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Who Benefits from Growth ?

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Who benefits from growth?*

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Abstract

In this paper we highlight the link existing between economic growth and inequality. Using the FH-DADS panel data set, resulting from the matching of Pôle Emploi (French National Employment Agency) historical database and the "Déclarations Annuelles de Données Sociales" data set (DADS), we show that inequality increases with mobility, and that mobility evolves with GDP variations.

Data show indeed that inequality tends to increase during economic growth periods and to decrease during slow down, through unequal mobility between individuals.

In order to explain this phenomenon, we use two structural models. One based on Jolivet, Postel-Vinay and Robin (2006) allows us to link inequality and mobility through equilibrium changes on the job market. Another one, due to Robin (2011), confirms on US data the link existing between inequality and economic growth.

JEL Classification : C23 ; J60 ; D31.

Key words : inequality, growth, labor market, mobility, panel data, equilibrium search model.

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When men living in a democratic state of society are enlightened, they readily discover that they are confined and fixed within no limits which constrain them to take up with their present fortune. They all therefore conceive the idea of increasing it; if they are free, they all attempt it, but all do not succeed in the same manner. (. . .) In free and enlightened democratic ages, there is nothing to separate men from each other or to retain them in their peculiar sphere; they rise or sink with extreme rapidity.

Alexis de Tocqueville, Democracy in America (1840, Translation by Henry Reeve)

1 Introduction

Alexis de Tocqueville explained in 1840 that social positions are not frozen in a democratic society. The functioning of society generates inequalities due to social mobility. This mobility comes from individual aspirations, their seek for well being, but also from human capital heterogeneity. According to Piketty (2001), skill differences and the ways they are evaluated are at the heart of this process.

This mechanism differs strongly from a representation of the job market, and more globally of society, that would be characterized by a stability of socio-economic positions, together with few mobility and associated with income inequality. If people can evolve differently, depending on their previous career, then in period of economic growth, some could benefit more from a wage level increase, and inequality could therefore increase.

Figure 1 shows that inequality, when measured as the income share of the 10% richest individuals in the population, is positively correlated with economic growth. During the 1964-2004 period, correlation between the two series is equal to 73,41% [1]. This correlation is relatively strong. Between 1964 and 1988, correlation even reaches the value of 85,41%[2].

Of course we only show here an illustration of this phenomenon since fiscal income is different from wage income [3]. Yet a positive link seems to appear, leading to the following question: if inequality and economic growth evolve in the same direction, how is this mechanism at work? This study aims to answer this question by looking whether, to a certain extent, inequality could be generated by individual mobility - differential, heterogeneous mobility - instead of a transmission of job positions. Obviously human capital plays a key role in this process but also the way in which the collectivity of economic agents values this capital at a given period of time.

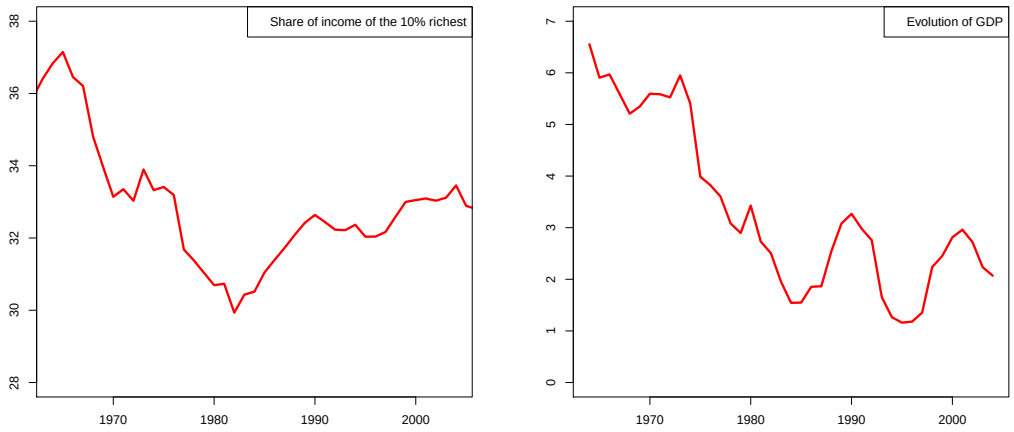
The link between growth and inequality is a controversial issue in economic literature. Kuznets (1955)'s inverted U-shape curve is the most famous example of formalization in this field, by linking inequality and level of development. It is based on differences in productivity between sectors of employment and their relative evolution during the development of a country, in an imperfect job market context.

[1] 95% bootstrap confidence interval is [56,79% ; 83,60%].

[2] This decrease in correlation observed during the last decades can eventually be linked to the existence of a particularly high unemployment rate during the nineties, associated with an intense introduction of technological innovations in a high number of sectors (in particular computer science, automation and web).

[3] One could thus think that the notion of fiscal income is not well suited because richer individuals have a higher share of capital income. Yet, in 2004, according to the "Revenus Fiscaux" French INSEE survey, at least 60% of income of the last decile was made up of wage income, which reduces in part this limitation.

Figure 1: Share of income of the 10% richest individuals in the population in whole fiscal income and evolution of GDP in volume



Source: Camille Landais and Thomas Piketty for income data, INSEE for GDP data. Notes: period is 1959-2005. The evolution of GDP is represented by its 5 years moving average.

Other theories and empirical analysis followed, contradicting this hypothesis. They are detailed in Attanasio and Binelli (2004), who draw a review of literature about the link between growth and inequality. We summarize below the two main trends.

Numerous authors assume a **positive correlation** between inequality and growth, through the study of individuals' savings and the incentive to invest. Different arguments can explain this assumption. One is based on Kaldor's hypothesis (Kaldor, 1961), which says that high income individuals have a higher marginal propensity to save. Argument leads to the conclusion that a country with more inequality will show higher economic growth. Another one is developed in Galor and Tsiddon (1997): appearance of new technologies generates high skilled job opportunities. Those sectors are not reluctant to pay more skilled workers, and inequality between skilled and unskilled workers increases. A last argument is about workers' motivation: under the assumption that wage is linked to productivity, some inequality is needed to maintain a sufficient national productivity. This was first formalized by Mirrlees (1971).

Other authors underline the **negative impact** of an unequal wage distribution on a country's growth through 3 factors: social and political instability, fiscal policies and taxation, and capital accumulation when facing imperfect credit market and inefficient financial market. The first factor comes from the fact that wage concentration, if too high, may lead to violence and social discontent (Hibbs, 1973): related instability and lack of regulation then discourage private investments. The second factor was developed by Benabou (1996): higher inequality decreases investment opportunities because marginal productivity of investments is lower for rich individuals, due to decreasing returns to capital. The last factor comes from imperfect capital markets. Inequality drives individuals to avoid lending, since in case of default it is impossible to ask for more repayment than what the borrower has. On the contrary, a redistribution policy allows individuals to use their own resources when starting a project, making them more responsible and thus increasing chances of repayment (Aghion et al., 1999).

Our paper follows this literature but goes beyond by showing how differences in mobility

between workers influence the link between growth and inequality.

Many authors have studied the measurement of mobility over the past few years. Buchinsky et al. (2003) look at the evolution of 6 different indices in France using the DADS panel and show that results strongly depend on the chosen index: income or ranks in income distribution, absolute or signed changes, etc. Shorrocks (1978), for his part, defined axioms on which a mobility index should be based, as Dalton (1920) and Cowell (1985) did for inequality indices. Yet numerous studies prefer looking directly at transition matrices between two periods, as did Givord and Wilner (2009) while studying job contract changes or Dickens and McKnight (2008) while studying wage mobility.

It seems that results always show heterogeneity, regardless of the type of mobility, depending on job or wage of individuals. Buchinsky et al. (2003) show that in terms of rank in wage distribution, the poorest and the richest individuals are less mobile than others. Groes et al. (2009) look at changes in social and occupational groups in Denmark and find that the probability to move depends on wage quantiles. Thus a hierarchy of jobs seems to exist. Regarding horizontal mobility, literature shows differences among sectors: while Lee and Wolpin (2004) show that the importance of the service sector strongly increased between 1950 and 2000, Givord and Wilner (2009) highlight the fact that this sector is a factor of instability: 2/3 of hiring are short term contracts in France in 2007 but this share reaches 3/4 when looking only at the service sector.

Yet, in light of these facts, few authors have considered the existence of a possible link between the evolution of inequality and mobility. Kopczuk et al. (2010) analyze jointly the evolution of wage mobility and income inequality in the United States. In the same way, Dickens and McKnight (2008) study the evolution of wage mobility between 1978 and 2005 with a mobility index introduced by Shorrocks (1978), using an English panel data set with individual yearly income. Mobility is assumed to have in this paper an income equalizing effect, at short and long term. The link is thus supposed to be negative.

Galor and Tsiddon (1997), for their part, study the link between inequality and intergenerational wage mobility. At each period an individual is born and chooses a job. If his human capital (partly inherited) is high and if new jobs with high returns on education exist, then his wage will increase relative to others who do not have the same human capital. Thus mobility and inequality are here linked positively.

To our knowledge, if the link between differences in wage mobility and inequality has been studied, the impact of other kinds of mobility seems to be somewhat eluded. Yet if vertical mobility - between social and occupational groups - is not the same for everyone, it seems logical to wonder about consequences of such a mobility. In the same way, horizontal mobility towards sectors where behaviors are different may cause inequality within careers. Among recent papers, only Atkinson et al. (2009) seem to briefly discuss the link between the evolution of inequality and the evolution of workforce in main sectors of employment, but rather to show that Kuznets (1955) inverted U-shape curve is not found in their data.

Using a unique French panel dataset, resulting from the matching of the ANPE (French National Employment Agency) historical data base and the French "Déclarations Annuelles de Données Sociales" panel data set (DADS), which allows to follow every employment and unemployment spell of private and semi private sector workers, we study in this paper the different categories of job market mobility, over a recent period in France. We aim at searching for a possible correlation between this mobility and the evolution of inequality. We also want to explain our empirical results through structural models based on Jolivet et al. (2006) and Robin (2011).

The paper is organized as follows. Section 2 describes data and presents some summary statistics. Following sections deal with different ways of measuring mobility and inequality from data and detail our empirical results. Finally we explain the underlying dynamics of these results with a structural model that links mobility and inequality.

2 Data and Measures

2.1 Data

The FH-DADS panel dataset results from the merge of two main sources: the ANPE (today "Pôle Emploi") historical database, that contains all job applications and their characteristics, and the "Déclarations Annuelles de Données Sociales" panel, that gives details about the wage of all individuals or corporate bodies, with the exception of departments officials (permanent or not), domestic sector and extraterritorial activities.

Selected individuals in the sample are those born in October of an even year and who have a job application or a DADS job episode between January 1999 and December 2004. Thus no information can be drawn after December 2004. Nevertheless, job applications ending after January 1997 and job episodes starting after 1976 are present in the dataset.

A limit of the panel is that the sample population is not representative of the whole population since it does not take into account inactive individuals. Besides, even in the worker population, the field of data is limited, since more than 10% of employees are state officials (central administration) and as a consequence are not taken into account in the base. For example, 83% of workers are covered by the panel in 2007, according to the French employment survey. We used occasionally the French Employment Survey to compensate for those limits.

In the framework of our study we limited our work to a more exhaustive period, that is to say between January 1997 and December 2004. From the dataset, we were able to reconstitute the careers of the whole group of 1 407 116 sampled individuals, for each month of the period. When one looks for example to year 2004, 49% of individuals experienced a job episode, 12% did not worked and applied for a job at the unemployment agency, and 38% were outside the scope of the FH-DADS panel.

The "Enquête Emploi" (French employment survey) is a survey carried out by the INSEE (the French National Institute for Statistics and Economic Studies) since 1950 and is the statistical source that allows to measure ILO unemployment. It also gathers data on occupations, youth working, work duration and insecure works. It allows for a better understanding of the situation of the unemployed and changes of situation towards employment.

Since 2003 this survey is described as continuous: collecting is carried out every quarter. Therefore, each individual is surveyed 6 consecutive quarters and a sixth of the sample is renewed every quarter.

2.2 Measures

2.2.1 The measurement of mobility

The term "job mobility" is associated with many concepts. Indeed at least four kinds of mobility coexist without obvious links between them. In September 2009 a report

on careers and mobility from the "Conseil d'Orientation pour l'Emploi" was published in France. It drew an overall review of papers on mobility aiming to give a general description of the field and to focus on its evolution (COE, 2009). Three types of mobility are thus highlighted.

First, wage mobility can be studied from two angles: changes of income levels and changes of ranks in wage distribution. For example, papers listed by the COE show that wage mobility became stable in France after a strong decrease during the seventies.

Second, changes of social and occupational group ("vertical" mobility) have for their part improved a lot since the eighties, whether upward or downward. For example, between 1998 and 2003, one worker over 3 changed groups, while one in five workers did between 1980 and 1985 (COE, 2009). We studied in our paper 6 different groups: corporate managers and craftsmen, executives, intermediate occupations (foremen, teachers, nurses, social workers...), white-collars, blue-collars and apprentices[4].

Last, changes of job within a same group ("horizontal" mobility) are shown as being frequent but without any clear evolution during last years. "DADS" classify jobs in numerous sectors that we gathered, for more readability, in 6 large sectors: industry I (raw material), industry II (car industry, machine making), energy, trade, transport and insurance, education and health (including information technology and research).

The 3 types of mobility that we studied in our paper (wage, vertical and horizontal mobility) can be measured from the analysis of transition matrices between 2 periods of time (see for example Beck and Kamionka (2012)). Yet we focused on a measurement based on indices. We used Buchinsky et al. (2003) indices for wage mobility, and Shorrocks (1978) index for vertical and horizontal mobility.

In a general way, wage mobility can be summarized with mobility indices, may it be a change of income level or a change of rank in wage distribution. We present them in appendix 6.1. We show below in figure 2 the evolution of some of these mobility indices between 1997 and 2003. One can see in particular that this evolution is strongly dependent on how the index is defined.

All indices show a more important evolution between 2000 and 2001, but not in the same direction. When mobility is measured as a change of income or a change of rank in wage distribution (in absolute terms), an increase is recorded, followed by a strong decrease the year after. When one looks at directional income changes, and in particular those measured in wage logarithms, the opposite is observed. Indeed a crisis occurred between 2000 and 2001, due to the bursting of a financial bubble linked to technological stocks (dot com companies), ending the growth of wages of the previous years. Thus, a lot of people experienced a drop of wage leading to stronger mobility in absolute terms, but a "negative" mobility since it leads to lower wage. In 2003, the situation does not seem to have improved.

More popular and easier to use, wage mobility indices are often used in literature. Yet it can be interesting, when one wants to understand the link between mobility and inequality, to summarize job or occupational group mobility. We saw indeed that mobility behaviors are not the same from one job (or sector) to another. In order to visualize the evolution of this mobility, the index defined by Shorrocks (1978), which is based on transition matrices, is a simple instrument for summarizing changes of state. A description of this index can be found in appendix 6.1.

[4]Results for apprentices are not shown in the following for clarity reasons.

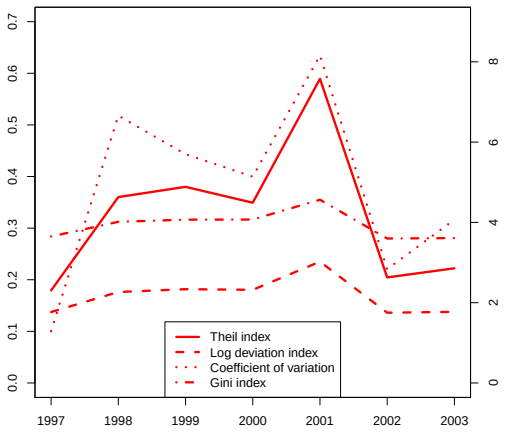
Figure 2: Wage mobility indices and Shorrocks' index computed on occupational groups and sectors transitions between 1997 and 2003

Source: FH-DADS. Notes: Left scale corresponds to income flow.

An increase of mobility between groups or sectors at the end of the nineties can be observed (see figure 2). It was followed by a decrease at the beginning of the 2000's when a crisis occurred, as we said, resulting in a drop in economic growth.

2.2.2 Inequality

Figure 3: Income inequality indices between 1997 and 2003



Source: FH-DADS. Notes: Right scale corresponds to coefficient of variation.

We show below in figure 3 the evolution of some income inequality indices computed on the whole sample.

The way those indices were measured is detailed in appendix 6.2. Variations are not all measured on the same scale but one can see that global evolution is somewhat identical

for all indices: an increase until 2001 followed by a relatively strong decrease, leading to levels observed in the middle of the nineties. [5]

3 A positive correlation between inequality and growth

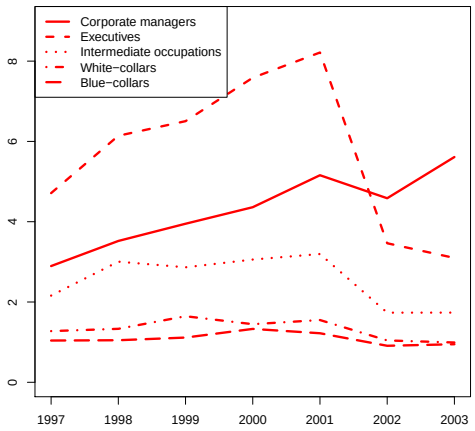
3.1 Different evolutions of mobility depending on individuals

Mobility may not be the same depending on the characteristics of individuals. This property is found to be true if we look at wage mobility or mobility across occupational groups.

3.1.1 Wage mobility

Wage mobility has a different evolution depending on occupational groups (see figure 4). One can see that levels of mobility are higher for groups with higher average wage, and that evolutions are also stronger for the latter. In particular, executives and corporate managers were most affected by the 2001 crisis.

Figure 4: Income flow index for different groups between 1997 and 2003



Source: FH-DADS

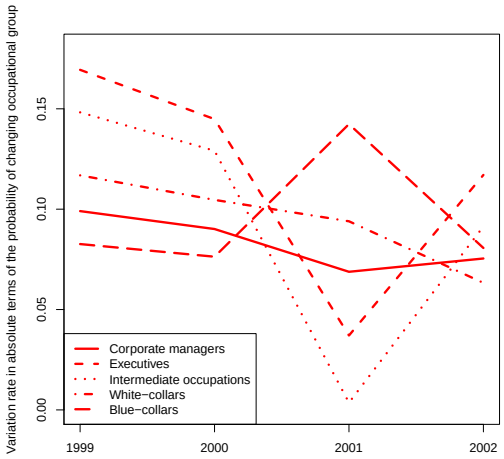
3.1.2 Vertical mobility

The evolution of the probability of changing group is not the same depending on social and occupational group. Yet one may notice that the variation of probability between

[5] Actually inequality indices usually found in the literature and used in our paper are wage inequality indices: they take into account only wage income. Yet if unemployment benefits were important, inequality could not be increasing with mobility since new low income workers would be in almost the same situation than when they were unemployed. That is why we have also defined a new kind of inequality: job income inequality. It takes into account the income of each individual: his wage if he is working and his unemployment benefits if he is unemployed. Results are quite similar (cf figure 19 in appendix 6.3). We did not include unemployment benefits in the following sections because data for public service lack in the FH-DADS panel.

2000 and 2001 shows a change of behavior (see figure 5). This time, blue-collar workers are those who seem to evolve more in terms of mobility.

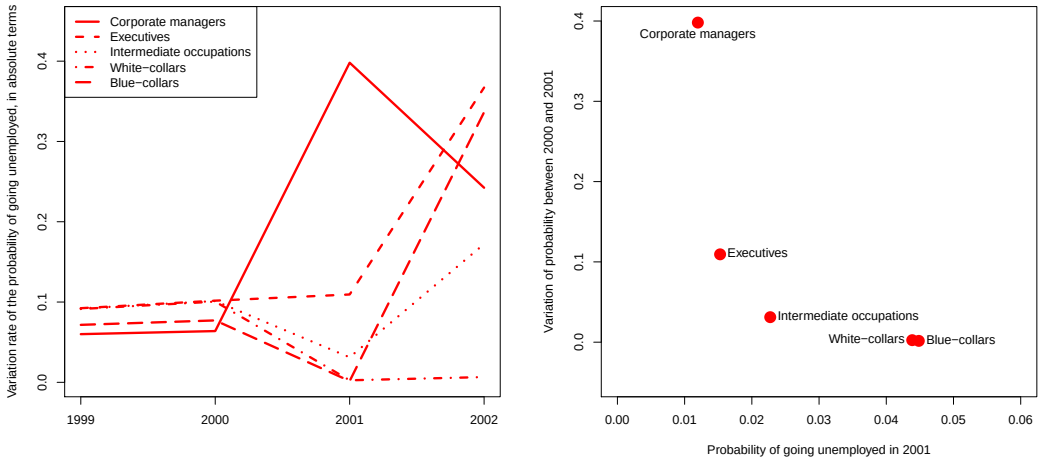
Figure 5: Variation rate of the probability of changing occupational group for someone who worked the previous year, between 1999 and 2002



Source: Employment Survey (INSEE). Notes: the variation rate is computed in absolute terms.

The evolution of the probability of becoming unemployed for a working individual is also different from one individual to another.

Figure 6: Variation rate of the probability of becoming unemployed for someone who worked the year before, between 1999 and 2002; level and variation rate of the probability of going unemployed in 2001 for someone who worked in 2000



Source: Employment Survey (INSEE)

Differences in variations of probability between different groups are particularly clear over the period 2000/2001 (see figure 6).[6] Three kinds of occupational groups may be

[6]The following years, from 2002 to 2006, were also studied using the "Enquête Emploi" survey. Differ-

summarized: white and blue collars have the strongest risk to go unemployed, executives and intermediate occupation workers have a lower chance to enter into unemployment and the risk is weakest for corporate managers.

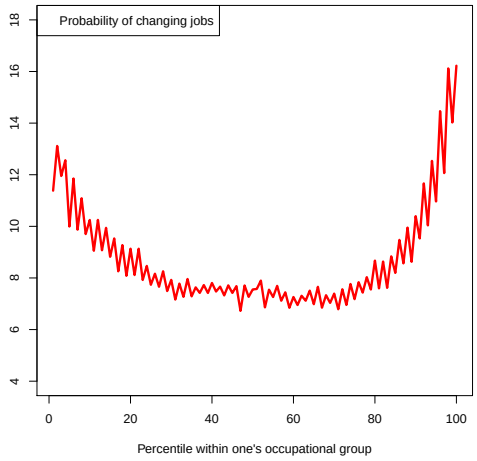
Thus high-wage groups have a higher mobility and a weaker probability of becoming unemployed.

3.2 An explanation of these differences

3.2.1 A stronger evolution for high wage workers

When one looks at the probability for an individual employed a given year of changing jobs the next year, a U-shape pattern can be observed (see figure 7). It depends on the rank in the wage distribution within the occupational group.

Figure 7: Probability of changing jobs for someone who worked the previous year



Source: FH-DADS. Notes: mean over the 1997-2004 period.

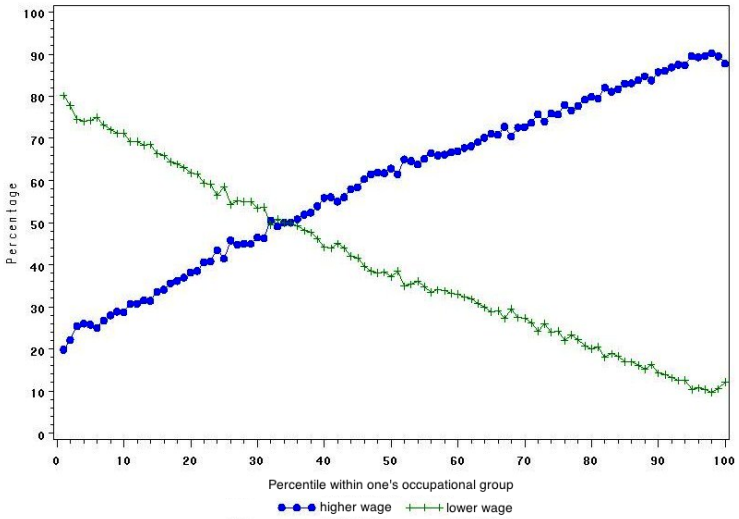
The shape of this relation was first highlighted by Groes et al. (2009) on Danish data. It remains valid when stratifying on gender but it depends on percentile within one's occupational group and not on the whole population. We could also obtain this relation using the residuals of the regression of the log of wage on a set of individual characteristics (such as experience, year dummies, etc.).

Consider now "vertical" changes (i.e. changes of social and occupational groups). Percentiles within one's group are given on the horizontal axis (see figure 8). The dark curve corresponds to the probability of changing occupational group for another one with at least the same average wage. The light curve gives the probability of transition from one group to another with a lower average wage. Workers with relatively higher wages (respectively lower wages) within their occupational group move more frequently into

ences are still present, but less evident. Indeed the "Enquête Emploi" became continuous after 2003. Because of this change, only few individuals can be followed from one year to another, especially if one wants the survey to be made at the same period than the previous one. Thus we did not include the results in the paper.

groups with higher average wage (respectively lower average wage). This result remains quite the same when one considers alternately the industry sector ("horizontal" changes).

Figure 8: Probability of changing occupational group for another one with higher or lower average wage, depending on the percentile within one's occupational group



Source: FH-DADS. Notes: first level of occupational groups (6 groups). Mean over the 1997-2004 period.

Mobility is not the same for all individuals. Groes et al. (2009) developed a theory in order to explain such differences. Consider the productivity of an individual i : $X_i = A_i + \epsilon_i$, where X_i stands for the production of individual i, A_i for his ability and ϵ_i is a residual term drawn from a standard normal distribution at each period. Individuals do not know their productivity.

The income of an entrepreneur k who employs individual i is: $R_{ki} = P_k X_i$, where P_k is the unit price of the good produced by the entrepreneur (distinct prices, augmenting with k). The entrepreneur gives a wage contract linked to the production in order to reach a given level of profit.

Then if there is no cost of changing occupation, workers will choose the job offer with the highest expected wage. Mobility comes from the existence of jobs with higher expected wage than individual's present wage, given the new information that workers get on their ability. Neither workers nor entrepreneurs are perfectly informed on skills. Each worker observes on a given period the output of his productivity and updates his a priori with a bayesian rule. The distribution of these a priori on expected skill in the whole population then determines benefits at equilibrium for each occupation.

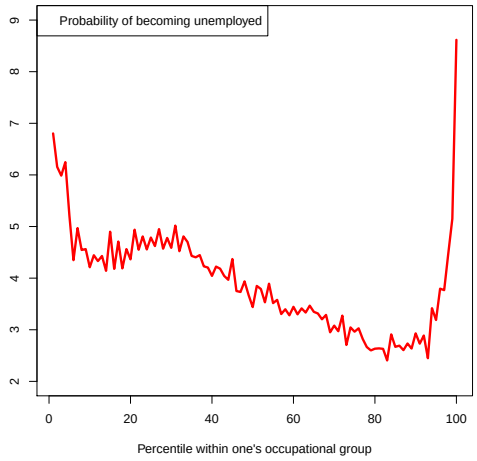
This model enables to explain two results that we found from our data:

- the relation between the probability of changing job and wage can be summarized with a U-shape curve (see figure 7).
- For each job group k, among individuals with a given experience who change job, the probability of changing for a job belonging to group $k' > k$ is higher when present wage is higher. Reciprocally, the probability of changing for a job belonging to group $k' < k$ is higher when present wage is lower. Transitions between occupational groups depend on the percentile within one's group and confirm these empirical implications (figure 8).

3.2.2 But with higher risks

Figure 9 shows that workers with the higher probability of losing their jobs and going unemployed are the "poorest" and the "richest" in their occupational groups. However, one can observe on figure 7 that these individuals are also the most mobile.

Figure 9: Probability of becoming unemployed for someone who worked the previous year



Source: FH-DADS. Notes: mean over period 1997-2004, in %.

In general it seems that the "poorest" and "richest" workers leave more frequently their occupational group, whatever the destination state (employment or unemployment). An explanation could lie in the behavior of firms who tend first to lay off highly paid workers (relative to their occupational group) and low skilled workers during economic slowdowns.

3.2.3 An explanation: mobility occurs towards new and risky sectors

The highest skilled workers (or the most productive) choose more frequently risky occupations with higher wage that they can leave quickly, for example during an economic slowdown. These new jobs come from technical progress and growth. A recent example could be the individuals working in financial services (and more particularly traders): jobs in this sector were very attractive and seen as a high wage destination. But this was a risky occupation and during the 2008 economic crisis a lot of workers in this sector had to find a new job or had to agree with a decrease in wage.

Thus, when one looks at the composition of the various sectors shown in the FH-DADS panel[7], it is interesting to note that these groups of jobs are different in terms of representativeness of occupational groups. For example, when looking at the share of the different social and occupational groups within each sector, it can be observed that proportions can vary up to 6 times more (see table 1).

[7]Note that farmers are not included in the dataset.

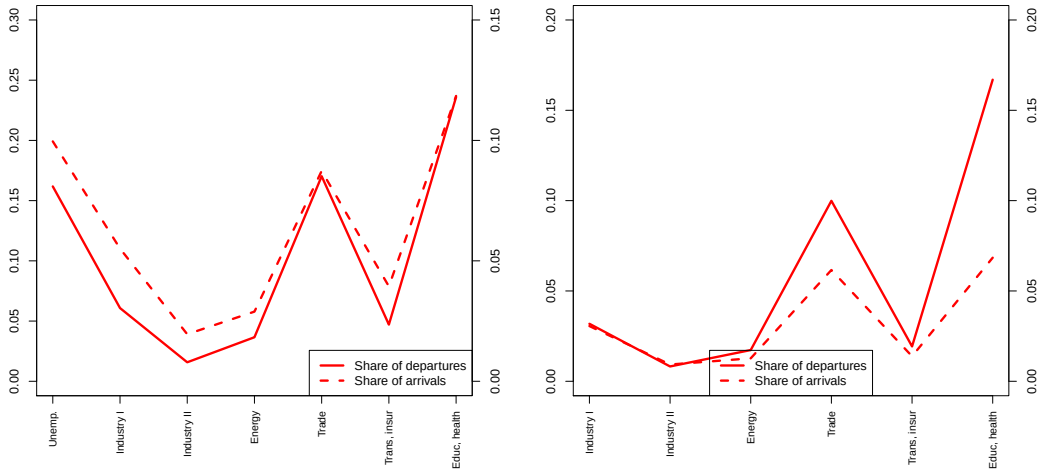
Table 1: Share of the social and occupational categories within each sector in 2004

	Industry I	Industry II	Energy	Trade	Trans,insur	Educ,health
Corp. managers	0,96	0,69	1,76	1,38	0,49	0,44
Executives	11,20	19,69	6,98	10,69	19,35	16,11
Int. occupations	19,35	23,35	18,47	21,79	27,89	27,78
White-collars	8,77	5,61	6,17	42,31	25,58	39,90
Blue-collars	57,66	49,03	62,63	20,32	26,13	12,80

Source: FH-DADS.

It can also be observed that mobility occurs mainly within specific sectors (service sector) where mobility involving unemployment is more frequent (see figures 10). These sectors offer occupations related in particular to information technology and research.

Figure 10: Share of departures and arrivals, within mobile individuals and for each sector, between two employment spells (left figure), and bewteen two employment spells separated by an unemployment spell (right figure)



Source: FH-DADS. Notes: left scale corresponds to the share of arrivals. Employment spells used for computations were those between 1997 and 2004.

The idea that workers in new sectors are better paid and more educated is quite common. For example, using firm level data, Bartel and Lichtenberg (1987, 1991) show that industries with relatively young or immature technologies pay more than industries based on mature technologies, for a worker at given age and education level. They also show that more educated individuals have a comparative advantage in implementing new technologies.

3.3 Differences that can explain the link between inequality and growth

As we said, mobility (wage or vertical) and its evolution differ among individuals. High skilled workers are thus more mobile than others but this mobility is more unstable and can vary along time (see figures 4 and 5).

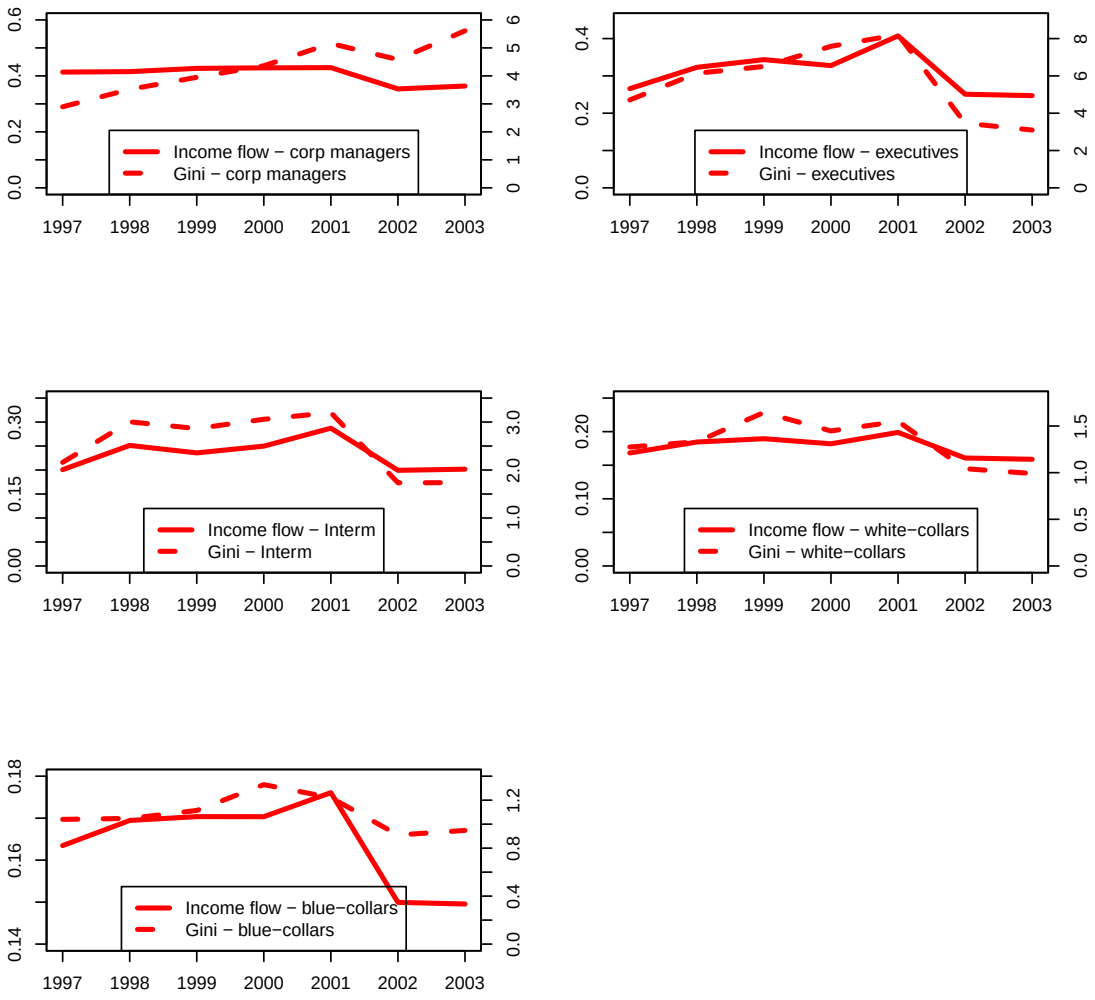
Besides this is also true for the evolution of inequality (see figure 11): inequality is stronger among groups with higher average wage.

It thus seems that mobility and inequality are correlated. We study this link in the following subsections.

3.3.1 A link between mobility and inequality

When one looks at the evolution of the Gini index and the income flow index, by occupational group between 1997 and 2003, behaviors seem to be closely related (see figure 11).

Figure 11: Gini index and income flow index by occupational group (1997-2003)



Source: FH-DADS. Notes: left scale corresponds to Gini index.

What is also striking in the figure is that the level of inequality for corporate managers and executives is quite high (it reaches 0.4) and those groups experience some strong

variations (the index doubles in 5 years for executives). Our results are nevertheless conform with recent literature. Indeed Koubi (2005) finds that the contribution of executives' inequality in whole inequality was multiplied by 8 between 1976 and 2000.

Yet it should be noticed that the link is not as strong when we compare the Gini index with other mobility indices. This is not surprising since we saw that each index is a summary of specific characteristics, and particularly with mobility.

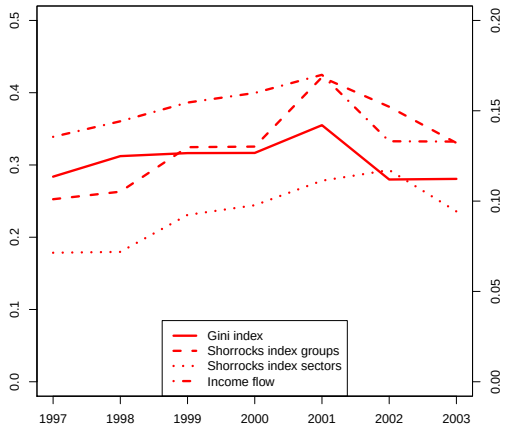
Besides, the parallel is less obvious for corporate managers. Wage dispersion for entrepreneurs is indeed stronger in cross section because there is a strong heterogeneity of situations among them and because each individual faces on average a high probability of experiencing a change of income from a period to another. This higher average payment is indeed linked with a higher risk. For other groups, on the other hand, results are more edifying.

3.3.2 What is observed on whole population

Is there a link between mobility indices and inequality indices? Superimposing the different indices on the same figure can bring an answer (see figures 12).

Inequality, summarized by the Gini index, wage mobility, described by the income flow index, and vertical and horizontal mobility evolve in the same direction. This indicates that wage mobility and job mobility are linked. And results reflect this idea: more wage inequality is correlated with higher mobility level between occupational groups or between sectors.

Figure 12: Gini index and Shorrocks' index for vertical and horizontal mobility

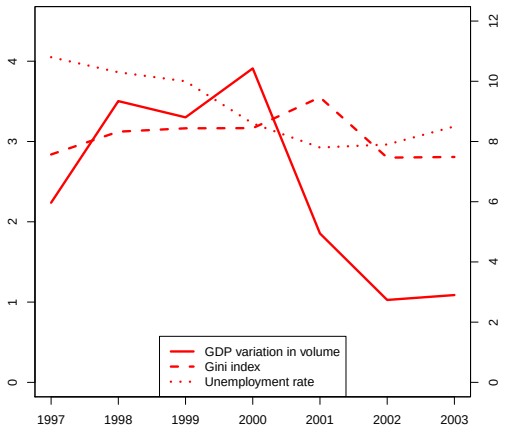


Source: FH-DADS. Notes: right scale corresponds to income flow index.

When looking at the joint analysis of unemployment rate, GDP evolution and inequality, a one year lagged link with GDP and, most of all, in anti phase with unemployment, seems to exist: an increase in unemployment due to a reversal of the economic situation the previous year leads to a decrease in inequality (see figure 13). This supports our results.

How can we explain the link between growth and inequality?

Figure 13: GDP variation, unemployment rate and Gini index between 1997 and 2004



Source: INSEE and FH-DADS. Notes: right scale corresponds to unemployment rate.

An explanation could lie in the mobility of workers: they can climb within their occupational group (in particular the lower wage workers) or from one group to another (in particular the higher wage workers). There is also a stock of unemployed - more particularly the youth - that continuously supplies the lower part of wage distribution.

In period of economic growth and job market improvement, the youth go more often into employment (cf. figure 20 in appendix 6.3). Besides, wage mobility increases but most of all for high skilled workers. In that context, inequality increases.

In period of economic slowdown (from 2001), fewer people go into the lower part of wage distribution and wage mobility decrease for high wage workers. Besides some of these high wage workers may lose their jobs (see figure 9). Thus mobility and inequality decrease. We can talk of composition effect (the situation gets better only on the surface).

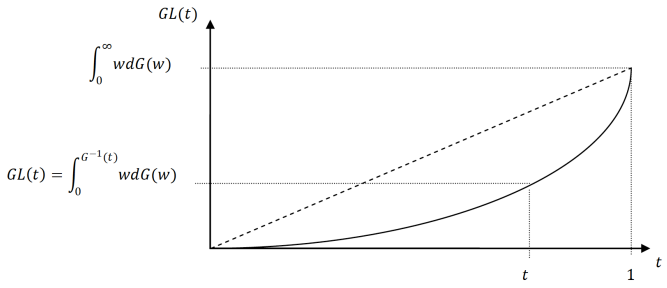
We describe below a model that allows to explain those linked evolutions.

4 Explaining the link between inequality and growth

4.1 Linking mobility and inequality : the model of Jolivet et al. (2006)

In order to define a structural model that meets our empirical results, our idea is to use a model proposed by Jolivet et al. (2006) to highlight under some assumptions the link between mobility and inequality. This model allows indeed to get a relation between accepted wage and mobility rate on the job market. Let w denote the accepted wage and G its distribution. It is then possible to draw the Lorenz's curve from G (see figure 14).

Figure 14: Lorenz's curve



Thus one can obtain the expression of the Gini index, which links mobility and inequality.

$$Gini = 1 - 2\frac{\int_0^1 \int_0^{G^{-1}(t)} wdG(w)dwdt}{\int_0^{\infty} wdG(w)}$$

Description of the model Jolivet et al. (2006)

Consider a population of potential workers with a proportion u of unemployed individuals. They receive employment offers with the hazard rate λ_0. Let w denote a wage offer and let $F(w) \in [\underline{w}, \overline{w}]$ denote the wage distribution. There is also on-the-job search, with λ_1 denoting the job offers arrival rate when workers are employed. An employed individual decides to move from one job to another if he/she receives a wage offer higher than his current one, which occurs with probability $\overline{F}(w) = 1 - F(w)$. Finally let δ denote the layoff rate.

At the equilibrium there is equality between entry into and exit from unemployment:

$$\lambda_0 u = \delta(1-u) \Longleftrightarrow u = \frac{\delta}{\delta + \lambda_0} \tag{1}$$

Let $G(w)$ denote the share of the $1-u$ workers who have a wage lower than w. The probability of getting a wage lower than w is thus $(1-u)G(w)$. At the equilibrium the number of individuals who find a job with a wage lower than w is the same than the number of workers who lose their job or find a job with a wage higher than w[8]. Then:

$$[\delta + \lambda_1 \overline{F}(w)](1-u)G(w) = \lambda_0 u F(w) \tag{2}$$

Taking into account the balance of flows into and out of unemployment (equation (1)), this gives,

[8]From now on w represents the logarithm of wage and job offers are such that the log of wage is a normal random variable.

$$G(w) = \frac{\delta F(w)}{\delta + \lambda_1 \overline{F}(w)} = \frac{F(w)}{1 + \frac{\lambda_1}{\delta}\overline{F}(w)} \tag{3}$$

$$G'(w) = \frac{\delta(\delta + \lambda_1)}{(\delta + \lambda_1 \overline{F}(w))^2} F'(w) \tag{4}$$

A link between mobility and inequality

With these equations, linking mobility and inequality becomes possible. Using the $G(w)$ function, one can indeed draw the Lorenz's curve, which allows to compute the Gini index. Using a mathematical software, the evolution of the Gini index with mobility rates can then be drawn.

What is the link between the job offers arrival rate, the job destruction rate and mobility defined in our previous sections? We show in appendix 6.4 that the Shorrocks' index can be easily computed from these different rates and is an increasing function of them. These arrival rates depict thus well occupational mobility.

However the wage offer distribution $F(w)$ needs to be determined for computations because it cannot be observed. In order to characterize this distribution, assume that wage offers follow a log-normal distribution. Using the observed distribution $G(w)$, one can then compute the mean and the variance of the wage offer distribution $F(w)$.

Assume now that there is a proportion $p_u = p$ of unskilled workers in the population and a proportion $p_s = 1 - p$ of skilled workers[9]. Each group of individuals follows its own distribution of accepted wages and offered wages (G_u for unskilled workers, and G_s for skilled workers). The mean and variance of these distributions have to be computed. Whole distributions are then deduced from wage distributions of each subgroup. We get $G(w) = pG_u(w) + (1-p)G_s(w)$.

In order to measure for each subgroup of workers the empirical mean and variance of the accepted wage distribution $G(w)$, we use the french employment survey. We compute the moments of the wage offer distribution $F(w)$ such that theoretical moments of the accepted wage offer distribution $G(w)$ are as close as possible to empirical moments. In order to do so, we use the parameters estimated by Jolivet et al. (2006):

Parameters	Skilled workers	Unskilled workers
δ	0.0140 (0.0016)	0.0217 (0.0019)
λ_1	0.0632 (0.0100)	0.0639 (0.0078)
λ_0	0.1480 (0.0150)	0.5717 (0.0998)

Because the log of the wage offer distribution is assumed to be normal, computations lead to $F'(w) = \frac{1}{\sigma_F}\phi(\frac{w-\mu_F}{\sigma_F})$ and $F(w) = \Phi(\frac{w-\mu_F}{\sigma_F})$. Then using equation (4) one gets

$$G'(w) = \frac{\delta(\delta + \lambda_1)}{(\delta + \lambda_1 \overline{F}(w))^2} F'(w) = \frac{\delta(\delta + \lambda_1)}{(\delta + \lambda_1(1 - \Phi(\frac{w-\mu_F}{\sigma_F})))^2} \frac{1}{\sigma_F}\phi(\frac{w-\mu_F}{\sigma_F}) \tag{5}$$

The expressions of the theoretical moments of $G(w)$ can thus be written as follows:

[9] We called skilled worker every individual who had a diploma corresponding to at least two year of college in the french employment survey.

$$\begin{cases} E_G(w) = \int_{-\infty}^{+\infty} wG'(w)dw = \delta(\delta+\lambda_1)\int_{-\infty}^{+\infty} \frac{w\frac{1}{\sigma_F}\phi(\frac{w-\mu_F}{\sigma_F})}{(\delta+\lambda_1(1-\Phi(\frac{w-\mu_F}{\sigma_F})))^2}dw \\ V_G(w) = \int_{-\infty}^{+\infty}(w-E_G(w))^2G'(w)dw = \delta(\delta+\lambda_1)\int_{-\infty}^{+\infty} \frac{(w-E_G(w))^2\frac{1}{\sigma_F}\phi(\frac{w-\mu_F}{\sigma_F})}{(\delta+\lambda_1(1-\Phi(\frac{w-\mu_F}{\sigma_F})))^2}dw \end{cases}$$

Assume now that $E_G(w) = \mu_G = \mu_{emp}$ and $V_G(w) = \sigma_G^2 = \sigma_{emp}^2$, or in other words that the theoretical moments of $G(w)$ are equal to the empirical moments. This leads to a nonlinear system with two unknown parameters μ_F and σ_F^2, i.e. the moments of the wage distribution $F(w)$. Solving this system gives the value of moments for skilled and unskilled workers.

One can then compute the value of the Gini index for each value of the mobility rates using the accepted wage distribution: $G(w) = pG_U(w) + (1-p)G_S(w)$.

$$Gini = 1 - 2\frac{\int_0^1 \int_0^{G^{-1}(t)} wG'(w)dwdt}{\int_0^\infty wG'(w)dw}$$

The obtained function $Gini(\delta^U, \lambda_1^U, \delta^S, \lambda_1^S)$ depends on the mobility rates of skilled and unskilled workers. In order to illustrate this phenomenon, we assume that the mobility of unskilled workers does not vary, which helps taking into account the higher mobility level of skilled workers.

Note that this assumption of higher stability of mobility for unskilled individuals is consistent with our empirical observations.

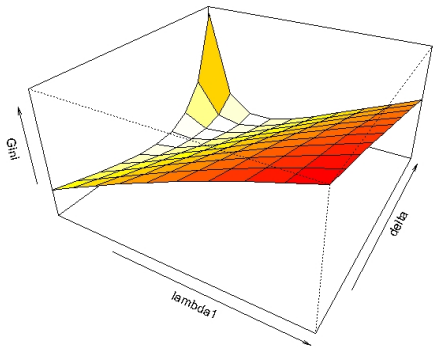
We saw indeed that the following points were observed in our data:

- Wage mobility evolves over time, differently depending on one's social and occupational group: mobility measured by the income flow index is higher for occupational groups with higher average wage (see figure 4).
- The evolution is more important for occupational groups with higher average wage: the evolution of the probability of changing group (which is representative of job to job mobility rate) is not the same depending on the occupational group. The same is found for the probability of losing one's job, which is representative of job destruction rate (see figure 5).

It is then possible to draw, with a mathematical software, the inequality index as a function of λ_1^S and δ^S (see figure 15).

It can be observed that inequality, measured by the Gini index computed on the distribution of accepted wage, increases with the job offers arrival rate and decreases with the layoff rate. Then, during a period of economic growth, upward mobility increases (more employment opportunities and fewer job losses) and wage inequality increases. Note that inequality also increases in the absence of wage offer for skilled workers when their layoff rate increases because the situation of unskilled workers has been set. Figure 15 meets our empirical results obtained on the FH-DADS panel and on the french employment survey.

Figure 15: Gini index as function of job offer arrival rate λ_1^S and layoff rate δ^S



It is possible to look at our results with a broader interpretation. Thus, innovation and growth are correlated: the introduction of steam engine and its improvements allowed for the building of particularly efficient pumps in England in the late 18th century (see the work of James Watt) and was followed by a significant increase in the production of coal, at a lower cost. This high amount of coal available at a low price was an important factor for encouraging progress, especially in steel production. This led to the building of steam machines, used for example for the construction of locomotives. Thus innovation can generate economic growth, and also promote the emergence of other innovations (Joseph Schumpeter speaks of "clusters of innovation"). Innovations lead to the creation of new jobs requiring skilled workers. Thus the demand for skilled workers during growth periods increases and income inequality follows.

The intense arrival of innovations during the years 1990-2000 may be an explanation for the lower observed correlation between growth and inequality in the short term: these innovations gradually spread throughout economy, mutually reinforcing each others and maintaining inequality at a relatively high level.

4.2 Linking a country's inequality and its growth

The limit of our previous model is that it does not include growth endogenously. Yet it is possible to find in the literature models that incorporate productivity shocks in the labor market. As an example that may illustrate our theory on the link between inequality, careers and growth, we use the model developed in Robin (2011). This matching model goes beyond the previous search model by introducing aggregate productivity shocks.

This allows to deduce, from a growth trajectory, a dynamics of wage distribution and mobility. Worker's mobility can be summarized by the exit rate from unemployment, job to job mobility and job destruction rate.

Using the data provided by the author (BLS quarterly series) and using his estimated parameters, it is possible to plot jointly the evolution of growth, wage distribution and mobility over the last decades.

The two structural models that we consider in this section are complementary in some aspects. The model that we described above, based on Jolivet et al. (2006), allows to correlate the evolution of mobility and the evolution of wage inequality. The other, due to Robin (2011), allows to take into account the relation between growth and mobility. These models are conceptually closely related and both belong to job matching theory.

A quick summary of Robin (2011) model

The economy may experience N state of production and state may change with probability transition matrix π. M types of workers with ability x_m may match with a job if the surplus of the match $S_t(m)$ is above 0. The output $y_i(m)$ of a worker m depends on his ability but also on the aggregate productivity.

The unemployment rate for a category of workers and at a period t is denoted $u_t(m)$ and the proportion of workers m in the population is l_m. The following mobility rates can then be computed:

- Exit rate from unemployment

$$f_t = \lambda_0 \frac{\sum_m \mathbb{1}_{S_t(m)>0} u_t(m) l_m}{u_t}$$

- Job-to-job mobility

$$q_t = \tau \lambda_1 (1-\delta) \frac{\sum_m \mathbb{1}_{S_t(m)>0} [1-u_t(m)] l_m}{1-u_t}$$

- Job destruction rate

$$s_t = \delta + (1-\delta) \frac{\sum_m \mathbb{1}_{S_t(m)\leq 0} [1-u_t(m)] l_m}{1-u_t}$$

For each state of economy and each type of worker, wage offers are supposed to take only 2 values: $w_{min}(m,t)$ and $w_{max}(m,t)$. This assumes that employers have full monopsony power with respect to workers and that firms are identical with no mobility costs.

At each period, the output of a worker changes, depending on the new state of the economy. The new surplus of the match may thus lead workers to remain in their job, find a new job with a better wage, loose their job and go to unemployment or leave unemployment and find a job. A distribution of accepted wage $g_t(w,m)$ may thus be computed at each period.

A simulation of wage trajectories

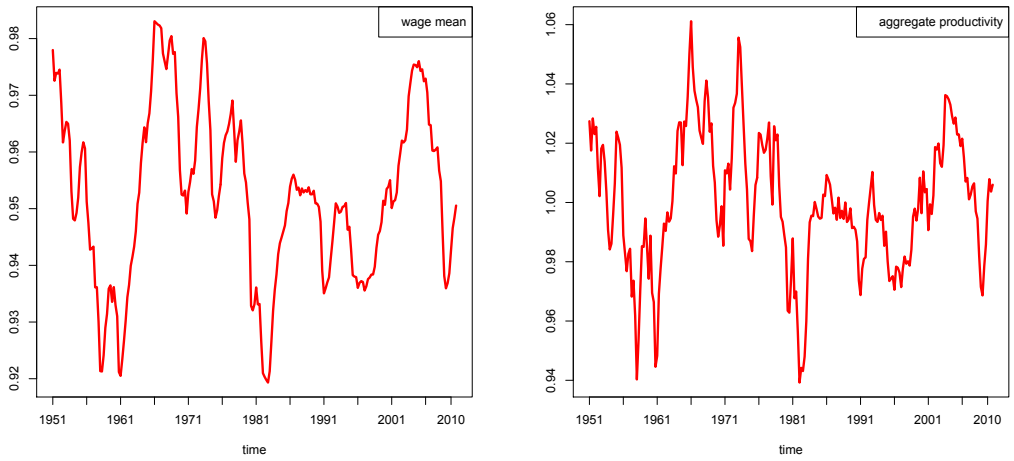
In order to see the implications of the model on the link between growth and inequality, we simulate some wages for 500 types of workers (occupational groups).[10]

We use the estimated values of parameters obtained by Robin (2011). This gives us, for each quarter between 1951 and 2011, the wage distribution corresponding to the state of

[10]We thank Jean-Marc Robin for providing access to his programs and data.

the economy at that time. Data used to construct the aggregate productivity process are the BLS quarterly series of seasonally adjusted real output per worker in the non-farm business sector (see Robin, 2011).

Figure 16: Predicted wage mean and aggregate productivity



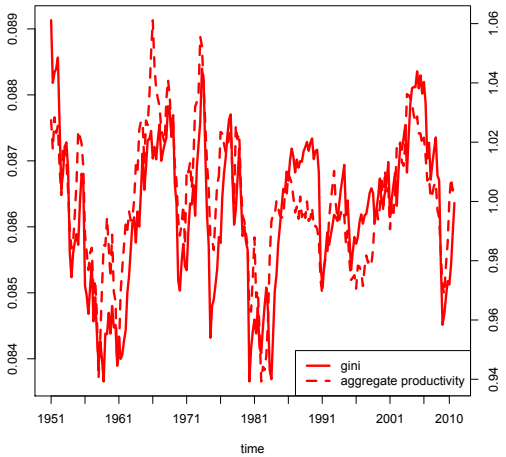
Source: Robin (2011) and authors computations.

Thanks to the distribution of wages, one can compute at each period the Gini index. Since observed wage distribution is discrete, we use the following definition of the index:

$$Gini = \frac{1}{2\bar{w}} \sum_i \sum_j g(w_i) g(w_j) |w_i - w_j|$$

The Gini index shows a strong correlation with the evolution of productivity and inequality clearly increases during growth periods.

Figure 17: Gini and aggregate productivity (US data)

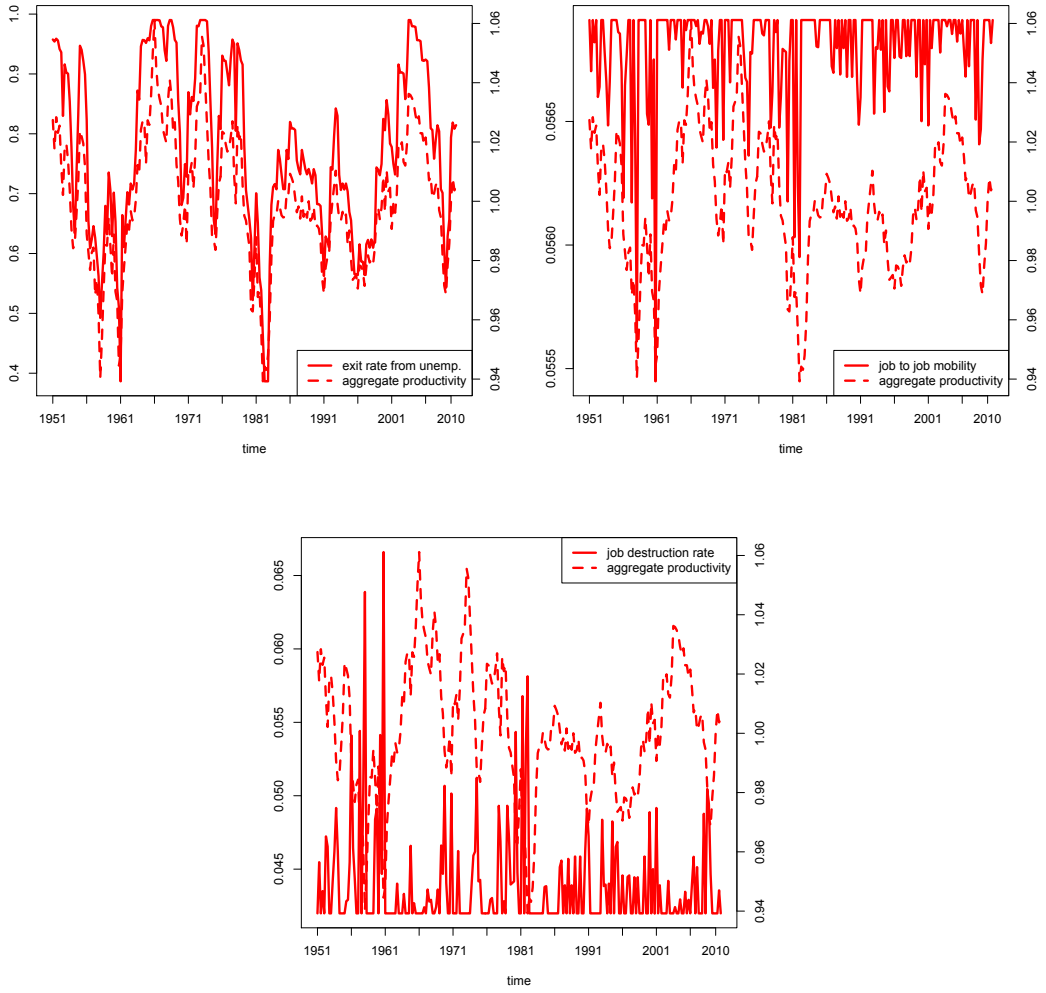


Source: Robin (2011) and authors computations. Notes: left scale corresponds to Gini index.

Correlation between aggregate productivity and Gini index is higher than 76% over the whole period.

Mobility indices are also computed along the model. They also show a strong correlation with productivity. Correlation between growth and the job offer arrival rate is indeed equal to 96%. For job-to-job mobility and job destruction rate, assumptions of the model imply that workers are laid off only when aggregate productivity is such that the surplus of the match becomes negative. Yet a strong correlation can be observed, pro-cyclical for job-to-job mobility and counter-cyclical for the job destruction rate.

Figure 18: Mobility indices



Source: Robin (2011) and authors computations. Notes: right scale corresponds to productivity.

We argued that growth and technical progress take part in the development of new sectors and new jobs, that are often better paid but correspond to more risky activities. Those occupations are often held by highly skilled individuals and a differential in the evolution of occupational mobility occurs. The matching models we presented above enables to explain and illustrate how this heterogeneity in mobility among workers is linked to wage inequality.

5 Conclusion

Kuznets (1955) thought that the evolution of inequality could be summarized with a U-shape curve. His description corresponds to the transition from primary sector to town with mostly jobs in manufacturing and service sectors. In this context inequality should decrease as long as the primary sector is losing its workers. Now let us hypothesize that non primary sector - town for Kuznets - contains an variety of jobs in terms of required skills and that this heterogeneity is always renewed. Indeed new sectors appear continuously with highly skills required jobs, and lead interested individuals to get some highly specialized education. Under this assumption there would not be any global decrease in inequality and some strong growth in inequality could even be observed during highly innovative times (China's case for a few years now). Kuznets's curve was thus quite criticized recently (see for example Atkinson et al. (2009)).

In this paper, we were interested in the link between growth and inequality through the study of mobility. Data thus show that because of unequal mobility between individuals, income inequality tends to increase in period of economic growth and to decrease when growth is slowing down. In order to explain this phenomenon, we used a structural model based on the one proposed by Jolivet et al. (2006). It allowed us to link inequality and mobility through changes of equilibrium on job market. We also described another model developed in Robin (2011), allowing to take into account the link between growth and mobility. Those models met our empirical relations and confirmed the existing positive link between inequality and economic growth.

Inequality can thus increase naturally during economic growth justifying the use of redistribution policies. Yet a redistribution policy would not be neutral in terms of economic growth at least because it modifies the amount and structure of consumption. Even if one wants to maximize for example the current value of a sequence of redistributed income, interdependence between growth and inequality should be taken into account. Inequality, growth and innovation are closely linked concepts that may depend on other factors such as institutional context (corruption, quality of administration, etc. (Guasch et al., 2007)).

For now the missing key element in our demonstration is maybe innovation, which continuously renews the link between growth and inequality. Indeed, the dissemination of technical progress has probably a nonlinear effect. Dissemination between sectors may increase inequality as a greater share of workers concentrate high wages. But dissemination within sectors will probably decrease inequality as it induces an increase of labour supply for the corresponding specific abilities and a decrease of the related wage premium. The nature and the stability of the relationship between growth and inequality depend intrinsically on the intensity of innovation.

In addition it is known that world inequality rose over a long period of time (see Bourguignon and Morrisson (2002)). Even if this increase was far weaker from the fifties to the seventies, inequality increased again over the period 1970-1992. World inequality and its evolution can be broken down into inter-country inequality and intra-country inequality: this is the case when using a Theil inequality index. Inter-country inequality never stopped increasing during the period 1820-1992, while intra-country inequality decreased between 1910 and 1992.

Countries can also be represented as economic agents within a world economy. Our results, if transposed to this economy, tend to confirm the idea that if innovation and

growth are related, then investment and research are the main impulse of growth. This growth may be the source of inequality between economic agents, or countries. But this growth is also necessary to face productivity gains and, if there is any, demographic growth. The role of the state is then to adjust inequality by making a hard trade-off between solidarity and efficiency, between short and long term. Economy can throw light on ways to achieve those goals and to check the effectiveness of this action. It can also provide information about the consequences of such economic choices.

6 Appendix

6.1 Constructing mobility indices

Measuring mobility by a single indicator is ambitious. Indeed, the concept of mobility can be understood in several ways and produce several types of indices. Buchinsky et al. (2003) recall the expressions of five indicators for wage mobility.

- The **time dependence index** measures the influence of past individual economic welfare on current individual welfare. Several ways to compute it are proposed in the paper and we selected in our study only the following definition: $TD = -\sum_{ij} \frac{(p_{ij}-0.1)^2}{0.1}$, where p_{ij} is the transition probability from decile i to decile j.
- The **positional movement indices** reflect the movements of individuals in their economic position (rank, decile, percentile...). Let $quant$ denote the studied quantile, then $PM = \frac{\sum_i |quant(y_{it-1}) - quant(y_{it})|}{n}$.
- The **share movement index** follows the evolution of individual shares in the aggregate income of the population : $SM = \frac{\sum_i \left| \frac{y_{it-1}}{\bar{y}_{t-1}} - \frac{y_{it}}{\bar{y}_t} \right|}{n}$.
- The **income flow index** allows to track changes in income of individuals (or logarithms of income) : $IF = \frac{\sum_i |y_{it-1} - y_{it}|}{n}$.
- The **directional income change index** measures the same changes but treats separately gains and losses : $DIM = \frac{\sum_i y_{it} - y_{it-1}}{n}$.

Shorrocks (1978), for his part, defined several properties that a mobility index should verify, somewhat in the manner of Dalton (1920) and Cowell (1985). These groups of index are computed with transition matrices between states, and meet criteria such as immobility (value of the index for a unit matrix is equal to zero), invariance between periods (which allows to compare two transition matrices over different periods) or monotonicity (if each coefficient p_{ij}, $i \neq j$, of a transition matrix are such that $p_{ij} > p'_{ij}$, then the population represented by this matrix is more mobile than the population whose matrix has coefficients p'_{ij}). Thus, Shorrocks proposes an index computed from a transition matrix P: $\hat{M}(P) = \frac{n - trace(P)}{n-1}$, where n is the number of states.

Besides, the mobility indices are computed from changes of state from January to January of next year. For example, the value of an index in 1999 represents the mobility that occurred between January 1999 and January 2000.

6.2 Constructing inequality indices

An index is by definition the representation of some characteristics and therefore a simplification of reality. Several indices can coexist and describe the same characteristics, depending on whether one wants to focus on particular aspects of a problem.

Thus, for example, indices used to describe inequality are numerous. The most known are summarized in Litchfield (1999). There exists several ways to measure inequality, and variance appears to be the easiest one. However such an indicator is improper and should be interpreted carefully since, for example, if the whole income of a population is doubled, measured inequality is quadrupled.

Five prerequisites have been defined to assess the relevance of an index (Dalton (1920), Cowell (1985)). The principle of **Pigou-Dalton transfer** says that a transfer of income from a poor person to a rich person should not be recorded as a decrease in inequality, and vice versa. The **independence of income scale** requires that the inequality index is invariant to a proportional change identical for the whole population: if the income of all individuals is doubled, then the index should not be affected. The **principle of population** requires the index to be invariant in case of a replication of the population. Thus merging two identical populations should not affect the measure of inequality. The axiom of **symmetry** means that inequality does not depend on individual characteristics other than income. Finally, the **principle of decomposability** requires that the inequality index of a population is linked to inequality among its various subgroups. We present below the most known indices:

The **Gini coefficient** satisfies four axioms out of the 5 we presented, but cannot be decomposed in a simple way using inequality within subgroups of people and between these groups:

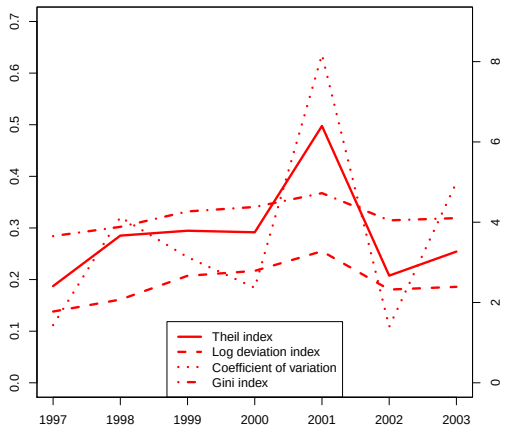
$$Gini = \frac{1}{2n^2\overline{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| y_i - y_j \right|$$

Less popular but with the advantage of satisfying all the axioms, generalized entropy indices are also interesting. It is the case for the **log deviation index**, $MLD = \frac{1}{n} \sum_{i=1}^{n} \log \frac{\overline{y}}{y_i}$, the **coefficient of variation**, $CV = \frac{1}{\overline{y}} \left[\frac{1}{n} \sum_{i=1}^{n} (y_i - \overline{y})^2 \right]^{1/2}$, and the **Theil index**: $Theil = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{\overline{y}} \log \frac{y_i}{\overline{y}}$.

What does the decomposability of an index allow? In the case of the Theil index, it is possible to show that $Theil = \sum_{m=1}^{M} s_m Theil_m + \sum_{m=1}^{M} s_m \log \frac{\overline{y}_m}{\overline{y}} = Theil_{intra} + Theil_{inter}$, where the population is divided into M subgroups. The share of total income of group m is equal to s_m. This enables to see whether inequality is the result of inequality between different groups (inter), or alternatively is due to inequality between individuals within groups (intra).

6.3 Complementary figures

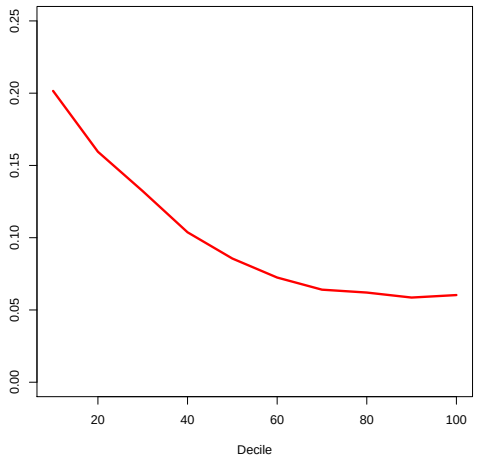
Figure 19: Inequality indices including unemployment benefits



Source: French Employment Survey (INSEE).

Remark: the figure shows an increase in inequality in 2001, and a general shape very close to the one depicted by inequality computed using wage only.

Figure 20: Share of new workers coming from unemployment within wage distribution (wage between 1997 and 2004)



Source: FH-DADS

6.4 Mobility and job offers arrival and destruction rates

What is the link between job offers arrival and destruction rates and the mobility index we defined in previous sections? In order to understand it, it can be useful to compute the Shorrocks' index (defined in appendix 6.1) from the transition probability matrix. In order to simplify, only two states are considered: unemployment and employment. There

is thus a job offers arrival rate for unemployed individuals, λ_0, and a job destruction rate for workers, δ.

Let Q be the matrix of transition intensities: $Q = \begin{bmatrix} -\lambda_0 & \lambda_0 \\ \delta & -\delta \end{bmatrix}$. By definition, the transition probability matrix takes the following value:

$$P(t) = \exp(Qt)$$

where $t \in R^+$ represents the observation length.

One can obtain, after computations, $P(t) = \frac{1}{1+\frac{\delta}{\lambda_0}} \begin{bmatrix} \frac{\delta}{\lambda_0} + \exp(-(\lambda_0+\delta)t) & 1 - \exp(-(\lambda_0+\delta)t) \\ \frac{\delta}{\lambda_0} - \frac{\delta}{\lambda_0}\exp(-(\lambda_0+\delta)t) & 1 + \frac{\delta}{\lambda_0}\exp(-(\lambda_0+\delta)t) \end{bmatrix}$.

The Shorrocks' mobility index can thus be computed:

$$I_{Shorrocks} = 2 - trace(P) = 1 - \exp(-(\lambda_0 + \delta)t)$$

As a result mobility is linked to transition rates.

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