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Abstract

In this paper, we analyze the changes in the risks of involuntary job loss in France between 1982 and 2000. Our analysis suggests that these risks are structurally higher in the 1990s than they were in the 1980s for both high and low-seniority workers. We develop a new labor demand model to interpret these persistent changes. We show that they are consistent with a decrease in the relative productivity of high-seniority workers.

Keywords: Labor Demand, Job Stability, Seniority.

JEL: J23, J63.

1 Introduction

In most Western countries, an increasing number of workers are worried about the risks of losing their job (OECD, 1997, Schmidt, 1999). Job stability is a growing public concern and has become an important political issue. It remains very difficult, however, to make out any clear idea about actual changes in job stability, and above all, to understand these changes. Many questions remain unanswered, and policies that might make employment relationships more stable are far from clear. Why and how does the risk of losing one’s job change over

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time? Is it simply due to the variations in the macro-economic environment? Or is it due to the changes in the labor market institutions? Is it more deeply linked to the effects of technological changes on the organization of the workplace and labor management?

To address these issues, we have developed a new model for hiring and layoffs that makes it possible to separate the effects of institutions and technology from the effects of the business cycle on the risks of job loss. In this model, firms must continually adapt their job structure to specific micro-economic shocks affecting productivity level and to common macro-economic shocks affecting the degree of persistence of high- and low-productivity periods. We use this model to analyze and interpret the evolution of job stability in France between 1982 and 2000. Our data bring to light a structural increase in the risks of job loss in France for both high and low-seniority workers, i.e. an increase that cannot be explained by changes in the macro-economic environment. When comparing the recession periods of the 1980s with those of the 1990s, we find that the risks were higher during the 1990s. The same result holds true when we compare the expansion periods. Within our theoretical framework, such an overall decline in job stability can hardly be explained by the kind of labor market institutions that were introduced in France at the end of the 1980s to make the labor market more flexible. On the contrary, our estimated increases in the risks of job loss are consistent with a persistent drop in the relative productivity of high-seniority workers.

1.1 Identifying the sources of job instability

Job instability and its evolution over time are at the heart of public debate in many Western countries. The bulk of the existing empirical research has been solely based on the United States, however. The least we can say is that this literature leads to controversial and much debated conclusions.

The latest on this debate has been published in a special issue of the Journal of Labor Economics (1999). Neither Gottshalk and Moffit (1999) nor Neumark, Polsky, and Hansen (1999) identify any significant persistent changes in job stability in the United States. Neumark, Polsky, and Hansen (1999) find an increase in the risk of job loss for senior workers during the 1990s, but also find a decline in the risk for recently hired workers. Jaeger and Stevens (1999) do not identify any significant changes in the share of workers with less than one year of seniority, only a decrease in the share of workers with less than ten years of seniority. Bernhart et al (1999) report an unambiguous increase in job instability, but their study is only based on American workers at the beginning of their careers. See also the debate between Diebolt and alli (1997) and Swinnerton and Wial (1996), as well as Farber (1996).
As for other industrialized countries, the OECD (1997) has not identified any significant changes in the share of workers with less than one year of seniority in total employment, or in the rate at which workers change jobs. The OECD did report, however, a general increase in the risk of involuntary job loss during the 1990s (OCDE, 1997, Table 5.12). This result is consistent with recent research carried out in Germany and the United Kingdom (Mertens, 1999, Burgess and Rees, 1996).

There are several reasons why these issues are not easy to clarify. The first one is linked to the difficulty in agreeing on a concept and a measurement for job instability. In this paper, we concentrate on the rates of involuntary job loss, as they can be measured by the transitions between employment and unemployment in a standard Labor Force Survey. This corresponds to criteria that have already been widely used in the literature, and which, for France, can be measured consistently and precisely over a 20-year period.

Beyond measurement problems, the relative confusion of the debates is also linked to the difficulty still very poorly resolved of identifying the sources of job instability and understanding the meaning of their variations from country to country or from period to period. The increase in job instability could be due to very different origins. It could be the consequence of a general slowdown in economic activity. In such a context, the number of sectors and companies in trouble increases, and mechanically, the number of workers who lose their jobs increases as well. In France, during the last 20 years, the number of people who lost their jobs was never as high as in 1993. That year, the French economy experienced its most severe postwar recession. Beyond the macro-economic environment, the increase in job instability could also reflect the introduction of more flexible labor market institutions. In many Western countries, it is easier nowadays to use short-term contracts or to layoff workers than it was 20 years ago (OECD, 1999). These institutional changes are a potentially important factor of job instability. Finally, regardless of whether institutions become more flexible or not, the increase in the risk of job loss could be the consequence of a wider use of technologies that makes the accumulation of specific job experience within the company useless. Such technological innovations reduce the productivity differentials between high- and low-seniority workers, reduce the relative demand for senior workers and increase job instability.
In order to test for the existence of persistent changes and identify their main causes, we cannot do without a structural model for the impact of the labor laws and the business cycle on firms’ behavior. In this paper, we have thus developed a new hiring and lay-off model, where firms are faced with idiosyncratic shocks to their specific productivity, and with macro-economic shocks to the degree of persistence of high- and low-productivity periods. In our model, high- and low-seniority workers represent two potentially distinct productive factors, with potentially very different productivity levels. High- and low-seniority workers also have different levels of job protection, which is in accordance with current legislation in almost all the developed countries, where lay-off costs vary not only according to the number, but also the seniority of the laid-off workers. To our knowledge, this aspect of Western legislation has hardly been modeled until now. As we shall see, taking into account the problems faced by firms in managing the seniority of personnel profoundly modifies the theoretical analysis of the links between labor market institutions, technology and job stability.

Empirically, we have used our model to analyze and interpret the information contained in the French Labor Force surveys conducted between 1982 and 2000. Our database retraces the risks of job loss based on worker seniority, for each year, each educational level and each industry between 1982 and 2000. Our econometric analysis reveals that (a) controlling for the effect of changes in the macro-economic climate, job stability turns out to be structurally lower during the 1990s than during the 1980s; (b) this structural decrease in job stability is perceptible at every educational level, whether dealing with high or low-seniority workers. Within our theoretical framework, such a decline in job stability for both low- and high-seniority workers is consistent with a decrease in the impact of seniority on workers productivity. It cannot have been generated by the institutional changes introduced in France at the end of the 1980s to make the labor market more flexible.

This paper is organized in the following way. The first section gives an outline of the evolution of the risks of job loss in France during the last 20 years. Section 2 presents the labor demand model, from which we develop our theoretical and econometric analysis. In Section 3, the model is used to break down the evolution of the risks of becoming unemployed into its different structural and transitory components.

Before developing our theoretical framework, we will describe how labor laws, macroeconomic climate and job instability evolved in France between 1982 and 2000. The purpose of this section is to formulate the terms of the problem we are trying to theorize and interpret.

From the viewpoint of labor laws, we can pinpoint at least two major changes during the last 20 years: in 1986 when the labor laws restricting lay-offs and the use of short-term contracts became more relaxed; and in 1990 when labor laws reaffirmed more restrictive regulations for employers (see Appendix A for more detail). Generally speaking, French labor laws have evolved towards more "flexibility", but not uniformly over time. This illustrates rather well what has happened at various degrees in most western countries (see Siebert, 1997).

From the viewpoint of the macro-economic climate, in the 1980s, as in the 1990s, three very distinct sub-periods can be distinguished: (i) a sub-period of expansion where total employment greatly increased (1988-1990, 1997-1999); (ii) a more recessive sub-period where total employment greatly decreased (1982-1983, 1992-1993); and finally, (iii) an intermediary sub-period where total employment remained relatively stable (1984-1987, 1994-1996). These changes in the institutional and macro-economic context have been accompanied by significant variations in the risks of job loss, which will now be described in detail.

2.1 Measurement for the job loss rates

We have used the Labor Force Surveys carried out by INSEE between 1982 and 2000 to measure the risks of job loss. A more detailed description of these data is presented in Appendix B. These surveys make it possible to measure the probability \( P_{t+1} \) of being unemployed at the beginning of year \( t+1 \) while being employed at the beginning of year \( t \), for every sector, year and worker category.

The evolution of these annual transitions between employment and unemployment represents the simplest and most direct measurement of the long-term trends of job loss suffered by workers in France. It is clear, however, that this statistic underestimates the total number of jobs lost each year by workers: some workers are employed at the beginning of year \( t \) and at the beginning of year \( t+1 \), although they were temporarily unemployed between these dates. In other
words, the annual probability of transition from employment to unemployment $P_{tu}$ underestimates the intensity of the instantaneous transition $\tau_{tu}$ of passing from employment to unemployment. Similarly, the annual probability of transition from unemployment to employment $P_{eu}$ underestimates the intensity of the instantaneous transition $\tau_{eu}$ from unemployment to employment.

Supposing that the transition intensities $^2\tau_{tu}$ and $\tau_{eu}$ remain constant throughout the $[t, t + 1]$ period, it is possible, however, to estimate them from the observed annual transition probabilities $P_{tu}$ and $P_{eu}$ (see e.g. Fougère and Kamionka, 1992). This calculation is given in detail in Appendix B. In the next part of the analysis, we have used the two job instability measurements, the one given directly by the annual transition probability between employment and unemployment and the one corresponding to the estimated intensity of instantaneous transition. Figure 1 and Tables 1 to 3 give the details of these measurements and their evolution between 1982 and 1999. Generally speaking, we reach the same basic diagnosis with the annual transition probabilities and the instantaneous transition intensities. These results can be summed up in broad outline in the following way:

(1) When successively comparing the two sub-periods of expansion (1988-1990 vs 1997-1999), the two sub-periods of recession (1982-1983 vs 1992-1993) and the two intermediary sub-periods (1984-1987 vs 1994-1996), we can see that the risks of job loss were systematically higher during the 1990s than the 1980s (see Table 1). More generally, the average job loss rate for the 1992-2000 period was 32% higher than the average observed rate throughout the 1983-1991 period. Between the beginning of 1999 and the beginning of 2000, although employment had been rising at an unprecedented rate (+3.6%) since the 1960s, almost 10.5% of workers lost their jobs. Eighteen years earlier in 1982, the year of the greatest drop in total employment observed throughout the period studied, the job loss rate was only 7.9%. Beyond the major fluctuations linked to the macro-economic climate, this preliminary analysis shows that the risk of job loss has increased over time$^3$.

$^2$By definition, the transition intensity $\tau_{kl}$ between state $k$ and state $l$ corresponds to $\lim_{d\to0} \frac{p_{kl}(s, s + ds)}{ds}$, where $p_{kl}(s, s + ds)$ represents the probability of being in state $l$ at $s + ds$ on the condition of being in state $k$ at instant $s$.

$^3$A regression of the probability of passing from employment to unemployment $P_{eu}$ on the total employment growth rate $G$ confirms that beyond the short-term fluctuations, job loss increased at a rate of 0.28 points per year. The results of the regression can be written:
The evolution of the turnover rate (i.e., the average of job access rate and job loss rate) gives another simple index for the structural rise in job instability over time. Assuming that the variations in the level of economic activity are absorbed more or less equally by job creation and destruction, the turnover rate is a measurement of involuntary job reallocation experienced by workers each year. As figure 1 shows, the rate of turnover rose from about 2.5% at the beginning of the 1980s to about 7% at the end of the 1990s. For any given growth rate, the firms management of human resources appears to impose much greater rates of involuntary mobility in the 1990s than in the 1980s.

From one year to the next, the risk of job loss is considerably greater for workers with less than one year’s seniority than for higher seniority workers (see Table 2). Among the workers with less than one year’s seniority at the beginning of 1999, 12.4% were unemployed at the beginning of 2000, signifying a transition probability five times higher than that for workers with more than one year’s seniority. For a given seniority level, the less educated workers are also more exposed to the risks of job loss than higher educated workers. Among the workers with less than one year’s seniority, 20% of high-school dropouts went from employment to unemployment between March 1999 and March 2000, compared to only 10% of those with at least a high school diploma.

Given these considerable differences in the risks of job loss between educational and/or seniority levels, the overall evolution of the risks of going from employment to unemployment over time reflects the evolution of the share of educated and/or high-seniority workers in total employment as well as the changes in the risks of job loss by seniority or education level. To disentangle the two mechanisms, we have reconstructed the evolution of job loss for each of the major worker categories defined by seniority and education level (see Table 3). This analysis confirms a rise in the risks of job loss for each of the worker categories. The rise in job instability is most particularly perceptible for educated workers. For the 1982-1991 period, the average annual transition rate from employment to unemployment for workers with at least a high school diploma was 1.8% for those with more than one year’s seniority, and 7.6% for those with less than one year’s seniority. For the 1992-2000 period, the same average rates were practically multiplied by two, going from 2.8% for those with more than one year’s

\[ P_{ur} = -0.41 \cdot G + 0.28 + w. \]
seniority to 14.1% for those with less than one year’s seniority. There was also a significant increase for workers without a high school diploma, but less severe: between 1982-1991 and 1992-2000, the average job loss rate rose from 21.1% to 24.9% for those with less than one year’s seniority and from 3.1% to 4% for those with more than one year’s seniority.

Altogether, it appears that beyond the effects of the business cycle, the risks of job loss tended to increase over time, as much for low- as high-seniority workers, and as much for higher educated as less educated workers. The exact measurement of this structural increase in job loss risks remains, however, difficult to establish based on simple statistics and without any specific theoretical assumption on the impact of the business cycle.

At a deeper level, even if the structural rise in job instability were better established empirically, its signification would still be problematic and its causes unclear. In order to identify the structural factors of this phenomenon, we cannot avoid developing a theoretical model for firms’ hiring and lay-off behaviors. Given the basic feature of French labor laws, it is crucial that this model takes into account the differences between workers with high and low-seniority, with special emphasis on their productive contributions and their levels of job protection.

3 The theoretical framework

In this section, we analyze the hiring and lay-off behavior of a firm placed in an uncertain environment and dealing with lay-off costs that increase with workers seniority. The firm must continually adapt its job structure to idiosyncratic shocks that affect its productivity. Within this framework, we show that the optimal behavior for this firm is to continually hire and lay off low-seniority workers. In other words, the firm responds to the unexpected demand shocks essentially by adjusting over time the hiring and lay-off rates of low-seniority workers. The lay-off of high-seniority workers only happens during persisting phases of low productivity.

This kind of behavior complies with what the micro-econometric analysis

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4In this section, we will only consider idiosyncratic shocks and focus on individual behaviors. We will introduce macro-economic shocks and address the issue of aggregating individual behaviors in the next section.
shows about firms behavior, at least within the French context (see Goux and al. 2001, Goux and Maurin, 2000, Abowd and al. 1999). As we will see in the following sections, this model also makes it possible to interpret the long-term trends highlighted in the Labor Force Surveys.

3.1 The Model

Let us consider a firm placed in an uncertain environment. Time is discrete and at the beginning of each period, the firm undergoes a stochastic change in its productivity. It can adapt by either hiring and/or laying off workers. These adjustments involve costs (noted \(AC_t\)). In accordance with current employment protection laws in most Western countries, we assume that these costs depend not only on the number of lay-offs, but also on the seniority of the laid-off workers. To simplify, we assume that the marginal lay-off costs increase after one period within the firm (i.e., when the seniority level becomes greater than one period) and that \(AC_t\) can be approximated by a quadratic function:

\[
AC_t = c_{L1}s_{t1} + c_{L2}s_{t2} + \frac{c_H}{2}h_t^2 + \frac{c_Q}{2}s_{t2}^2 + \sigma_A h_t s_{t2}, \tag{1}
\]

where \(h_t\) represents the number of hired workers at the beginning of the period \([t, t+1]\), \(s_{t1}\) the number of laid-off workers after one period in the firm and \(s_{t2}\) the number of laid-off workers after more than one period in the firm.

The parameter \(c_{L1}\) corresponds to the compensation allowance for insecurity of employment (prime de précarité), which laid-off workers benefit from at the end of their first period in the firm. The parameter \(c_{L2}\) measures the compensation that the employer must pay its workers when they are laid off after having been integrated into the workforce (i.e., after having been kept for more than one period)\(^5\). The harder it is to establish mass lay-offs, the more parameter \(c_{Q2}\) increases, whereas the parameter \(\sigma_A\) captures the limits created to the hiring of new workers during a lay-off period. The parameter \(c_H\) measures the hiring costs.

\(^5\)Keeping in line with the French institutional context, as severance payments are not available before two years seniority in a firm, \(c_{L2}\) should be varied according to seniority, i.e. we should postulate \(c_{L2} = 0\) for workers with between one and two periods of seniority, and \(c_{L2} \geq 0\) for higher seniority workers. It is not difficult to verify that the solutions to the firms problems are the same when \(c_{L2}\) is varied with those obtained without varying \(c_{L2}\), assuming that \(c_{L2}\) is less than \(c_{L1}\). For simplicity’s sake, we will assume \(c_{L2}\) to be constant, but less than \(c_{L1}\).
For simplicity’s sake, let us assume that for a given firm and date, productivity and wages are solely dependent on the level of seniority defined by the adjustment costs. If \( L_{0t} \) (resp. \( L_{1t} \)) represents the number of workers with less than (resp. more than) one period of seniority at the beginning of the period \([t, t+1]\), production \( y_t \) is thus approximated by a quadratic function of the kind\(^6\),

\[
y_t = a_0 L_{0t} + a_1 L_{1t} - \frac{b_0}{2} L_{0t}^2 - \frac{b_1}{2} L_{1t}^2 + \sigma_R L_{1t} L_{0t}
\]

where \( a_0 \) and \( a_1 \) characterize productivity at the beginning of the period \([t, t+1]\).

The net income \( R_t \) per unit of time can be written as:

\[
R_t = y_t - (w_{0t} L_{0t} + w_{1t} L_{1t}),
\]

where \( w_{0t} \) and \( w_{1t} \) represent the wages. Concerning the structure of uncertainty, the profitability parameters \( a_{0t} = (a_0 - w_{0t}) \) and \( e_{1t} = (a_1 - w_{1t}) \) are assumed to follow a two-stage Markovian process: \( e^+ = (e_0^+, e_1^+) \) and \( e^- = (e_0^-, e_1^-) \). The probability of continuing in state \( e^+ \) (resp. \( e^- \)) is constant over time\(^7\), and noted \( p \) (resp. \( q \)).

Assuming the quit rate is constant over time, (noted \( 1 - \theta \)), the relations between flows and stocks can be written as:

\[
L_{10t} = \theta L_{0t-1} - s_{1t},
\]

\[
L_{11t} = \theta L_{1t-1} - s_{2t},
\]

where \( L_{10t} \) represents the number of workers with exactly one period of seniority and \( L_{11t} \) those with higher seniority. Using these notations, the firm’s objective is to maximize \( V_t \) with

\[
V_t = E_t \left\{ \sum_{k=0}^{\infty} \beta^k (R_{t+k} + AC_{t+k}) \right\}
\]

In Appendix C, we analyze the Bellman equation associated with the firm’s problem. We determine a set of initial states (noted \( X^* \)) for which this equation

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Footnotes:
1. For previous uses of this kind of approximation, see, for example, Akerlof and Yellen (1990) or Agenor and Aizenman (1997).
2. In the next section, we will verify that our theoretical analysis of firms’ behaviour still holds true when these transition probabilities vary over time according to autoregressive processes. We will consider the case where these probabilities vary from one period to the next in order to model the variations in the distribution of high- and low-productivity firms across the business cycle.
has one solution. We also characterize the optimal labor management that corresponds to each solution. Generally speaking, this optimal management is in accordance with the micro-econometric observations from French administrative database: the firm is constantly hiring and laying off recently hired workers, and only lays off high-seniority workers during low-productivity periods. The magnitude of the hiring and lay-off flows depends on the cost structure.

One of the optimal trajectories corresponds to a stationary situation: when it is on this path, the firm continually passes between the same four states. Each state corresponds to a particular distribution of workers across the different seniority levels. At the beginning of each period, the choice of the state is made according to the past \((\epsilon_{t-1})\) and present situation \((\epsilon_t)\). We show that all firms starting from a job structure belonging to \(X^*\) converge towards the stationary path in less than two periods. The optimal job structures and the optimal hiring and lay-off decisions are expressed as functions of the exogenous parameters of the model in Appendix C. Figures 2a through 2d give a more concrete idea about the adjustment dynamics, which correspond to the optimal labor management. In a rather intuitive way, the lay-off rates are particularly high during slowdown periods and particularly low once productivity picks up again. The lay-off rate is highest for low-seniority workers when a recession sets in. In general, the more the environment is uncertain and changing, the less stable are the entry-level positions.

### 3.2 Structural effects of changes in labor laws.

In this sub-section, we analyze how modifications to job protection regulations and/or changes in productivity differentials between high- and low-seniority workers affect the firm’s optimal behavior. Our motivation is to identify the kind of shifts in the exogenous parameters that can generate what we observe in our data, i.e. an increase in job instability for both high- and low-seniority workers. The details of the calculations are given in the appendix D and the four main results are listed below (see also Table 4).

1. First, we confirm that a hardening of the lay-off procedures (i.e. an increase of \(c_{Q2}\)) leads to a decrease in the risks of job loss for high-seniority workers (i.e., a decrease of \(\tau_{H} = \frac{L_{2,1}}{L_{1,1}}\)), but to an increase in the risks of job loss for recently hired workers (i.e., a rise of \(\tau_{0} = \frac{L_{2,1}}{L_{0,1}}\)). The reasons are...
simple: the harder it is to lay off high-seniority workers, the more the burden of adjustment weighs on recently hired workers. The total effect is an increase in the overall separation rate (i.e. an increase of \[ \tau_t = \frac{s_{t-1} + s_{t-2}}{L_{t-1} + L_{t-2}} \]), an effect that is completely opposite to the one usually expected when a rise in lay-off costs occurs.

(2) Interestingly, an increase in the costs of terminating fixed-term contracts (i.e. a rise of \( c_{L1} \)) has diametrically opposite effects, meaning a decrease in the risks of low-seniority workers being laid off and an increase in the risks for higher seniority workers. The reasons are similar to those noted above: the harder it is to separate from recently hired workers, the less the adjustment burdens are placed on them. The overall effect is a decrease in the total separation rate.

Measures that aim to liberalize the use of short-term contracts and those aimed at reducing the lay-off costs are generally presented as having the same «flexibilization» effect on the job market. From the moment the seniority differences are taken into account, we can see that they correspond to two very distinct measures; the effects of these measures have a tendency to offset each other. Neither of these two measures can, in itself, explain the simultaneous increase in the risks of job loss for both recently hired and high-seniority workers.

(3) As for the theoretical impact of technological parameters, we can first check that an increase in the productivity of low-seniority workers (i.e., an average increase of \( \epsilon_0 \)) generates similar effects to those generated by a decrease in the costs of laying off these workers (\( c_{L1} \)). Such a productivity shift leads to an increase in the share of low-seniority workers in total employment, meaning a simultaneous increase in the hiring and separation rates for these low-seniority workers. An increase in the productivity of low-seniority workers also leads to a decrease in the lay-off rate of high-seniority workers, as far as these lay-offs are institutionally more difficult to justify during sustained hiring periods.

(4) Interestingly, an increase in the productivity of high-seniority workers (i.e., an average increase of \( \epsilon_1 \)) does not produce the same kind of effect. Such an increase leads to a simultaneous drop in the rates at which firms separate from high- and low-seniority workers. An increase in the productivity of high-seniority workers makes firms increase the number of high-seniority workers without modifying the number of low-seniority ones. A freeze of the hiring rate results in, but with it, an increase in the rate at which seniority is acquired.
and a decrease in the risks of being laid off after one year’s seniority. The firm responds to an increase in the value of seniority by raising both the influx of « new » senior workers and the rate at which high-seniority workers are laid off.

Altogether, we can emphasize that the only structural change susceptible to generating a simultaneous increase in the lay-off frequency of recently-hired and high-seniority workers is a decrease in the productivity of high-seniority workers. In other words, testing for the importance of changes in relative productivities opposed to changes in labor laws brings us back to testing the assumption of simultaneous increase in the risks of job loss suffered by low and high-seniority workers. In the next section, we construct an econometric test for this assumption. Given the available data, the main problem is to separate persistent structural changes from transitory variations linked to changes in the macro-economic situation.

4 An econometric test for the persistent rise in the risk of job loss

In this section, we are going to develop an econometric analysis for the layoff risks observed in our labor force surveys, under the assumption that french firms’ behaviors can be correctly approximated by the theoretical model developed in section 3. The goal of this analysis is to test that the risks of job loss (i.e., $\tau_{0t}$ and $\tau_{1t}$) have undergone structural changes over time and to identify the technological and/or institutional factors that have driven these changes.

To construct this test, our main empirical problem is that we do not observe trends in the risks of job loss at the firm level, but at the aggregate level. We only measure the average risks, whose variations over time reflect both structural changes in the firm-level risks and cyclical changes in the distribution of firms between the different states.

Indeed, standard Labor Force Surveys (as those carried out in France by INSEE) do not make it possible to measure the risks of job loss firm by firm. They only give an average measurement of the risks across high- and low-productivity firms. Within this framework, the observed risks of becoming unemployed do not only depend on the institutions and technologies that each individual firm must adapt to. These risks also depend on the macro-economic situation and
the way in which the firms are distributed between those in a high-demand period and those in a low-demand period.

Within our theoretical framework, these proportions are determined very directly by the degree of persistence of the positive ($p$) and negative ($q$) shocks. In order to construct our test for a persistent rise in job instability using data from the Labor Force Surveys, it is thus necessary to specify the way in which $p$ and $q$ change over time. It is also necessary to extend our labor demand model to include cases where the transition probabilities between states change over time.

4.1 Macro-economic shocks to the transition probabilities

In the model developed in Section 3, the only source of uncertainty for the firms corresponds to the idiosyncratic, micro-economic shocks, that modify their specific productivity. Henceforth, we assume that firms also face common shocks ($c_t$), of a macro-economic nature, that follow simple autoregressive process and continually modify the degree of persistence of the different states. More specifically, we now assume that $p_t$ and $q_t$ can be written $p_t = \frac{1}{2} + c_t$ and $q_t = \frac{1}{2} - c_t$ where $c_t$ is assumed to be an AR(1).

At the beginning of each period $t$, each firm $j$ discovers not only its specific state (i.e., the value of $\epsilon_{jt} = (\epsilon_{0jt}, \epsilon_{1jt})$), but also the value of $c_t$ and the values of the transition probabilities $p_t$ and $q_t$, which characterize the current macro-economic situation. Within this theoretical framework, we have verified that each firm continues to move between the same four states described in Section 3 (and presented in detail in Appendix C), when the transition probabilities $p_t$ and $q_t$ are assumed constant over time. In general, when $p_t$ and $q_t$ vary from one period to another, the nature of the firms' responses is the same as when $p_t$ and $q_t$ do not vary; the only thing that changes is the dynamic of their real profit: the latter fluctuates with both idiosyncratic productivity shocks ($\epsilon_{jt}$ for firm $j$) and macro-economic shocks ($c_t$).

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8 The literature on job flows show that, above all, it is mostly the proportion of firms that are growing or in decline that changes over the macro-economic cycle (Davis, Haltiwanger and Schuh, 1996). In the particular case of France, Lagarde et al. (1994) show, for example, that between the 1992-1993 (recession) and 1988-1989 (expansion) periods, the difference is essentially due to the proportion of growing firms decreasing from about 60% to 40%. The behavior of growing and declining firms can be compared between the two periods, the only difference being that a fraction of 10% of the firms shifted from a growth period to a slowdown.

9 See Appendix C, third subsection. Generally speaking, these results hold true whatever the degree of the autoregressive process followed by $c_t$. 

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In the next part of this section, we use the same notations as in the appendix C and note $L_0^+$ and $L_1^+$ ($L_0^-$ and $L_1^-$) as the optimal number of workers with less than or more than one year’s seniority in a firm that is dealing with a positive (negative) idiosyncratic shock. Similarly, $s_2^-$ represents the optimal number of laid-off workers with more than one year’s seniority in each of the firms dealing with a negative shock.

4.2 Aggregated hiring and lay-off flows

To complete our model of the hiring and lay-off flows observed at the aggregate level, we must now specify how individual behaviors have to be aggregated.

First, we must specify how the proportion of firms going through a high- (or a low-) productivity periods change over time with $c_t$. Assuming that the number of firms is constant ($F$), we can check that the proportion of firms going through a high (low) productivity period coincides with the degree of persistence $p_t$ ($q_t$) for the positive (negative) shock\(^\text{10}\). Within this framework, the total number of workers with more than one year’s seniority in the economy (noted $N_{1t}$) is no longer constant over time, but varies from one period to another with the macro-economic shock $c_t$ according to,

$$N_{1t} = F(p_t L_1^+ + q_t L_1^-) = \bar{L}_1 (1 + c_t \phi_1), \tag{7}$$

where $\bar{L}_1 = F \frac{L_1^+ + L_1^-}{L_1^+}$ and $\phi_1 = \frac{L_1^+ - L_1^-}{L_1^+ + L_1^-}$ are constants that only depend on the institutional and technological parameters. Similarly, the total number of workers with less than one year’s seniority at date $t$ (noted $N_{0t}$) varies with $c_t$, according to,

$$N_{0t} = F(p_t L_0^+ + q_t L_0^-) = \bar{L}_0 (1 + c_t \phi_0), \tag{8}$$

where $\bar{L}_0 = F \frac{L_0^+ + L_0^-}{L_0^+}$ and $\phi_0 = \frac{L_0^+ - L_0^-}{L_0^+ + L_0^-}$ again depend solely on the labor market institutions and the productivity parameters. Finally, the total number of the lay-offs of workers with one years (more than one years) seniority can be written as $S_{1t}$ ($S_{2t}$), and varies with both $c_{t-1}$ and $c_t$ according to,

$$S_{1t} = F(\theta L_{t-1} - L_{1t} - s_{2t}) = \pi(1 + c_{t-1} \psi_0 - c_t \phi_1),$$

$$S_{2t} = F f_t^- s_2^+ = \bar{\pi}(1 - 2\alpha),$$

\(^{10}\)Let $f_t^+$ ($f_t^-$) be the proportion of high- (low-) productivity firms at $t$. We have: $f_t^+ = p_t f_{t-1}^+ + \pi f_{t-1}^- = p_t$ and $f_t^- = q_t f_{t-1}^+ + \pi f_{t-1}^- = q_t$. These properties are confirmed once $\alpha$ can be written as $p_t = \alpha + \eta t$ and $q_t = \alpha - \eta t$. 

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where $\overline{S_2} = F(\frac{s_2}{2})$, $\overline{s_1} = F(\theta L - \overline{L_1} - \frac{s_2}{2})$, $\psi_0 = \frac{\theta(\phi_0 L_0 + \phi_1 L_1)}{s_1}$ and $\psi_1 = \frac{\phi_1 L_1}{s_1}$.

With these notations written out, we can see that the first-order development of $\ln(S_{2t})$ is,

$$\ln(S_{2t}) = \ln(\overline{S_2}) - 2c_t. \quad (9)$$

where $S_{2t}$ depends solely on institutions. In assuming that three institutional periods can be distinguished for the last two decades, the residual of the regression of $\ln(S_{2t})$ on three sub-period dummies gives a measurement of $c_t$ (noted $\hat{c}_t$), which is consistent with the theoretical framework developed in this paper.

The job-loss rates before $(\tau_{1t})$ and after $(\tau_{2t})$ one year’s seniority can be broken down into cyclical and structural components. Their first-order development can be written as:

$$\tau_{1t} = \frac{S_{1t}}{L_{t-1}} = \overline{\tau_1}(1 - c_t \psi_1 + (\psi_0 - \phi_0) c_{t-1}), \quad (10)$$

$$\tau_{2t} = \frac{S_{2t}}{L_{t-1}} = \overline{\tau_2}(1 - 2c_t - \phi_1 c_{t-1}). \quad (11)$$

where $\overline{\tau_2} = \frac{s_2}{2}$ and $\overline{\tau_1} = \frac{s_1}{L_0}$ depend solely on institutional and technological parameters as described in section 3.2.

The preceding developments are valid for each sector. Taking the log of equations 10 and 11, and then considering the first development, we can thus write for each sector $s$:

$$\ln(\tau_{1st}) = \alpha_1 P(t) + \beta_1 \overline{c}_{st} + \gamma_1 \overline{c}_{s-1} + \varepsilon_{1st}, \quad (12)$$

$$\ln(\tau_{2st}) = \alpha_2 P(t) + \beta_2 \overline{c}_{st} + \gamma_2 \overline{c}_{s-1} + \varepsilon_{2st}. \quad (13)$$

where $P(t)$ represents the institutional period including date $t$, and where $\overline{c}_{st}$ is the residual of the regression of $\ln(s_{2st})$ on the three period indicators$^{11}$. The residuals $\varepsilon_{1st}$ and $\varepsilon_{2st}$ represent the measurement error effect. The parameters $\alpha_1 P(t)$ and $\alpha_2 P(t)$ make it possible to measure the possible changes in the risks of job loss. Our econometric analysis applies to equation 12 and 13.

In short, we can proceed in two stages to separate the impact of the institutional and technological parameters from the impact of the business cycle. The first stage is a regression of the number of lay-offs of high-seniority workers.

$^{11}$That means that $c_t = \ln(S_{2t}) - \ln(S_{2P(t)})$, where $\ln(S_{2P(t)})$ represents the average of $\ln(S_{2t})$ during the period $P(t)$. 

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observed at the industry level (taken in logs) on the three sub-period indicators. The estimated residuals of the regression provide a measurement of $c_t$ for each year and each industry. The second stage is a regression of the risks of job loss observed each year at the industry level on the three sub-period dummies as well as on their interactions with the measurements of $c_t$ and $c_{t-1}$ obtained during the first stage. The structural impacts of institutions and technologies are captured by these sub-period dummies’ effects.

4.3 Results and interpretation

One problem with the estimation of equations 12 and 13 is that the variables capturing the effects of the business cycle are affected by measurement errors\textsuperscript{12}. Such measurement errors in the independent variables generate biases in the estimations obtained by the ordinary least squares (OLS) method. To evaluate these biases, we estimated equations 12 and 13 using both the OLS method and the instrumental variables (IV) method. We used the first-differences of lagged values of $\hat{c}_t$ and $\hat{c}_{t-1}$ (i.e., $\hat{c}_{t-2} - \hat{c}_{t-3}$ and $\hat{c}_{t-3} - \hat{c}_{t-4}$) as the instrumental variables. By using first-differences, we eliminated the biases generated by the fixed components in the measurement errors. By using lagged values, the correlation risks were lessened between the measurement errors in the independent variables and those in the instrumental variables\textsuperscript{13}.

In general, the results obtained using the IV method were very similar to those obtained using the OLS method. The errors that affected our measurement of $c_t$ and $c_{t-1}$ did not appear to be the source of significant biases in the OLS estimation of our job loss models. The diagnoses were also very similar as long as the risks of job loss were measured from the annual probabilities of transition from employment to unemployment or from the instantaneous transition intensities. In the following paragraphs, we will focus on the estimations obtained by taking the annual transition probabilities.

\textsuperscript{12}In other words, the same measurement error (i.e. \( \hat{c}_t - c_t \)) simultaneously determines the value of $\hat{c}_t$ and that of $c_t$ or $c_{t-1}$.

\textsuperscript{13}We also estimated the models taken in first-difference using the lagged values of the independent variables (i.e., $\hat{c}_{t-3}$ and $\hat{c}_{t-4}$) as instrumental variables. The estimation of $\alpha_{2P(t)}$ obtained using this instrumentation method was very similar to the one obtained by taking the model in level and the instruments in difference. The IV estimation of $\alpha_{1P(t)}$ obtained with this model was, on the other hand, very imprecise, due to the insufficient power of the instruments.
Table 5 presents the estimation results relating to the risks of job loss according to seniority. The OLS estimator suggests that the risks of job loss of workers with less than one year's seniority did not vary significantly between the periods 1982-1986 and 1986-1990. It does show, however, an increase of 20% between the 1986-1990 period and the 1990s.

Given the number of lags required by our instrumental variables strategy, the IV estimations did not allow for the coefficient of the first sub-period (i.e., 1982-1986) to be identified. Thus, the method does not make it possible to confirm the stability of job loss risks between the beginning and end of the 1980s. On the other hand, these estimations confirm a structural increase of $\tau_{11}$ between the second half of the 1980s and the 1990s.

As regards workers with more than one year's seniority ($\tau_{21}$), the OLS estimators show an increase of 10% in $\alpha_{2P}$ between the beginning and end of the 1980s. They subsequently show an even more significant increase of about 20% between the beginning of the 1980s and 1990s. This result is confirmed by the IV estimations. They show an increase of between 20% and 40% in the log of the risks of job loss for high-seniority workers between the second half of the 1980s and 1990s.

In order to test the soundness of these results, we re-estimated the different models using two sub-samples: the sub-sample of workers without a high-school diploma (Table 6a), and the sub-sample of workers with at least a high school diploma (Table 6b). These estimations led to the same diagnosis of a significant, overall increase in the job-loss rates during the 1990s. By distinguishing between workers with high-level diplomas and those with low-level (or no) diplomas, we also discovered that the increase in the risks of job loss is perceptible for workers with low-level diplomas from the 1980s onwards, no matter what their seniority level. The start of an increase can also be spotted during the 1980s for workers with diplomas, but only for high-seniority workers.

Altogether, our estimations show a significant, overall increase in job instability, which began during the second half of the 1980s, and accelerated during the 1990s. Beyond the transitory effects of variations in macro-economic activity, an important structural modification occurred concerning lay-off behavior starting in the middle of the 1980s.

This result gives way to the following two remarks, which are essential to its
interpretation. First, the increase in job instability continued, even increased, between the end of the 1980s and 1990s. It is thus difficult to attribute the increase in job instability solely to the softening of labor laws in 1986. Second, this increase involved both high- and low-seniority workers. Within our theoretical framework, such an overall shift cannot be interpreted as the consequence of the changes in labor laws that happened in France. Indeed, these institutional changes affect low- and high-seniority workers differently.

On the other hand, an overall increase in job instability can be very directly interpreted as the result of a drop in the impact of seniority on the workers’ productivity. It is clear that firms hesitate less about laying off high-seniority workers when their productivity is low. It is equally clear that firms hesitate more about keeping the least experienced workers when their productivity does not increase in line with their seniority level. A decrease in the impact of seniority on productivity leads firms to strengthen the proportion of recently hired workers in their workforce by increasing the lay-off rate at all levels of seniority.

5 Conclusion

For the last few years, the French economy has been creating jobs at a very steady rate. In spite of this recovery, the risks of losing one’s job and becoming unemployed have remained higher than at the beginning of the 1980s when French firms were going through deep restructuring and were destroying on average 1% to 2% of jobs per year. Twenty years later, job creation is considerably higher, but it relies on a higher volume of lay-offs and re-hirings.

In this paper, we have presented a very simple framework of interpretation for these changes. Our analysis suggests that the functioning of the French job market has been deeply altered over the last twenty years: for the same net increase or decrease in total employment, it is now necessary to simultaneously lay-off and hire a much higher total number of workers, lowest seniority and highest seniority workers included. This trend generates greater job instability. Within our theoretical framework, this simultaneous increase in job instability for both low- and high-seniority workers cannot have been generated only by the labor institutions introduced in the late eighties that make it easier to use fixed-term contracts and to lay-off workers. The simultaneous increase can be
much more easily interpreted as the consequence of a decrease in the impact of seniority on worker productivity.

In our view, this paper answers some important questions, but also raises a lot of others. Why should the impact of seniority be on the decline? Is it because new technologies are incorporating more and more the skills acquired by workers over time in the firm? A theoretical framework more complete than the one used in this paper must be developed to answer these questions. This framework would require much richer data on the ways in which new technologies are being distributed in firms and the ways in which the distribution is changing.

References


Appendix A

Employment Protection in France

French law imposes a set of specific restrictions on lay-off practices. More specifically, firms cannot implement mass redundancies before having defined, as well as having approved by the administration, a social plan for helping the laidoff workers to find a new job. When ten or more workers are laid off, firms must also pay an independent expert to help the personnel’s representatives who participate in the meetings that will define the scheduled lay-off program.

Regardless of the number of workers that are made redundant, French laws protect above all high-seniority workers. A worker can be made redundant without dismissal notice or redundancy payment if he/she has under six months seniority. On the other hand, laying off a worker with two years seniority requires that the employer gives two months notice and the right to redundancy payment. For workers who have between one and two years seniority, the legal dismissal notice is one month (see Couturier, 1996, article L. 122-6 of the labor law manual « code du travail »). If the dismissal notice is not respected, the employer must pay the worker compensatory redundancy payments equal to what the worker would have made in wages and benefits if the dismissal notice had been respected.
Only workers with at least two years seniority can collect redundancy payment. These payments represent one-tenth of one month's gross wages per year of seniority (the labor law manual, code du travail, art. L 122-9). The redundancy payment are increased to one-fifteenth of one month's gross wages per year of seniority after ten years in a firm. In general, compensation planned by collective labor agreements specific to each sector are added to these unemployment benefits.

As regards layoff restrictions, the first important change happened in 1986 when the newly elected conservative government suppressed the "autorisation administrative de licenciement" (hereafter: AAL). Before 1986, employers had to obtain an authorization from the administration before beginning any mass redundancies procedure. In 1986 this provision was suppressed.

The second significant change happened four years later, after the socialists' come-back. They reaffirmed more restrictive regulations for employers. They did not bring the AAL back, but made it mandatory for firms to negotiate social plans with personnels' representative before any mass redundancies (i.e., before any redundancies involving more than ten workers).

**Fixed-term contracts**

For short-duration jobs, firms can use fixed-term labor contracts. These contracts are non-renewable and contribute solely to the employment of low-seniority workers. Current French labor laws are rather flexible on the hiring practices concerning fixed-term contracts. A fixed-term contract can be signed to meet increased activity or to replace a temporarily absent worker. These restrictions are softened when the new job can be interpreted as an irregular activity. On the other hand, the law is very restrictive on the time limit (one and a half years) of fixed-term contracts, unless they are automatically converted into permanent contracts.

For each given skill level, firms are required by law to pay the same wages to workers under fixed-term contracts as to workers under indefinite-term contracts. Furthermore, when employers terminate a fixed-term contract (i.e. when they do not transform a fixed-term contract into an indefinite term one), they must pay a redundancy payment to the fixed-term worker. The value of this payment must represent at least 6% of the employment contracts' total value.
The important changes in the labor-contract legislation happened approximately the same years as those in layoff restrictions. Before 1986, fixed-term contracts could only be signed to meet a very restrictive list of situations. In 1986, the restrictive lists were suppressed and French labor laws became very flexible on the hiring practices concerning fixed-term contracts. In 1990, a new law reintroduced specific limitations. Also, the redundancy payment to fixed-term workers was increased from 5% to 6% of the employment contracts’ total value.

Appendix B
The data and transition intensities’ estimation method

The data used in this study are taken from the French Labor Force surveys (hereafter : LFS) conducted by the French National Institute for Statistics and Economic Studies between 1982 and 2000. The surveys take place in March each year.

The survey samples are representative of the French population aged 15 and up. The sampling fraction is approximatively 1/300, meaning about 150 000 respondents each year. The following standard information is completed for each interviewee: educational attainment, job tenure, labor market status (in employment, unemployment, not in the labor force), industry.

One interesting feature of the French LFS is that only one-third of the sample is renewed each year. One can thus track the career of large sample of French workers for 2 years. More specifically, for each \([t, t+1]\) period (\(t=\text{March 1982} \ldots \text{March 1999}\)) we have on average 25 000 individuals interviewed in \(t\) and \(t+1\) who are private sector workers in \(t\) and for which we know the labor market states in \(t+1\).

In this paper, the annual probability of transition from employment to unemployment are estimated from these subsamples.

The method for estimating transition intensities

Let us consider a worker that can move between three possible states: employment, unemployment and out-of-the labor force. Let us assume that his/her transitions follow a continuous-time homogeneous Markov process. For each
state $k$ and each state $l \neq k$, $\tau_{kl}$ will represent the instantaneous intensity of transition between $l$ and $k$. By definition, $\tau_{kl}$ is the limit of $\frac{p_{kl}(s, s+ds)}{ds}$ when $ds \to 0$, where $p_{kl}(s, s+ds)$ stands for the probability to be in the state $l$ at time $s+ds$ conditionally at being in state $k$ at time $s$. Under the continuous-time homogeneous Markovian, the $\tau_{kl}$ are constant and we have for all $k$, $\tau_{kk} \geq 0$ when $k \neq k$ and $\sum_l \tau_{kl} = 0$.

Furthermore, if $T$ denotes the $(3,3)$ matrix which components are the $\tau_{kl}$s and $P$ the corresponding $(3,3)$ annual transition probabilities' matrix, we have the following relationship between $P$ and $T$ (see for instance Doob, 1953):

$$P = \sum T^{k}_{k} = \exp(T). \tag{14}$$

Let us now assume that we observe the annual transitions of a representative sample of individuals and let us suppose that these transitions follow the continuous-time process defined by $T$. Let us denote $\hat{P}$ the transition probability matrix that corresponds to the observed annual transitions. The elementary component of $\hat{P}$ is $\hat{p}_{ij} = \frac{n_{ij}}{n_i}$, where $n_{ij}$ is the number of workers in state $i$ at $t$ and state $j$ at $t+1$, while $n_i$ is the total number of workers in state $i$ at $t$. $\hat{P}$ corresponds to the maximum likelihood estimator of $P$ (Anderson and Goodman, 1957). Furthermore, once $\hat{T}$ is a solution of

$$\hat{P} = \exp(\hat{T}), \tag{15}$$

then $\hat{T}$ represents a maximum-likelihood estimator of $T$.

Let us emphasise that equation 15 can have more than one solution, but does not necessarily have a solution consistent with the homogeneous Markov assumption. Once $\hat{P}(t, t+1)$ is diagonalisable and has three distinct positive real eigen values $(\lambda_1, \lambda_2, \lambda_3)$, we have however,

$$\hat{T} = \ln \hat{P} = Q diag(\ln \lambda_1, \ln \lambda_2, \ln \lambda_3) Q^{-1} \tag{16}$$

This equation makes it possible to estimate the transition intensities as functions of the observed annual transition probabilities. Kalbfleish and Lawless (1985) provide different methods for estimating the standard errors of these transition intensities' estimators.

Until now we have assumed that the transition intensities were the same for workers with less than one year's seniority as for those with more than one year.
year's seniority. Generally speaking, this hypothesis is not easy to withdraw. The main issue is that workers with less than one year's seniority at \( t \) can become workers with more than one year's seniority within the \([t, t+1]\) period, i.e. before \( t+1 \). In other words, if we assume that job loss risks become different after one year's seniority, the job loss risks for these low-seniority workers change within the \([t, t+1]\) period. Furthermore, they do not change at the same time for everybody: workers with 11 months' seniority at \( t \) are exposed to job loss risks potentially very different from those of workers with only 1 month's seniority at \( t \).

One potential solution is to assume that job terminations only happen at the beginning of each month and to distinguish 13 possible states for employed workers (i.e., one for workers with more than one year's seniority, and one for workers with exactly \( k \) months' seniority, \( k = 1, \ldots, 12 \)). Within this framework, we only have to write the likelihood of each of the 13*13 possible transitions and to maximize the likelihood of our sample to estimate the new system of transition intensities. This technique is not difficult to conceptualize, but cumbersome to implement.

For simplicity's sake, we have chosen a more straightforward solution. We have assumed that only four states had to be distinguished at \( t \): (a) more than one year's seniority, (b) less than one year's seniority, (c) unemployment and (d) out-of-the labor force. It amounts to assuming that the relevant criterium to define states and analyse mobility between \( t \) and \( t+1 \) is not workers' seniority per se, but the date of hiring (i.e., before or after \( t-1 \)). We have analysed the observed annual transitions between these four states as the result of a homogeneous Markov process.

Appendix C

In this appendix, we analyze the Bellman equation that corresponds to the firm's infinite-horizon programming problem. We determine a set of conditions on the exogenous parameters and a set of initial job structures (\( X^* \)) for the firm such that the corresponding optimal policies of the firm are consistent with what we actually observe in French administrative database (see eg Abowd and al. (1999) or Goux and Maurin (2000)). These optimal decisions are such that the firm is continually hiring and laying-off low-seniority workers.
One of these solutions corresponds to a stationary trajectory. This trajectory is such that the optimal job structure takes only four values depending on the past and present productivity shocks. More specifically, the stationary trajectory \( L_t = ( L_0, L_{10}, L_{11} ) \) is such that when \( ( \epsilon_{t-1}, \epsilon_t ) = ( \epsilon', \epsilon ) \) the firm chooses \( L(\epsilon', \epsilon) = ( L_0(\epsilon'), L_{10}(\epsilon'), L_{11}(\epsilon', \epsilon) ) \) with

\[
L_0(\epsilon^+) = L_0^+ = \frac{b_1 \epsilon_0^+ + \sigma_R \epsilon_1^+ + c_{L1}(\sigma_R(1 - \beta \theta) - \beta \theta b_1)}{b_1(c_H + b_0) - \sigma_R^2 b_1} \quad (17)
\]

and \( L_0(\epsilon^-) = L_0^- = \frac{1}{b_1(c_H + b_0) - b_1 \frac{\sigma_A^2}{\sigma_R^2} - \sigma_R^2} \left[ b_1 \epsilon_0^- + \sigma_R \epsilon_1^- \right. \]

\[
+ c_{L1}(\sigma_R(1 - \beta \theta) - \beta \theta b_1) - \frac{\sigma_A}{\sigma_R} b_1(c_{L1} - c_{L2}) \right] \quad (18)
\]

\( L_{10}(\epsilon', \epsilon) + L_{11}(\epsilon', \epsilon) = L_1(\epsilon) = \frac{c_1 + \sigma_R L_0(\epsilon) + (1 - \beta \theta)c_{L1}}{b_1} \) for all \( \epsilon \) and \( \epsilon' \)

\( L_{11}(\epsilon', \epsilon) = \theta L_1(\epsilon') - s_2(\epsilon), \quad (19) \)

\( L_{10}(\epsilon', \epsilon) = L_1(\epsilon') - L_{11}(\epsilon', \epsilon), \quad (20) \)

with \( s_2(\epsilon^-) = s_2^- = \frac{\epsilon_1 - \sigma_A L_0(c)}{\epsilon_2 c_L} \) and \( s_2(\epsilon^+) = 0 \). Given 17 and 18, the optimal number of layoffs of low-seniority workers can be written,

\[ s_{1t} = \theta L_{0t-1} - L_{10t} \quad (21) \]

We will also show that all firms starting from a job structure within \( X^* \) converge towards the stationary path in less than two periods.

The Bellman Equation

The Bellman equation can be written,

\[ v(L_{t-1}, \epsilon_t) = \sup_{Y \in \Gamma(L_{t-1})} [ F(L_{t-1}, Y, \epsilon_t) + \beta E_t v(Y, \epsilon_{t+1}) ] , \]

where \( \Gamma(L_{t-1}) = \{ Y = (Y_0, Y_{10}, Y_{11}) \} \)

\[
\text{stands for the job structures } Y = (Y_0, Y_{10}, Y_{11}) \text{ that are feasible from } L_{t-1} = (L_{0t-1}, L_{10t-1}, L_{11t-1}), \text{ while } F(L_{t-1}, Y, \epsilon_t) \text{ stands for the one-period profit for a firm that chooses } Y = (Y_0, Y_{10}, Y_{11}) \text{ when its past job structure is } L_{t-1} = (L_{0t-1}, L_{10t-1}, L_{11t-1}) \text{ and its present productivity } \epsilon_t. \]
Let us assume that the exogenous parameters are such that
\[
\begin{aligned}
\theta(L_0^- + L_1^-) &\geq L_1^+
\theta(L_0^- + L_1^-) &\geq L_1^- + s_2^- \\
L_1^- + s_2^- &\geq \theta L_1^+
\end{aligned}
\]
and let \( \pi^* \) be the contingency plan that corresponds to the policy \( L(\varepsilon, \varepsilon') \) defined by equations (17)-(21). Furthermore, let \( X^* \) be the set of initial job structures such that (a) it is possible to have at once a number of low-seniority workers \( L_0 \) and a number of high-seniority workers \( L_1 \) corresponding to \((L_0^-, L_1^-)\) in case of a positive shock and \((L_0^+, L_1^-)\) in case of a negative shock, and (b) \( \pi^* \) is feasible from \( L(\varepsilon, \varepsilon') \) if some low-seniority workers are terminated. More specifically, we have,
\[
X^* = \{ (x_1, x_2, x_3) / \theta(x_2 + x_3) < \min \{ L_1^+, L_1^- + s_2^- \} ; \theta(x_1 + x_2 + x_3) > \max \{ L_1^+, L_1^- + s_2^- \} \}
\]
Using these notations, we verify easily that there exists one linear solution to the Bellman equation within the set of function defined by \( X^* \times \{ \varepsilon^+, \varepsilon^- \} \). This solution can be written:
\[
v(L_{t-1}, \varepsilon_t) = A_0 \varepsilon_0 + A_1 \varepsilon_{1t} - \theta c_{L,1}(L_{0t-1} + L_{1t-1}) \tag{22}
\]
where \( A_0 \) and \( A_1 \) are two intercepts\(^{14}\). The associated optimal policy can be written:
\[
G(L_{t-1}, \varepsilon^+) = (L_0^+, L_1^+ - \theta L_{1t-1}, \theta L_{1t-1}) \tag{23}
\]
\[
G(L_{t-1}, \varepsilon^-) = (L_0^-, L_1^- - \theta L_{1t-1} + s_2^- ; \theta L_{1t-1} - s_2^-) \tag{24}
\]
We check that a firm which is initially on the trajectory defined by \( L(\varepsilon, \varepsilon') \) remains on this trajectory. We also verify that a firm which is not on this trajectory, but in \( X^* \), converges towards this trajectory in two periods.

\(^{14}\)The verification can be made in two steps. First, we check that
arg max \( [F(L_{t-1}, Y, \varepsilon_t) + \beta E_t v(Y, \varepsilon_{t+1})] \) corresponds to \( Y^* = G(L_{t-1}, \varepsilon_t) \). Second, we check that the equation \( v(L_{t-1}, \varepsilon_t) = F(L_{t-1}, Y^*, \varepsilon_t) + \beta E_t v(Y^*, \varepsilon_{t+1}) \) defines two intercepts \( (A_0, A_1) \) that do not depend on \( L_{t-1} \).
The Principle of Optimality

A solution of the Bellman equation is a solution to the firm’s infinite-horizon programming problem if it verifies, the orthogonality condition,
\[ \lim_{s \to -\infty} \beta^s E_{t-1}(v(\pi_{t-1+s}(e^{t+s-1}), c_{t+s})) = 0, \] (25)
for each initial employment structure \( L_{t-1} \) in \( X^* \) and each plan \( \pi \) feasible from \( L_{t-1} \), where \( \pi_{t-1+s}(e^{t+s-1}) \) represents the expected state at \( t-1+s \) if the sequence of productivity shocks turns out to be \( e^{t-1+s} = (\varepsilon_1, \ldots, \varepsilon_{t-1+s}) \).

Given that \( F \) is not bounded, the \( v \) defined in the previous subsection does not necessarily satisfy this condition. \( F \) is upward bounded, however, and becomes \(-\infty\) when employment becomes \(+\infty\). In such a case, the principle of optimality still holds true. Following Stockey and Lucas, (1989), let us assume that there exists a plan \( \pi \) feasible from \( L_{t-1} \), such that \( \lim_{s \to -\infty} \beta^s E_{t-1}(v(\pi_{t-1+s}(e^{t+s-1}), c_{t+s})) \neq 0 \). Given that \( v \) is a linear decreasing function of total employment, this can be the case only if \( \pi \) implies some unbounded sequences for firms’ total employment. But for each of these unbounded sequences, the expected profit is \(-\infty\). This implies that \( \pi \) generates less expected profit than \( \pi^* \) where \( \pi^* \) is equal to \( \pi \) for each sequence such that \( \lim_{s \to -\infty} \beta^s E_{t-1}(v(\pi_{t-1+s}(e^{t+s-1}), c_{t+s})) = 0 \) and equal to \( \pi^* \) (i.e., the stationary contingency plan defined in the previous section) for the other sequences. In other words, for each \( \pi \) that does not satisfy 25 we can define \( \pi^* \) that generates more discounted profit than \( \pi \) and that satisfies 25. In such a case, we can apply the principle of optimality for unbounded return functions (see Stockey and Lucas, 1989, theorem 9.12) and \( v \) is the value function associated to the firm’s optimization.

Extension: Macro-economic shocks to the transition probabilities

The previous results can be directly extended to a model where the transition probabilities vary from one period to another as \( p_t = \frac{1}{2} + c_t \) and \( q_t = \frac{1}{2} - c_t \), where \( c_t \) is a white noise. In this framework, the associated Bellman equation can be written:

\[
v(L_{t-1}, \varepsilon_t, c_t) = \sup_{v} \max_{F(L_{t-1})} \left\{ F(L_{t-1}, Y, \varepsilon_t) + \beta E_t(v(L_{t+1}, \varepsilon_{t+1}, c_{t+1}) \right\}
\]

with
\[
E_t(v(L_{t}, \varepsilon_{t+1}, c_{t+1})) = P(\varepsilon_t, \varepsilon^+, c_t) E(v(L_{t}, \varepsilon^+, c_{t+1}))
+ P(\varepsilon_t, \varepsilon^-, c_t) E(v(L_{t}, \varepsilon^-, c_{t+1})) \quad (27)
\]
where $P(\varepsilon_t, \varepsilon_{t+1}, c_t)$ represents the probability of observing the state $\varepsilon_{t+1}$ at period $t+1$, when the present state is $\varepsilon_t$ and the macro-economic situation $c_t$. Using these notations, we check directly that the value function defined by the equation (22) is still solution of the Bellman program.

Let us now assume that $c_t$ is a first-order autoregressive process (meaning $c_t = \rho c_{t-1} + u_t$ where $u_t$ is a white noise). Under this assumption, we verify that a linear combination of $c_t$ and of the solution (22) gives a solution of the new program. More specifically the Bellman solution can now be written,

$$v(L_{t-1}, \varepsilon_t, \eta_t) = A_0 \varepsilon_t + A_1 \varepsilon_{t+1} + A_2 c_t - \theta c_{L_{t-1}} (L_{\alpha-1} + L_{\beta-1})$$

where $A_2$ is a time constant.

The optimal stationary plan $\pi^*$ remains the same as the one associated with the solution (22). More generally, when the shock $c_t$ follows a $k$-order autoregressive process and when both $q_t$ and $p_t$ can be written as linear functions of $c_t$ and of his $k-1$ last realizations, the solution to the Bellman program can be written as a linear combination of the solution described by (22) and of the $k - th$ last realizations of $c_t$. Regardless of the value of $k$, the optimal plan remains $\pi^*$.

Appendix D

The impact of changes in labor laws on layoff rates: a theoretical analysis.

In this appendix, we analyse the impact of changes in institutional and technological parameters on the risks of job loss. For simplicity’s sake, we assume that $\sigma_R$ and $\sigma_0$ are negligible, which is consistent with the econometric analysis in Goux and Maurin (2001). The total layoff rate is $\tau_t = \frac{s_{1t} \sigma}{L_{0t-1} + L_{1t-1}} = \theta - \frac{L_{1t}}{L_{0t-1} + L_{1t-1}}$. The layoff rate for high-seniority workers is $\tau_{Ht} = \frac{s_{2t}}{L_{0t-1}} = \theta - \frac{L_{1t}}{L_{0t-1}}$, and the layoff rate for low-seniority workers is $\tau_{Lt} = \frac{s_{1t}}{L_{0t-1}} = \theta - (1 - \theta) \frac{L_{1t}}{L_{0t-1}} - \frac{s_{2t}}{L_{0t-1}}$.

Impact of changes in $cQ_2$:

We verify:

$$\frac{\partial L_{Q_t}}{\partial cQ_2} = s_{2t} \frac{\sigma}{c_H cQ_2 - \sigma^2} \geq 0 \text{ and } \frac{\partial L_{1t}}{\partial cQ_2} = 0, \forall t$$

(29)
\[
\begin{align*}
\frac{\partial s_2}{\partial c_{Q2}} &= -s_2 \frac{c_H}{c_H c_{Q2} - \sigma_A^2} \leq 0 \\
\frac{\partial \tau_1}{\partial c_{Q2}} &= -\tau_1 \frac{c_H}{c_H c_{Q2} - \sigma_A^2} \leq 0 \\
\frac{\partial \tau_0}{\partial c_{Q2}} &= \left(\theta - \tau_0\right) \frac{L_{Q2-1}}{L_{Q2-1}} \frac{\partial s_2}{\partial c_{Q2}} - \frac{1}{L_{Q2-1}} \frac{\partial s_2}{\partial c_{Q2}} \geq 0
\end{align*}
\]

An increase in the costs of laying off high-seniority workers implies a decrease in the layoff rate for high-seniority workers, but an increase in the rates of hiring and layoff for low-seniority workers. Given that the number of high-seniority workers remains unaffected by variations in \(c_{Q2}\), an increase in \(c_{Q2}\) has a positive impact on total employment, in spite of an increase in the separation rate. There are more layoffs, but more jobs too.

**Impact of changes in \(c_{L1}\):**

The impacts of changes in the costs of laying off low-seniority workers (\(c_{L1}\)) are very different from those in the costs of laying off high-seniority workers (\(c_{Q2}\)). We verify:

\[
\begin{align*}
\frac{\partial L^+_0}{\partial c_{L1}} &= -\frac{\beta \theta}{c_H} < 0 \quad \text{and} \quad \frac{\partial L^-_0}{\partial c_{L1}} = -\frac{\beta \theta c_{Q2} + \sigma_A}{c_H c_{Q2} - \sigma_A^2} < 0 \\
\frac{\partial L^-_1}{\partial c_{L1}} &= \frac{1 - \beta \theta}{b} > 0 \quad \forall t
\end{align*}
\]

Given 23 and 24, it can be deduced \(\frac{\partial \tau_1}{\partial c_{L1}} < 0\). Furthermore,

\[
\begin{align*}
\frac{\partial s_2}{\partial c_{L1}} &= \frac{c_H c_{L2} + \sigma_A \varepsilon_0}{c_H c_{Q2} - \sigma_A^2} > 0 \\
\frac{\partial \tau_1}{\partial c_{L1}} &= \frac{1}{b(c_H c_{Q2} - \sigma_A^2) L_{Q2-1}^2} \left\{ (1 - \beta \theta)(c_H c_{L2} + \sigma_A \varepsilon_0) + \varepsilon_{Q2-1}(c_H + \sigma_A \beta \theta) \right\} > 0 \\
\frac{\partial \tau_0}{\partial c_{L1}} &= \left(\theta - \tau_0\right) \frac{L_{Q2-1}}{L_{Q2-1}} \frac{\partial s_2}{\partial c_{L1}} - \frac{1}{L_{Q2-1}} \frac{\partial s_2}{\partial c_{L1}} + (1 - \theta) \frac{\partial L^-_1}{\partial c_{L1}} \leq 0
\end{align*}
\]

Thus, an increase in the costs of laying off low-seniority workers implies a decrease in the rates of hiring and layoffs for low-seniority workers, and an increase in the rates of layoffs for high-seniority workers. The total effect is a decrease in the layoff rate, however.
Impact of changes in $\varepsilon_0$ and $\varepsilon_1$.

Let us consider an elementary variation in both $\varepsilon_0^+$ and $\varepsilon_0^-$. We verify:

$$\frac{\partial L_0}{\partial \varepsilon_0^+} = \frac{c Q_2}{c_H c Q_2 - \sigma_A} > 0 \quad \text{and} \quad \frac{\partial L_0}{\partial \varepsilon_0^-} = \frac{1}{c_H} > 0 \quad (38)$$

$$\frac{\partial s}{\partial \varepsilon_0^-} = -\frac{\sigma_A}{c_H c Q_2 - \sigma_A^2} < 0 \text{ then } \frac{\partial \tau_{1t}}{\partial \varepsilon_0^-} \leq 0 \quad (39)$$

$$\frac{\partial s_{1t}}{\partial \varepsilon_{0t}} = \theta \frac{\partial L_{0t-1}}{\partial \varepsilon_{0t}} - \frac{\partial s_{2t}}{\partial \varepsilon_{0t}} > 0 \quad (40)$$

$$\frac{\partial \tau_{0t}}{\partial \varepsilon_{0t}} = \frac{1}{L_{0t-1}} (\frac{\partial L_{0t-1}}{\partial \varepsilon_{0t}} (\theta - \tau_{0t}) - \frac{\partial s_{2t}}{\partial \varepsilon_{0t}}) > 0 \quad (41)$$

An increase in the productivity of low-seniority workers implies an increase in the total number of jobs, but also an increase in the layoff rate for low-seniority workers. On the contrary, the number of layoffs for high-seniority workers decreases while their number remains unaffected. All in all, we observe an increase in the share of low-seniority workers in total employment and an increase in the total layoff rate.

A variation in the productivity of high-seniority workers ($\varepsilon_1^+$ and $\varepsilon_1^-$) is the only exogenous change that can imply an increase of layoff rates for both high- and low-seniority workers. We check:

$$\frac{\partial \tau_{0t}}{\partial \varepsilon_{1t}} = -\frac{(1 - \theta)}{b L_{0t-1}} < 0 \quad (42)$$

$$\frac{\partial \tau_{1t}}{\partial \varepsilon_{1t}} = -\frac{\tau_{1t}}{b L_{1t-1}} < 0 \quad (43)$$

An increase in the productivity of high-seniority workers implies an increase in the number of high-seniority workers and an increase in the total number of jobs. The share of high-seniority workers increases and the total number of layoffs decreases.
Reading : The turnover rate is defined as half of the sum of the transition rates from unemployment to employment and from employment to unemployment. For the period between March 1982 and March 1983, this turnover rate is 2.5%.
### Table 1: Changes in job loss rates in France between 1982 and 2000.

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Transition Probability (%)</th>
<th>Transition Intensity</th>
<th>Employment Net change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>82/83</td>
<td>3.2</td>
<td>4.5</td>
<td>-1.5</td>
</tr>
<tr>
<td>83/84</td>
<td>4.4</td>
<td>6.2</td>
<td>-2.2</td>
</tr>
<tr>
<td>84/85</td>
<td>4.5</td>
<td>6.2</td>
<td>-0.9</td>
</tr>
<tr>
<td>Mean 82-85</td>
<td>4.0</td>
<td>5.6</td>
<td>-1.5</td>
</tr>
<tr>
<td>85/86</td>
<td>4.3</td>
<td>6.0</td>
<td>-0.5</td>
</tr>
<tr>
<td>86/87</td>
<td>4.8</td>
<td>6.6</td>
<td>0.0</td>
</tr>
<tr>
<td>87/88</td>
<td>4.4</td>
<td>6.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Mean 85-88</td>
<td>4.5</td>
<td>6.3</td>
<td>0.1</td>
</tr>
<tr>
<td>88/89</td>
<td>4.4</td>
<td>6.4</td>
<td>1.9</td>
</tr>
<tr>
<td>89/90</td>
<td>4.3</td>
<td>6.1</td>
<td>3.3</td>
</tr>
<tr>
<td>90/91</td>
<td>5.0</td>
<td>7.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Mean 88-91</td>
<td>4.6</td>
<td>6.7</td>
<td>2.3</td>
</tr>
<tr>
<td>91/92</td>
<td>5.6</td>
<td>8.2</td>
<td>-0.1</td>
</tr>
<tr>
<td>92/93</td>
<td>6.4</td>
<td>9.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>93/94</td>
<td>6.9</td>
<td>9.7</td>
<td>-1.1</td>
</tr>
<tr>
<td>Mean 91-94</td>
<td>6.3</td>
<td>9.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>94/95</td>
<td>5.6</td>
<td>8.0</td>
<td>1.9</td>
</tr>
<tr>
<td>95/96</td>
<td>5.9</td>
<td>8.2</td>
<td>1.2</td>
</tr>
<tr>
<td>96/97</td>
<td>5.8</td>
<td>7.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Mean 94-97</td>
<td>5.8</td>
<td>8.0</td>
<td>1.1</td>
</tr>
<tr>
<td>97/98</td>
<td>5.4</td>
<td>7.7</td>
<td>1.5</td>
</tr>
<tr>
<td>98/99</td>
<td>5.5</td>
<td>7.6</td>
<td>2.4</td>
</tr>
<tr>
<td>99/00</td>
<td>4.8</td>
<td>7.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Mean 97-00</td>
<td>5.2</td>
<td>7.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Reading: Among workers who had a job in March 1982, 3.2% are unemployed in March 1983. The annual transition probabilities between employment and unemployment make it possible to estimate at 4.5% the instantaneous transition intensity from employment to unemployment between 1982 and 1983. During the same period, the total number of jobs decreased by 1.5%. Field: All workers in French private sector. Source: Labor Force Surveys, 1982-2000.
Table 2: Share of workers with less than one year’s seniority and changes in job loss rates according to seniority between 1982 and 2000.

<table>
<thead>
<tr>
<th>Year</th>
<th>Share of low-seniority workers (%)</th>
<th>Annual transitions (%)</th>
<th>Instantaneous intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>82/83</td>
<td>14.6</td>
<td>10.9</td>
<td>2.1</td>
</tr>
<tr>
<td>83/84</td>
<td>15.2</td>
<td>13.4</td>
<td>3.0</td>
</tr>
<tr>
<td>84/85</td>
<td>13.3</td>
<td>13.6</td>
<td>3.3</td>
</tr>
<tr>
<td>85/86</td>
<td>13.1</td>
<td>14.1</td>
<td>3.1</td>
</tr>
<tr>
<td>86/87</td>
<td>14.6</td>
<td>14.9</td>
<td>3.4</td>
</tr>
<tr>
<td>87/88</td>
<td>15.4</td>
<td>13.9</td>
<td>3.0</td>
</tr>
<tr>
<td>88/89</td>
<td>17.4</td>
<td>14.0</td>
<td>2.7</td>
</tr>
<tr>
<td>89/90</td>
<td>18.5</td>
<td>13.3</td>
<td>2.6</td>
</tr>
<tr>
<td>90/91</td>
<td>19.6</td>
<td>14.1</td>
<td>3.1</td>
</tr>
<tr>
<td>91/92</td>
<td>18.2</td>
<td>16.6</td>
<td>3.5</td>
</tr>
<tr>
<td>92/93</td>
<td>17.1</td>
<td>19.0</td>
<td>4.2</td>
</tr>
<tr>
<td>93/94</td>
<td>16.7</td>
<td>21.6</td>
<td>4.4</td>
</tr>
<tr>
<td>94/95</td>
<td>15.7</td>
<td>17.7</td>
<td>3.8</td>
</tr>
<tr>
<td>95/96</td>
<td>17.3</td>
<td>20.1</td>
<td>3.4</td>
</tr>
<tr>
<td>96/97</td>
<td>17.2</td>
<td>18.8</td>
<td>3.6</td>
</tr>
<tr>
<td>97/98</td>
<td>17.1</td>
<td>17.0</td>
<td>3.4</td>
</tr>
<tr>
<td>98/99</td>
<td>17.8</td>
<td>17.5</td>
<td>3.4</td>
</tr>
<tr>
<td>99/00</td>
<td>18.6</td>
<td>14.0</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Reading: In March 1982, workers with less than one year’s seniority represent 14.6% of total employment in the private sector. Among workers with less than one year’s seniority in March 1982, 10.9% are unemployed in March 1983. This corresponds to an estimated instantaneous job loss rate of 16.4%. Field: All workers in private sector. Source: Labor Force Surveys, 1982-2000.
Table 3: Changes in job loss rates according to seniority and education level between 1982 and 2000 (annual transitions).

<table>
<thead>
<tr>
<th>Year</th>
<th>Low-seniority workers</th>
<th>High-seniority workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High-school graduates</td>
<td>High-school dropouts</td>
</tr>
<tr>
<td>82/83</td>
<td>5.3</td>
<td>16.9</td>
</tr>
<tr>
<td>83/84</td>
<td>6.5</td>
<td>21.4</td>
</tr>
<tr>
<td>84/85</td>
<td>7.0</td>
<td>20.6</td>
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<tr>
<td>85/86</td>
<td>6.7</td>
<td>23.1</td>
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<td>86/87</td>
<td>8.1</td>
<td>21.7</td>
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<td>87/88</td>
<td>7.8</td>
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<td>8.2</td>
<td>21.7</td>
</tr>
<tr>
<td>89/90</td>
<td>8.6</td>
<td>20.2</td>
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<tr>
<td>90/91</td>
<td>8.4</td>
<td>19.9</td>
</tr>
<tr>
<td>91/92</td>
<td>9.9</td>
<td>24.3</td>
</tr>
<tr>
<td>92/93</td>
<td>14.2</td>
<td>23.9</td>
</tr>
<tr>
<td>93/94</td>
<td>15.7</td>
<td>29.4</td>
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<td>94/95</td>
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<td>95/96</td>
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<td>28.0</td>
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<td>26.3</td>
</tr>
<tr>
<td>99/00</td>
<td>10.1</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Table 4: The Structural Effect of Labor Laws: Theoretical Predictions

<table>
<thead>
<tr>
<th>Increase in ( c_{Q2} )</th>
<th>Job Loss Risks</th>
<th>Hiring Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>senior.&lt;1</td>
<td>senior.( \geq 1 )</td>
</tr>
<tr>
<td>Increase in ( c_{L1} )</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Increase in ( \epsilon_0 )</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Increase in ( \epsilon_1 )</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Reading: An increase in \( c_{Q2} \) (high-seniority workers’ layoff cost) implies a rise in low-seniority workers’ job loss risks, a decline in high-seniority workers’ job loss risks, and a rise in hiring rates.
Figure 2: The structural effects of changes in labor laws on the optimal layoff rates

Figure 2a: Impact of a decrease in $c_{Q2}$

Figure 2b: Impact of a decrease in $c_{L1}$

Reading: Within our theoretical framework, the layoff rates $\tau_1$ for low-seniority workers are the highest when productivity slows down ($\varepsilon_{t-1} = +, \varepsilon_t = -$) and the lowest when it recovers ($\varepsilon_{t-1} = -, \varepsilon_t = +$). An increase in the redundancy payments ($c_{Q2}$) implies an increase in $\tau_1$ (figure 1a), whereas an increase in the costs of laying off low-seniority workers (i.e., $c_{L1}$) implies a decrease in $\tau_1$ (figure 1b). A decrease in the low-seniority workers’ productivity ($\varepsilon_0$) implies an increase in $\tau_1$ (figure 1c) too, as will do the high-seniority workers’ productivity ($\varepsilon_1$) (figure 1d).
Figure 2c: Impact of a decrease in the productivity of low-seniority workers

Figure 2d: Impact of a decrease in the productivity of high-seniority workers
Table 5: Structural changes in job loss risks: an Estimation of Equations 12 and 13.

<table>
<thead>
<tr>
<th>Indep. Variables</th>
<th>Job loss rates for workers with less than one year’s seniority (log).</th>
<th>Job loss rates for workers with more than one year’s seniority (log).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MCO (1)</td>
<td>IV(1)</td>
</tr>
<tr>
<td>Intercept</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>(72.6)</td>
<td>(35.3)</td>
</tr>
<tr>
<td>Dummy [1982-1986]</td>
<td>-0.04</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>(-0.7)</td>
<td></td>
</tr>
<tr>
<td>Dummy [1991-1999]</td>
<td>+0.2</td>
<td>+0.3</td>
</tr>
<tr>
<td></td>
<td>(4.2)</td>
<td>(3.5)</td>
</tr>
<tr>
<td>Nb of observations</td>
<td>534</td>
<td>300</td>
</tr>
<tr>
<td>Nb of instruments</td>
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<td>6</td>
</tr>
<tr>
<td>$R^2_{adj}$</td>
<td>0.17</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Note (1): For each year and each industry (2-digits, 36 items), the dependent variable in models MCO(1) and IV(1) (MCO(2) and IV(2)) is the probability of transition from employment to unemployment for workers with less than one year’s seniority (more than one year’s seniority). The set of independent variables also includes the interactions of our measures of the effect of the business cycle ($\hat{c}_t$) and its lag ($\hat{c}_{t-1}$) with the three sub-period dummies, meaning a set of 6 supplementary independent variables. The corresponding estimated coefficients are not reported. The models MCO(1) and MCO(2) have been estimated by the ordinary least squares method. The models IV(1) and IV(2) have been estimated by the instrumental variables method: the six variables that interact sub-period and cycle effects are instrumented by their two-period lagged values, taken in first-differences. The Student statistics are given between parentheses. Reading: Once the effects of the business cycle controlled, the low-seniority workers’ job loss rate is 20% higher during the 91-99 period than during the 87-90 period.
Table 6a: Structural changes in low-skilled workers’ job loss risks: an Estimation of Equations 12 and 13 for high-school dropouts.

<table>
<thead>
<tr>
<th>Indep. variables</th>
<th>Job loss rates for workers with less than one year’s seniority (log).</th>
<th>Job loss rates for workers with more than one year’s seniority (log).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MCO (3)</td>
<td>IV(3)</td>
</tr>
<tr>
<td>Intercept</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>(71.1)</td>
<td>(36.6)</td>
</tr>
<tr>
<td>Dummy [1982-1986]</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>(-1.5)</td>
<td>(-1.9)</td>
</tr>
<tr>
<td>Dummy [1991-2000]</td>
<td>+0.1</td>
<td>+0.2</td>
</tr>
<tr>
<td></td>
<td>(2.8)</td>
<td>(2.7)</td>
</tr>
<tr>
<td>Nb of observations</td>
<td>515</td>
<td>367</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>506</td>
<td>361</td>
</tr>
<tr>
<td>Nb of instruments</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>$R^2_{adj}$</td>
<td>0.10</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Note (2): For each year and each industry (2-digits, 36 items), the dependent variable in models MCO(3) and IV(3) (MCO(4) and IV(4)) is the probability of transition from employment to unemployment for high-school dropouts with less than one year’s seniority (more than one year’s seniority). The set of independent variables also includes the interactions of our measures of the effect of the business cycle ($\hat{c}_t$) and its lag ($\hat{c}_{t-1}$) with the three sub-period dummies, meaning a set of 6 supplementary independent variables. The corresponding estimated coefficients are not reported. The models MCO(3) and MCO(4) have been estimated by the ordinary least squares method. The models IV(3) and IV(4) have been estimated by the instrumental variables method: the six variables that interact sub-period and cycle effects are instrumented by their two-period lagged values, taken in first-differences. The Student statistics are given between parentheses. Reading: Once the cyclical effects controlled, the job loss rate of low-seniority high school dropouts is 10% higher during period 91-00 than during period 87-90.
### Table 6b: The structural changes in job loss risks: estimation of equations 12 and 13 for high-school graduates.

<table>
<thead>
<tr>
<th>Indep. variables</th>
<th>Job loss rate for workers with less than one year's seniority (log)</th>
<th>Job loss rates for workers with more than one year's seniority (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.2 (32.0)</td>
<td>0.6 (8.8)</td>
</tr>
<tr>
<td>Dummy [1982-1986]</td>
<td>+0.1 (0.8)</td>
<td>−0.3 (−2.3)</td>
</tr>
<tr>
<td>Dummy [1991-2000]</td>
<td>+0.3 (4.0)</td>
<td>+0.3 (4.6)</td>
</tr>
<tr>
<td>Nb of observations</td>
<td>363</td>
<td>414</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>354</td>
<td>405</td>
</tr>
<tr>
<td>Nb of instruments</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$R^2_{adj}$</td>
<td>0.11</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Note (3): For each year and each industry (2-digits, 36 items), the dependent variable in models MCO(5) and IV(5) (MCO(6) and IV(6)) is the probability of transition from employment to unemployment for high-school graduates with less than one year’s seniority (more than one year’s seniority). The set of independent variables also includes the interactions of our measures of the effects of the business cycle ($\tilde{c}_t$) and its lag ($\tilde{c}_{t-1}$) with the three sub-period dummies, meaning a set of 6 supplementary independent variables. The corresponding estimated coefficients are not reported. The models MCO(5) and MCO(6) have been estimated by the ordinary least squares method. The models IV(5) and IV(6) have been estimated by the instrumental variables method: the six variables that interact sub-period and cycle effects are instrumented by their two-period lagged values, taken in first-differences. The Student statistics are given between parentheses. Reading: Once the cyclical effects controlled, the job loss rate of low-seniority high school graduates is 30% higher during period 91-99 than during period 87-90.