unbalanced and unequal growth

We can now try to come back to the overall macroeconomic issue raised by the productivity paradox. It is widely acknowledged that a major part of this paradox may be linked with the learning process that requires the diffusion of information technologies largely based on decentralised coordinations, difficult to implement. Our survey of the "skill bias" issue stressed some characteristics of this learning process on the production side. It conveyed the impression of a rather atomistic approach to the reorganization of work which ended putting a new emphasis on personal characteristics. From this perspective, the change going on on the side of consumption appeared to have some similarities : skilled consumers seemed capable of improving their share of the total welfare. Reviewing the debate over the unmeasured consumer surplus supported this view. Moreover the development of a sizeable set of "skilled consumers", which accounts for the more competitive nature of markets (along with the trend of internationalisation), suggested some new linkage with the group of skilled workers (broadly redefined as mentioned above), tying together the learning processes at work on both the production and demand side. This linkage may also be seen as a comprehensive extension of the user-producer relationships that tend to shape the innovations and their diffusion (see Lundvall (1988)).

It follows that the productivity slowdown is related to two interdependent "macro" learning processes. This helps to put in a more comprehensive perspective questions on the effect of income inequality on growth. In effect, it is clear that income inequality hinders some comprehensive developments taking the best advantages of ICTs on the demand side. It may also be the case that it leads to less advantageous solutions on the production side. Service activities and especially intermediation services or large networked social services have a special role in this dynamic. They are central in the organization of markets or to the welfare of the population. Furthermore such services are interactive (the way in which they are provisioned is as important as their very content) and open to transformation through the use of ICTs (see Petit and Soete, (1996)). Moreover they represent a major share of value added and employment (as illustrated in Table 1).

One can schematize that unbalanced growth between the two spheres of production and consumption as follows:

$$\begin{aligned} z_1 &= f_1(x_1, y_2) \quad ; \quad z_2 = f_2(x_2, c) \\ y_2 &= f_3(u, z_2) \quad ; \quad c = f_4(u, x_2) \\ u &= f_5(w_1/w_2) \quad ; \quad w_1/w_2 = f_6(z_1/z_2) \end{aligned}$$

using the notations defined in section II, with c as indicator on the welfare impact of consumption and u an indicator of income inequality. We have assumed that u was itself an increasing function of the wage differential between sectors taken as a proxy of the wage differential between skilled and unskilled labour. The wage differential is assumed to be itself an increasing function of the productivity differential.

This formalization hints at the fact that the relations we described above can lead to virtuous or vicious cumulative mechanisms. It depends on the specific forms of the above relations as well as on the determinants of both components of demand which have not been explicitated.

The only aim of this crude scheme and of our paper has been to summarize the main lines of the architecture of the linkages that can be suggested by the debates around various aspects of technical change, inequality and growth. It also gives a framework for the analytical and empirical investigations that our exercise suggests. The issues we addressed are of course much more complex than we hinted at ; still this complexity may mask some crucial interdependencies. Our questions focus on ways where income inequality and skill issues might interfere. It is not "manicheist" either and leaves some room to the thesis which stresses that innovation at some scale may convey for some times greater inequality. Still the reason for the comprehensive, loose approach we developed here, is to stress that ICTs are no evil and on the contrary potentially powerful tools but that they can be misused if focusing too much on the atomistic aspects of the current learning process while ignoring the large interdependencies which finally will shape their outcome.

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Table 1
Productivity Growth by sector
 (over two periods (1) 1960-1973 ; (2) 1984-1993)
 for The USA, Canada, Japan, Germany and France
 w : share in value added ; Z : labour productivity growth rate ;
 P : contribution to total productivity growth

COUNTRY	USA			CAN			JPN			DEU			FRA		
VARIABLE SECTOR	w	Z	P	w	Z	P	w	Z	P	w	Z	P	w	Z	P
AGR (1)	3,1	2,4	-0,1	3,1	0,2	-0,1	3,1	1,7	-0,1	2,7	7,0	0,0	7,8	8,4	0,1
(2)	1,9	3,6	0,0	3,3	0,7	0,0	3,2	0,7	-0,1	2,0	1,8	0,0	4,1	2,0	0,0
MID (1)	5,0	3,5	0,0	5,0	13,1	0,0	5,0	11,2	0,0	4,0	3,3	-0,1	2,9	-0,6	-0,1
(2)	3,3	5,8	0,0	6,3	4,1	0,1	0,3	4,0	0,0	0,9	1,4	0,0	0,9	6,3	0,0
MAN (1)	19,9	3,3	0,5	19,9	5,0	0,5	19,9	7,3	0,5	33,5	4,5	1,3	20,3	4,7	1,0
(2)	19,6	3,2	0,2	18,8	2,2	0,0	27,9	2,9	0,6	32,2	0,9	-0,1	23,6	2,4	0,0
EGW (1)	2,8	4,7	0,1	2,8	5,9	0,1	2,8	0,8	0,1	1,6	5,5	0,1	1,2	8,9	0,1
(2)	3,1	2,7	0,1	3,3	0,0	0,0	3,0	3,6	0,1	2,8	2,5	0,0	2,5	3,7	0,1
CST (1)	8,5	-2,4	-0,2	8,5	-1,1	-0,2	8,5	1,3	-0,2	8,6	2,5	0,2	7,8	2,8	0,1
(2)	4,1	0,2	0,0	5,9	-1,0	0,0	7,8	2,2	0,2	5,8	0,6	0,0	5,6	1,9	0,0
RET (1)	13,2	1,7	0,3	13,2	2,7	0,3	13,2	2,7	0,3	11,5	2,3	0,3	na	na	na
(2)	16,5	1,2	0,2	13,1	1,2	0,2	14,3	1,2	0,2	10,3	1,3	0,2	15,3	0,7	0,1
TRS (1)	4,8	3,7	0,1	4,8	3,1	0,1	4,8	1,1	0,1	5,0	4,0	0,2	na	na	na
(2)	6,3	2,5	0,1	7,0	2,7	0,1	6,3	1,7	0,1	5,8	3,1	0,2	6,3	4,2	0,3
FNI (1)	17,2	0,1	0,4	17,2	2,8	0,4	17,2	7,8	0,4	9,3	7,8	0,4	13,3	1,8	0,7
(2)	23,1	-1,0	0,2	18,0	0,8	0,4	14,6	1,8	0,3	12,9	1,8	0,3	18,8	-0,5	0,5
SOC (1)	8,2	1,1	0,1	8,2	-4,8	0,1	8,2	1,2	0,1	9,8	1,2	0,3	na	na	na
(2)	8,9	-0,9	0,1	5,4	1,3	0,1	13,5	1,2	0,2	13,0	2,1	0,7	5,1	1,1	0,2
TIN (1)	85,5	1,7	1,4	85,5	3,0	1,4	85,5	4,8	1,4	85,9	3,7	2,9	77,6	4,3	3,3
(2)	88,2	1,0	0,9	81,2	1,3	0,9	90,0	1,5	1,5	85,8	1,7	1,4	82,2	1,9	1,2
TET (1)	100,0	1,5	1,5	100,0	2,2	2,2	100,0	4,4	4,4	100,0	3,3	3,3	100,0	3,6	3,6
(2)	100,0	0,9	0,9	100,0	0,9	0,9	100,0	1,5	1,5	100,0	1,5	1,5	100,0	1,4	1,4

Table 2
 Employment growth breakdown by skill level
 in manufacturing and services
 (yearly growth rates in %)

	Blue-collar low-skilled		Blue-collar high-skilled		White-collar low skilled		White-collar high-skilled	
	Manuf. Ind.	Market Services	Manuf. ind.	Market services	Manuf. ind.	Market Services	Manuf. ind.	Market services
United States 1983-93	-0.2	0.2	-0.1	0.2	-0.1	1.4	0.2	0.9
Canada 1981-91	-0.7	0.1	-0.2	-	0.1	0.8	0.4	1
Japan 1980-90	0.1	0.3	-0.2	-0.1	0.5	1.3	0.4	0.9
Germany 1980-90	-0.8	-0.2	0.2	0.3	0.2	1	0.3	0.6
France 1982-90	-1.4	0.2	-0.3	-	-0.2	0.5	0.4	1.2
Italy 1981-91	-0.5	0.6	-1.0	0.1	-0.1	1.2	0.2	1.0
Australia 1986-91	-0.6	0.5	-0.3	0.1	-	1.2	0.4	1.8
New-Zealand 1976-91	-0.5	-1	-1.3	0.3	-0.1	0.8	-0.1	2.3

Source : OECD (STI/EAS Division)