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Changes in job security and their causes: An empirical analysis for France, 1982–2002

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Abstract

In this paper, we analyze the changes in the risks of involuntary job loss in France between 1982 and 2002. We find that these risks are higher in the 1990s than they were in the 1980s. We develop an econometric analysis to separate the effects of institutional changes from the effects of new technologies. Our estimates show that the rise in job loss rates is significantly more pronounced in industries that have the largest share of R&D workers and the largest rate of new technologies' users. These findings suggest that technological changes contribute to decreasing the incentive to keep workers for long period of time and to increasing job insecurity.

JEL classification: J23; J63

Keywords: Job security; Labor demand; Seniority

1. Introduction

In most Western countries, an increasing number of workers are worried about the risks of losing their job (OECD, 1997). Job security is a growing public concern and an increasingly large number of studies are concerned with this issue. Generally speaking, this literature leads to controversial and debated conclusions.

Using the data from the Displaced Workers Survey (DWS) from 1984 to 2000, Farber (1998, 2001) shows that the US rate of involuntary job loss had a strong counter-cyclical component in the 1980s, but increased in the mid-1990s despite the sustained economic expansion. The increase was larger for more educated workers, even if less educated ones continue to have the highest rates of job loss overall. As

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emphasized by Farber (2001) or Kletzer (1998), it does appear that there was more job loss in the US in the mid-1990s than during other periods even after taking into account the state of the labor market. This fact may account for workers' perception of declining job security (Schmidt, 1999). The studies based on the Panel Study of Income Dynamics (PSID) and the National Longitudinal Survey of Youth (NLSY) give a picture of changes in job insecurity in the US which is rather consistent with studies based on the DWS. Using the PSID, Boisjoly et al. (1998) show a rather sharp increase in the rates of involuntary terminations in the US between 1968 and 1992. Analyzing the NLSY, Monks and Pizer (1998) also find an increase in the rates of involuntary separation for the young in the 1970s and the 1980s.

In contrast, using monthly information on workers' employers from the Survey of Income and Program Participation (SIPP), Gottschalk and Moffit (1999) do not find any significant upward trend in the probability that a job exit was followed by a non-employment spell and argue that job security is not downward trended in the US. It is not easy to determine why different datasets provide different results. The SIPP files used by Gottschalk and Moffit do not differentiate between voluntary and involuntary terminations and this may explain why they end up with a different diagnosis.

Also, we should emphasize that papers focusing simply on job tenure or on job retention rates have found very little evidence of any significant trend in job stability in the US.[1] Using data from the CPS, Neumark et al. (1999) find a modest decline in retention rates in the first half of the 1990s (the decline being significant for high-seniority workers only) while Jaeger and Huff Stevens (1999) report a slight increase in the proportion of men with less than 10 years of job tenure in the US, starting in the late 1980s. Using the SIPP, Gottschalk and Moffit (1999) report an overall stability in job retention rates in the US.

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 for job security and in finding datasets providing consistent measurement of job security over time. Most of the debate in the US has focused on these measurement issues.

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 insecurity and understanding the meaning of their variations from country to country or from period to period. The existing literature on changes in job security is mostly empirical, the main issue being to identify robust factual findings. One interesting exception is Valetta (1999) who conceptualizes periods of increasing job insecurity as periods during which unexpected economic conditions provide employers with incentives to break the implicit labor contracts that were designed to overcome incentive problems in the employment relationships. Using data from the PSID, Valetta (1999) finds that the negative effect of job tenure on the probability of dismissals has significantly weakened between 1976 and 1992 and interprets this result as reflecting employer branch of implicit employment arrangements in the early 1990s.

[1] See the special issue of the Journal of Labor Economics (1999). See also the debate between Diebolt et al. (1997) and Swinnerton and Wial (1995), as well as Farber (1995). See Bergemann and Mertens (2001) and Burgess and Rees (1996) for analysis of job stability in the German and the English cases.

1.1. The role of technological and institutional changes

All in all, many questions remain unanswered, and policies that might make employment relationships more secure are far from clear. Why and how does the risk of losing one's job change over 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 shed some lights on these issues, this paper proposes an in-depth analysis of the evolution of job security in France between 1982 and 2002.

Most of the existing literature on changes in job security has focused on the US case. The US economy is characterized by a much less regulated labor market than most other advanced economies and this is plausibly why the question of the effect of institutional changes on job insecurity has not yet been addressed. Also, this is why the examination of a typical continental European labor market may be of particular interest. Furthermore, as far as France is concerned, the 1982–2002 period is very interesting. After a strong relaxing in 1986, the labor laws have became more restrictive again after 1990. By comparing the three different institutional sub-periods (i.e., 1982–1986, 1986–1990 and 1990–2002), it is possible to give an insight into the impact of increasing (or decreasing) the flexibility of labor laws on job security.

The two last decades have also been a period of dramatic technological change. The interesting point is that the dissemination of new information technologies has been very different across industries. In 1998, the proportion of French workers who use the internet is two times as high in the chemical industry than in the automobile industry. By comparing industries, it is possible to identify the impact of new technologies on the strength of the employment relationships. To perform these comparisons, we have used the French Labor Force surveys (and the 1998 supplement on new technologies) conducted between 1982 and 2002. We have focused on the rates of involuntary job loss, as they can be measured by the involuntary transitions between employment and unemployment in a standard Labor Force Survey (LFS). 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. Our database retraces the risks of job loss for each year, each educational level, each level of seniority and each industry between 1982 and 2002.

The main empirical findings may be summarized as follows. After controlling for the effect of changes in the macro-economic climate, job security turns out to be structurally lower during the 1990s than during the 1980s. This structural decrease in job security is perceptible at every educational level, whether dealing with workers with less than 1 year's seniority or with workers with more than 1 year's seniority. Finally, the decline in job security is more pronounced in industries that have the largest share of new technology users or R&D workers. Most interestingly, these basic findings are consistent with Farber's findings, according to which the increase in job displacement during the 1990s in the US was especially pronounced for skilled white-collar workers. In contrast, our finding that the decline in job security is as perceptible for low-seniority as for high-seniority workers is not consistent with Valetta's results and interpretation of the decrease in the relative job security of high-seniority workers in the US.

Generally speaking, our empirical analysis confirms that labor market institutions matter: The decline in job security observed during the last two decades would have been more significant if employment protection had not been reinforced in 1990. Symmetrically, the decline in job security observed during the 1980s would have been less significant if French labor laws had not become more flexible in 1986.

At the same time, our analysis reveals that institutional changes alone cannot account for the long-term decline in job security observed in France. In particular, the changes in labor laws that took place in France cannot account for the decline in job security observed *after* 1990 nor for the differences in job security trends across industries. In contrast, technological change seems to be a good candidate for explaining these facts. New information technologies seem to modify the degree of substituability between low and high-seniority workers and firms have less and less incentive to keep their workers for long period of time. This interpretation is consistent with the recent developments of the literature on the labor-demand effects of technological change. There exists a very large literature showing rising demand for skills in advanced countries and suggesting that technological change is one important cause for this trend.[2] Recent studies on American and French data suggest that the most direct effect of new information technologies is to eliminate routine tasks (regardless of whether they are complex or not) and argue that these technologies increase the demand for skills mostly because routine activities are performed on average by less skilled workers than non-routine ones (see Autor et al., 2001; Maurin and Thesmar, in press). Given that routine tasks are typically those for which senior workers may have a comparative advantage – they have had time to learn them on the job – the dissemination of information technologies is likely to decrease the relative demand for senior workers and decrease job security.

The paper is organized in the following way. Section 2 provides a brief description of our theoretical and econometric framework. Section 3 gives an outline of the evolution of the risks of job loss in France during the last 20 years. In Section 4, a very simple econometric model is used to break down the evolution of the risks of becoming unemployed into its different structural and transitory components.

2. Identifying the sources of job security

A decline in job security 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 decrease in job security 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

[2] See e.g. the recent papers by Bresnahan (1999) or Card and DiNardo (2002). For a specific analysis of French trends, see Goux and Maurin (2000).

was 20 years ago (OECD, 1999; Goux et al., 2001). These institutional changes are a potentially important factor of job insecurity.

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. By construction, new information technologies tend to eliminate routine tasks and complement innovative activities.[3] Given that routine tasks are mostly learned on the job, the dissemination of information technologies is likely to decrease the relative demand for senior workers and to decrease job security.

To separate the role of institutions and the role of technologies, we cannot do without a structural model for the impact of the labor laws and the business cycle on firms' demand for labor. In a companion paper, we have developed a dynamic model of hiring and separations 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 (Givord and Maurin, 2001). In this model, high- and low-seniority workers represent two distinct productive factors (i.e., they are not perfect substitute). They also have different levels of job protection. Within this framework, a decline in job security can have two very different causes: A decline in employment protection, on the one hand, and, on the other hand, a decline in the degree of complementarity between low- and high-seniority workers. It is beyond the scope of this paper to develop this dynamic labor-demand model in greater details. We are simply going to focus on its main empirical implication. More specifically, if τ_{kst} denotes the rate of involuntary job loss experienced at date t, in industry s, by the workers of category k, the model implies the following very simple decomposition of τ_{kst} into its cyclical, institutional and technological components:

$$\tau_{kst} = \alpha_k + \beta_s + \gamma_{I(t)} + \delta_{I(t)} T_s + \theta_0 c_t + \theta_1 c_{t-1} + \varepsilon_{kst}, \tag{1}$$

where $I(t)$ represents the institutional sub-period that corresponds to date t. The α_k parameters are worker-category fixed effects capturing the heterogeneity of workers' productivity. The β_s parameters are industry fixed effects capturing the heterogeneity of technologies across industries (one key aspect being the variations in the degree of substituability between low- and high-seniority workers across industries). The $\gamma_{I(t)}$ parameters are sub-period fixed effects capturing the changes in the costs of laying workers off across institutional sub-periods. The T_s variable measures the diffusion of new technologies in industry s while the $\delta_{I(t)}$ coefficients capture the effect of technological changes on job security. A positive $\delta_3 - \delta_1$ will indicate that the rise in job loss rates across the three subperiods is more pronounced in industries with the largest T_s, i.e. where the diffusion of new technologies is more significant. Lastly the c_t variable measures the cyclical variations in the macro-economic climate. The larger the θ_0 and θ_1 parameters, the larger the impact of the business cycle on job security. In Section 4, we will apply our econometric analysis to Eq. (1) and to simple variants of this equation. The aim of this econometric analysis will be precisely to separate

[3] See Autor et al. (2001) or Maurin and Thesmar (in press).

the impact of changes in the levels of employment protection and in the degree of complementarity between high- and low-seniority workers.

3. Basic facts: The risks of job loss in France between 1982 and 2002

Before developing our econometric analysis, we will describe how labor laws, macro-economic climate and job security evolved in France between 1982 and 2002. The purpose of this section is to formulate the terms of the problem we are trying to 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 details). 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). As for the early 2000s, the economic expansion remained sustained in 2000–2001, but slowed down in 2001–2002. 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.

3.1. Measurement for the job loss rates

We have used the LFS carried out by INSEE between 1982 and 2002 to measure the risks of job loss. A more detailed description of these data is given in Appendix B. These surveys make it possible to measure the probability 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. Also, the French LFS provide information on whether unemployed workers became unemployed after a voluntary quit or after an involuntary job loss. For each industry, year and worker category, our measure of job loss risks will correspond to the probability of being involuntarily unemployed at $t+1$ while being employed at t.[4] The evolution of these annual involuntary 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.

A potential problem with this measurement is that the annual transition rate between employment and unemployment underestimates the total number of jobs lost each year by workers: Some workers are employed at the beginning of year t and at the

[4] The basic findings are the same when we analyze all job losses rather than involuntary job losses only.

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 plausibly underestimates the rates of job loss that workers have experienced within the $[t,t+1]$ period. Similarly, the annual probability of transition from unemployment to employment underestimates the probability of job accession that unemployed workers have experienced within the $[t,t+1]$ period. Supposing that the instantaneous intensities of transition remain constant throughout the $[t,t+1]$ period, it is possible, however, to estimate these intensities from the observed annual transition probabilities and to compare their evolution with the evolution of the annual transition probabilities.[5] This calculation is given in Appendix B. Table 1 provides us with the two basic job security measurements, the one given by the annual transition probabilities and the one corresponding to the estimated intensities of transition. Generally speaking, the variations of the two indicators over time are very similar[6] and we reach the same basic diagnosis with the annual transition probabilities and the instantaneous transition intensities. In the remainder of this paper, we will focus on the estimations obtained by taking the annual transition probabilities. The findings 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 involuntary job loss were systematically higher during the 1990s than the 1980s (see Table 1). The average job loss rate for the 1992–2000 period was 31% higher than the average observed rate throughout the 1982–1991 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 4.3% of workers lost their jobs involuntarily. Eighteen years earlier in 1982, the year of one of the greatest drop in total employment observed throughout the period studied (−1.4%), the job loss rate was only 2.9%. Beyond the major fluctuations linked to the macro-economic climate, this preliminary analysis shows that the risks of involuntary job loss has increased over time.

(2) From 1 year to the next, the risk of involuntary job loss is considerably greater for workers with less than 1 year's seniority than for higher seniority workers. Among the workers with less than 1 year's seniority at the beginning of 1999, 12.6% were unemployed at the beginning of 2000, signifying a transition probability four times higher than that for workers with more than 1 year's seniority. For a given seniority

[5] By definition, the transition intensity τ_{kl} between state k and state l corresponds to $\lim_{ds\to 0} \frac{p_{kl}(s,s+ds)}{ds}$, 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.

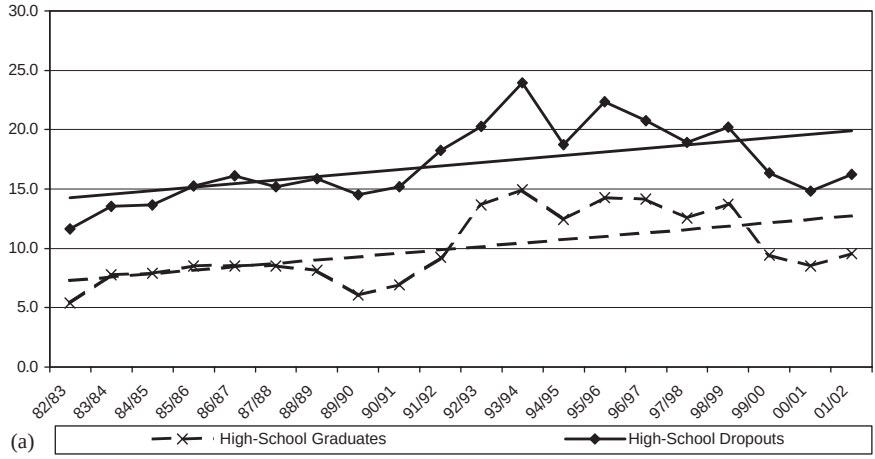
[6] Given that the estimation of intensities of transition from employment to unemployment uses the available information on all types of annual transitions (including the information on job accessions), this result is not a methodological artefact. For a given annual probability of job loss, the higher the annual probability of job accession is, the higher the estimated intensity of transition from employment to unemployment is. Estimated intensities of transition from employment to employment may vary over time even when annual probabilities of transition from employment to unemployment remain stable.

Table 1
Changes in job loss rates in France between 1982 and 2002

	Annual transition probabilities			Transition intensities (×100)	Employment net changes (%)
	All	Seniority < 1 year	Seniority 1 or more		
82/83	2.9	9.8	1.9	4.1	−1.4
83/84	4.0	11.8	2.8	5.5	−2.2
84/85	4.1	11.7	3.1	5.7	−0.9
Mean 82–85	*3.7*	*11.1*	*2.6*	5.1	*−1.5*
85/86	4.0	12.5	3.0	5.7	−0.5
86/87	4.5	13.5	3.3	6.3	0.0
87/88	4.2	12.6	2.9	5.9	0.7
Mean 85–88	*4.2*	*12.9*	*3.0*	*6.0*	*0.1*
88/89	4.0	13.0	2.5	5.7	1.9
89/90	3.8	11.7	2.3	5.5	3.3
90/91	4.5	12.4	2.9	6.7	1.3
Mean 89–91	*4.1*	*12.3*	*2.6*	*6.0*	*2.3*
91/92	5.0	15.0	3.1	7.1	−0.2
92/93	5.8	17.2	3.8	8.3	−1.0
93/94	6.4	20.2	4.1	9.1	−1.4
Mean 92–94	*5.7*	*17.4*	*3.7*	*8.2*	*−1.2*
94/95	5.1	15.9	3.5	7.3	1.8
95/96	5.4	18.7	3.2	7.6	1.1
96/97	5.4	17.2	3.4	7.6	0.2
Mean 94–97	*5.3*	*17.3*	*3.3*	*7.5*	*0.6*
97/98	5.0	15.6	3.2	6.9	1.4
98/99	5.0	16.3	3.0	6.9	2.3
99/00	4.3	12.6	2.8	6.1	3.6
Mean 97–00	*4.8*	*14.9*	*3.0*	*6.6*	*2.9*
00/01	4.0	11.6	2.5	5.6	3.2
01/02	4.7	12.9	3.0	6.7	0.9

Source: Labor Force Surveys, 1982–2002.
Reading: Among workers who had a job in March 1983, 4.0% are unemployed in March 1984. During the same period, the total number of jobs decreased by 2.2%. The estimation method for transition intensities is given in Appendix B. Field: All workers in French private sector.

level, the less educated workers are also more exposed to the risks of job loss than more educated workers. Among the workers with less than 1 year's seniority, about 16% of high-school dropouts went from employment to unemployment between March 1999 and March 2000, compared to only 9% of those with at least a high school diploma.



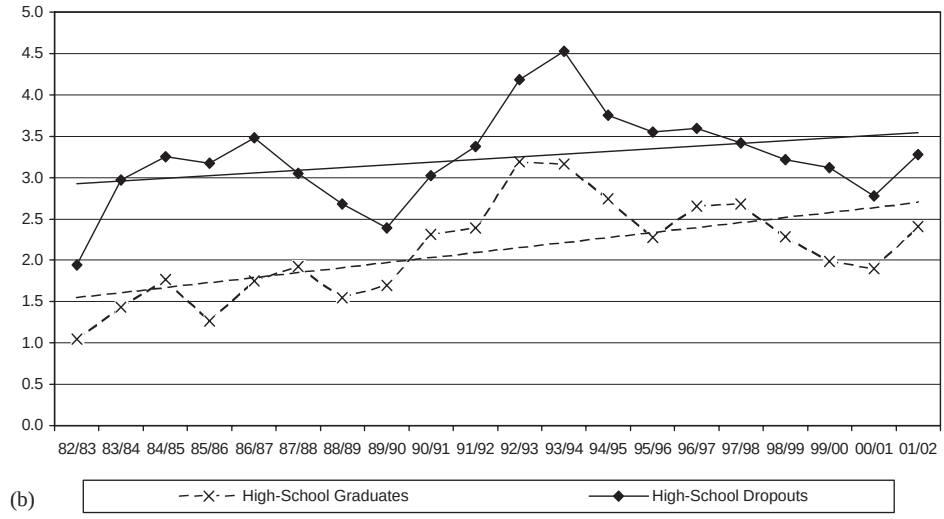


Fig. 1. Changes in job loss rates of (a) low-seniority workers and (b) high-seniority workers according to education level between 1982 and 2002 (annual transitions). *Source*: Labor Force Surveys, 1982–2002. *Reading*: Among high school dropouts with less than 1 year's seniority in March 1983, 13.5% are unemployed in March 1984. Field: All workers in private sector.

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 may reflect 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 involuntary job loss for each of the major worker categories defined by seniority and education level (see Fig. 1a and b). Interestingly

enough, this analysis confirms a rise in the risks of job loss for each of the worker categories. The rise in job insecurity is as perceptible for educated workers (dotted line) as for less educated ones (solid line). For the 1982–1991 period, the average annual transition rate from employment to unemployment for workers with at least a high school diploma was about 1.6% for those with more than 1 year's seniority, and about 7.5% for those with less than 1 year's seniority. For the 1992–2000 period, the same average rates were almost multiplied by two, going from 2.6% for those with more than 1 year's seniority to 12% for those with less than 1 year's seniority. There was also a significant increase for workers without a high school diploma: between 1982–1991 and 1992–2000, the average job loss rate rose from 14% to 20% for those with less than 1 year's seniority and from 2.9% to 3.6% for those with more than 1 year's seniority. Generally speaking, these results are still true when separate by age level (not reported).

Altogether, it appears that beyond the effects of the business cycle, the risks of involuntary 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. In order to identify the structural factors of this phenomenon, we are now going to develop our econometric analysis.

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

In this section, we develop an econometric analysis of Eq. (1) using the French LFS. The goal of this analysis is to test whether the risks of job loss have undergone structural changes over time and to identify the technological and/or institutional factors that have driven these changes.

4.1. Variables used in the analysis

For each industry, each year and each basic segment of the workforce (educated vs. non-educated), the basic dependent variable is the rate of involuntary job loss. For each year, industry and segment of the workforce, the basic control variables are 20 year dummies, 38 industry dummies capturing industries' technological heterogeneity, two dummies indicating the category of workers under consideration (i.e., high-school dropout vs. high-school graduated), and a variable giving workers' average age.

To analyze the role of technological factors, we have built three different technology measures. First, we have used a survey on workplace organization and working conditions conducted as a supplement to the LFS of 1998. For each industry, this survey makes it possible to estimate the rate of workers who use the internet. Given that the rate of users of new information technologies was negligible in the early 1980s, this end-of-the-period measurement can be interpreted as an indicator of the spread of new information technologies over the last two decades.

Secondly, we have used the French LFS to estimate the employment share of R&D workers for each industry.[7] We interpret this employment share as a measure of the R&D efforts at the industry level.

Lastly, to probe the robustness of the results, we have used the LFS to estimate the proportion of high-school graduates within each industry at the beginning of the period under consideration (i.e., 1982). We interpret this proportion as an indicator of the human capital intensity of the industry. Table 2 shows how our three technology indicators vary across sectors. Unsurprisingly, we find significant correlation across them.

Assuming that technological change decreases the degree of substituability between low- and high-seniority workers, we expect the increase in the risks of job loss to be more significant in industries where the share of internet users is the most significant. Assuming that R&D efforts drive technological changes and that human capital is a complement for new technologies, the decline in job security should also be more pronounced in industries that have the largest share of R&D workers and the largest rate of educated workers.

4.2. Results

Table 3 presents the estimation results for the various specifications of the period effects and technology effects. Model (1) confirms that – controlling for the full set of year and industry dummies – the rates of involuntary job loss are significantly larger for the youngest and least educated workers. The estimated set of year dummies is reported on Fig. 2 (bold line) and shows a significant upward trend.

Model (2) provides us with a more parcimonious decomposition of this time effect into its cyclical and structural components. We use past and present GDP growth rates to control for the effects of the business cycle and three sub-period dummies (i.e., 1982–1986, 1986–1990 and 1990–2002) to control for the effects of the institutional changes that took place in 1986 and 1990. This model shows that the rates of involuntary job loss are significantly less important during periods of economic expansion. An increase of 1% point in the GDP growth rate is associated with a 0.31% point decrease in the job loss rates. Model (2) also confirms a significant and persistent decline in job security over time: after controlling for the effect of the macro-economic environment, the rate of involuntary job loss is 0.97% point higher at the end of the 1980s than at the beginning and 0.25% point higher in the 1990s than at the end of the 1980s. These estimates show that the introduction of more restrictive labor laws in the early 1990s has not been followed by any significant decrease in job insecurity.

Models (3), (4) and (5) provide us with an analysis of the effects of technological change using our three different technology measures. To test for the impact of technological factors on job security, we have added the interactions between our three

[7] The French LFS provide us with the occupational code (4 digits, 450 items) of each worker. For each industry, it is possible to estimate the proportion of *ingénieurs d'étude et recherche* (i.e., four digit code: 382n, with $n = 0, \ldots, 9$) which – in the French context – is the most direct measure for the proportion of R&D workers.

Table 2
Three technology measures: the employment share of R&D workers, high-school graduates and users of new information technologies, by industry (%)

NAP40	Rate of workers who use Internet	Rate of high-school graduates	Share of R&D workers
Agriculture	0.8	5.2	0.3
Meat and dairy products	2.0	9.3	0.7
Other food	1.1	8.5	0.8
Coal mining	0.0	10.9	1.6
Crude petroleum, natural gas production	53.3	47.9	13.6
Electricity, gas and water	10.4	29.7	5.2
Iron and steel mining	2.5	15.6	2.6
Non-iron and steel mining	8.9	19.8	5.7
Cement, concrete, and stone products	2.7	9.4	1.0
Glass	6.8	5.5	1.1
Chemical	12.8	27.8	4.9
Parachemicals, soap, and cosmetics	13.1	28.3	4.8
Iron and steel foundries, metal industries	3.0	11.8	1.1
Machinery, except electrical	7.3	16.4	2.6
Electrical and electronical machinery	24.4	26.7	10.2
Land-transportation equipment (incl. Rail.)	5.8	12.1	3.3
Ship and boat building, aircraft and parts	11.5	26.4	11.3
Textiles and apparel	0.8	6.6	0.3
Leather and footwear	0.0	4.5	0.2
Lumber, furniture	2.1	8.8	0.5
Paper and paperboard mills	3.0	11.8	0.7
Printing, publishing (including newspapers)	11.6	25.5	0.8
Rubber and plastic products	2.6	12.5	1.5
Construction	0.8	8.2	0.8
Wholesale food trade	3.7	13.4	1.0
Wholesale non-food trade	11.9	25.1	2.1
Retail food trade	1.9	7.2	0.2
Retail non-food trade	3.8	21.4	0.4
Repair and car trade	3.8	7.9	0.3
Hotels, motels, eating and drinking places	1.9	10.2	0.2
Transportation	4.7	15.9	0.9
Telecommunications and mail	10.9	23.5	4.5
Business Services	18.3	43.8	9.6
Personal Services	2.8	38.6	0.3
Real estate and credit agencies	2.4	19.0	1.9
Insurance	10.6	32.5	3.8
Banking and finance	12.8	41.5	3.3
Public utilities	7.8	42.8	1.1
Pearson correlation			
Rate of Internet users/rate of high school graduates			0.70
Employment share R&D/rate of high school graduates			0.63
Rate of Internet users/employment share R&D			0.83

Reading: Column 1 provides the share of workers who use the internet by industry (2 digit, SIC) in 1998, column 2 the employment share of high-school graduates by industry in 1982, column 3 the employment share of R&D workers (averaged over the 1990–2002 period), by industry.

Table 3
The determinants of job loss risks 1982–2002

Independent variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
[High-school graduate = 1]	−1.53	−1.51	−1.55	−1.60	−1.61	−1.59
	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
Age	−0.08	−0.07	−0.09	−0.11	−0.11	−0.10
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Annual dummies	(Yes)		(Yes)	(Yes)	(Yes)	
[Rate of workers who use the Internet] × [1990–2002 = 1]			0.03			
			(0.01)			
[Share of R&D workers] ×[1990–2002 = 1]				0.16		
				(0.03)		
[Rate of high-school graduate] ×[1990–2000 = 1]					0.04	0.04
					(0.01)	(0.01)
[1982–1986 = 1]		−0.97				−0.96
		(0.23)				(0.22)
[1990–2002 = 1]		0.25				−0.47
		(0.19)				(0.28)
GDP growth rate $(t-1, t)$		−0.31				−0.30
		(0.06)				(0.06)
GDP growth rate $(t-2, t-1)$		−0.03				−0.03
		(0.06)				(0.06)
Industry fixed-effects	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
R^2	0.34	0.34	0.35	0.36	0.35	0.34
Nb observations	1520	1520	1520	1520	1520	1520

Source: Labor Force Surveys $t = 1982, \ldots, 2002$.
Note: For each year (defined as the interval between surveys $t-1$ and t), each industry (2 digits SIC index) and each educational group (high-school dropouts, high school graduates), the dependent variable is the rate of transition from employment to unemployment between $t-1$ and t. *Reading:* A 1% point difference in the share of R&D workers implies a 0.16% point difference in the increase in the rate of job loss between the [1990–2002] and the [1986–1990] periods. The higher the share of R&D workers is, the stronger the decline in job security is. Standard errors indicated in parentheses.

different technology measures and a dummy which value is one when $I(t)$=[1990, 2002] as additional independent variables. These models show that – controlling for the full set of year and industry dummies – the decline in job security is more significant in industries that have the largest share of users of new information technologies (model

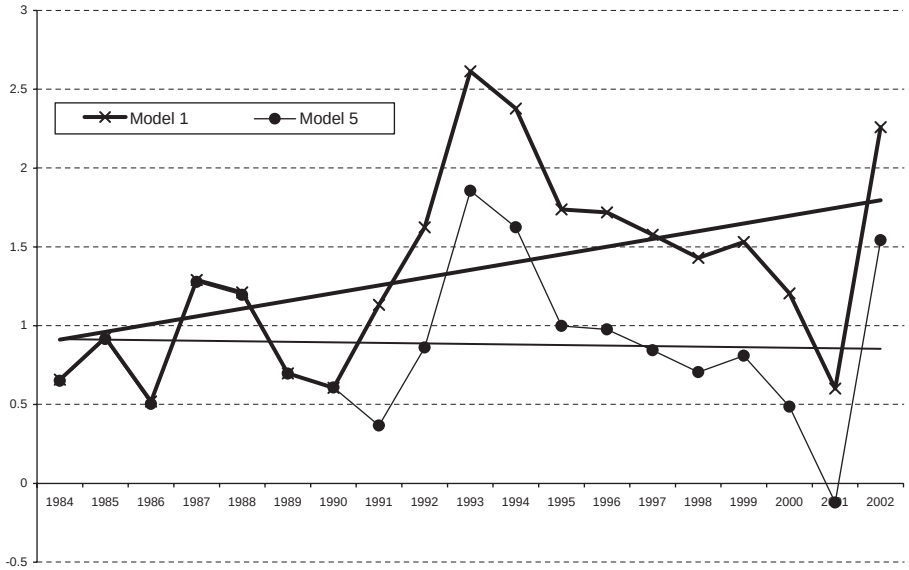


Fig. 2. The estimated year dummies' effects: a comparison of model (1) and model (5). *Reading*: The year dummies' effects in model (1) show an upward trend in job insecurity. The introduction of a technology × [1990, 2002] control variable in model (5) reveals that this trend is driven by high-technology sectors only.

(3)), R&D workers (model (4)), or high-school graduates (model (5)).[8] Model (3) shows that a 10 points increase in the rate of workers who use the internet is associated with a 0.3% point increase in the difference in job security between the 1990s and the late 1980s. A 0.3 point increase represents 25% of a standard deviation (SD) of the distribution of job security changes across industries over this period.[9] Similarly, model (5) shows that a 10 points increase in the rate of high-school graduates implies a 0.4% point increase in the difference in job security between the 1990s and the late 1980s, meaning a 33% of an SD increase. Lastly, model (4) shows that a 10% points increase in R&D intensity generates a 1.6% points increase in the difference in job security (i.e., about a 1.3 SD increase). As it turns out, our technology variables explain a significant share of the variance of the distribution of job security changes across industries.[10]

Fig. 2 reports the estimated set of year dummies corresponding to model (5) (light line) and shows that it is not trended anymore. The comparison with the set of dummies

[8] When we use the three indicators in the same model, the parameters are less well estimated (because of multicolinearity) and it is not easy to identify which measure the regressions prefer.

[9] The mean of the distribution of changes in job loss rates across industries (between the [1986–1990] and the [1990–2002] periods) is +0.9% point. The standard deviation of this distribution is 1.2.

[10] Denote R_1 the R^2 of model 1, R_i the R^2 of model (i) (for $i=3,4,5$) and R the R^2 of the model where one adds the full set of dummies interacting industry dummies and the [1990–2002] dummy as supplementary control variables. We have checked that $(R_i - R_1)/(R - R_1) = 8\%$ for $i = 3$, 49% for $i = 4$, and 28% for $i = 5$, meaning that our technology measures explain from 8% to 49% of the sectoral variance of the job security changes observed between the 1990s and the late 1980s.

Table 4
The determinants of job loss risks for educated and less educated workers

Independent variables	High school dropouts		High school graduate	
	Model (7)	Model (8)	Model (9)	Model (10)
Age	−0.19	−0.28	−0.04	−0.06
	(0.08)	(0.08)	(0.06)	(0.06)
[1982–1986 = 1]	−1.09	−1.06	−0.82	−0.82
	(0.33)	(0.32)	(0.29)	(0.29)
[1990–2002 = 1]	0.41	−0.60	0.32	−0.11
	(0.32)	(0.40)	(0.24)	(0.36)
GDP growth rate $(t-1,t)$	−0.37	−0.34	−0.22	−0.22
	(0.09)	(0.09)	(0.08)	(0.08)
GDP growth rate $(t-2,t-1)$	0.11	0.11	−0.18	−0.18
	(0.08)	(0.08)	(0.07)	(0.07)
[Rate of high school graduates]		0.06		0.02
×[1990–2002 = 1]		(0.02)		(0.01)
Industry fixed-effects	(Yes)	(Yes)	(Yes)	(Yes)
R^2	0.39	0.40	0.32	0.33
Nb observations	760	760	760	760

Note and *Reading*: See Table 3.

corresponding to model (1) (bold line) reveals that the decline in job security observed in the 1990s was mostly driven by technological factors. Most interestingly, model (6) confirms that – once we control for the technological context – the effect of the [1990–2002] dummy variable becomes significantly *negative*. This result suggests that job security would have actually increased in the 1990's if technological change had been neutral. Put differently, the decline in job security observed in the 1990s would have plausibly been even more significant if employment protection had not been reinforced in 1990.

Table 4 presents a re-estimation of models (2) and (6) for educated and less educated workers. Models (7) and (9) confirm a significant decline in job security over time for both educational groups. Also, models (8) and (10) show that – for both groups – the decline was more significant in the sectors with the highest proportion of educated workers at the beginning of the period.[11] Once we control for this indicator of human

[11] Generally speaking, the re-estimation of models (2) and (6) provides qualitatively similar results when we use the share of R&D workers (or the rate of users of the internet) rather than the rate of high-school graduates as technology measure. Tables 4 and 5 focus on the human capital indicator because it provides us (on average) with the most significant effects when we analyze separately the different subgroups of workers.

Table 5
The determinants of job loss risks for three seniority groups

Independent variables	Seniority < 1 year		Seniority 1–2 years		Seniority 2 years or more	
	Model (11)	Model (12)	Model (13)	Model (14)	Model (15)	Model (16)
[High-school graduate = 1]	−7.17	−7.18	−3.4	−3.5	−0.76	−0.78
	(0.64)	(0.64)	(0.53)	(0.53)	(0.11)	(0.12)
Age	−0.03	−0.04	0.08	−0.02	0.001	−0.008
	(0.11)	(0.11)	(0.10)	(0.08)	(0.03)	(0.03)
[1982–1986 = 1]	−2.9	−2.9	−1.25	−1.33	−0.69	−0.69
	(1.1)	(1.1)	(0.92)	(0.95)	(0.16)	(0.17)
[1990–2002 = 1]	2.27	−0.24	1.28	−0.12	−0.44	−0.69
	(0.91)	(1.4)	(0.77)	(1.2)	(0.15)	(0.21)
GDP growth rate $(t-1,t)$	−0.57	−0.57	−0.56	−0.52	−0.21	−0.21
	(0.31)	(0.31)	(0.25)	(0.25)	(0.05)	(0.05)
GDP growth rate $(t-2,t-1)$	−0.47	−0.48	−0.11	−0.12	−0.10	−0.10
	(0.27)	(0.27)	(0.22)	(0.23)	(0.04)	(0.04)
[High school graduate rate in 1982] ×[1990–2002 = 1]		0.13		0.08		0.02
		(0.05)		(0.04)		(0.01)
Industry fixed-effects	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
R^2	0.16	0.16	0.10	0.10	0.26	0.27
Nb observations	1476	1476	1413	1413	1520	1520

Note and *Reading*: See Table 3.

capital intensity, we find that the effect of the [1990–2002] dummy variable becomes negative for both skilled groups, but significantly different from zero for low-skilled workers only. This result suggests that the restrictions on mass lay-off introduced in 1990 has had a greater effect on less educated workers than on more educated ones. Low-skilled jobs are the most exposed to demand shocks and to mass job destructions, which plausibly explains why more restrictive redundancies procedures have a more significant impact on less educated workers.

Table 5 presents a re-estimation of models (2) and (6) for three seniority groups: less than 1 year's seniority, 1–2 years, and more than 2 years. This partition defines reasonably large subgroups of workers and corresponds (roughly) to the main seniority partition in the French labor laws (see Appendix A). Workers with less than 1 year's seniority hold either fixed-term contracts or relatively insecure indefinite-term contracts (ITC), while workers with more than 2 years' seniority hold the most secure ITC.

Models (11), (13) and (15) confirm a decline in job security between the 1990s and the 1980s for low- and medium-seniority workers, but not for workers with more than 2 years' seniority. For this last group, the effect of the [1990–2002] is not significantly different from the effect of the [1982–1986] dummy. For all three seniority groups, our technology measure affects negatively job security. For low- and medium-seniority workers, models (12) and (14) show that the decline in job security was more significant in the sectors with the highest proportion of educated workers. For workers with more than 2 years' seniority, model (16) shows that the decline in the rate of involuntary job loss observed between the 1990s and the late 1980s was actually less significant in the sectors with the highest proportion of educated workers. Taken together, these findings suggest that technological change has driven a significant decline in job security for all seniority groups, while the reinforcement of employment protection in 1990 has less benefited to low-seniority workers than to high-seniority ones. An important proportion of low-seniority workers hold fixed-term contracts (or relatively insecure indefinite-term contracts) and are not directly impacted by variations in the legal restrictions on mass redundancies procedures.

All in all, our econometric analysis reveals a significant, and almost general, decline in job security over the two last decades in spite of the reaffirmation of more restrictive regulations in 1990. Beyond the transitory effects of the variations in macro-economic activity, an important structural modification occurred concerning lay-off behavior starting in the early 1980s. The diffusion of new information technologies seems one important key for understanding this persisting job insecurity.

5. Conclusion

This paper examines changes in the incidence of involuntary job loss in France between 1982 and 2002. Beyond the effects of the business cycle, the risk of involuntary job loss has increased over time, as much for educated as less educated workers. Furthermore, the rise in job loss rate is significantly more pronounced in industries that have the largest share of R&D workers or new technologies' users. These findings suggest that technological changes contribute to decreasing the incentive to keep workers for long periods of time and to increasing job insecurity. This interpretation is consistent with the recent literature on skilled-biased technological change, which shows that one important effect of new technologies is to eliminate routine tasks. These tasks are typically those for which job tenure provides workers with a comparative advantage.

Beyond technological changes, our econometric analysis confirms that institutions matter. The strong relaxation of employment protection rules which took place in 1986 explains part of the decrease in job security observed in the 1980s. Symmetrically, the reaffirmation of more restrictive rules in 1990 has contributed to protecting workers against a larger decline in job security, especially the least educated and highest seniority ones.

Contemporary technological change seems to increase job insecurity, but its effect may be significantly mitigated by institutional changes. Further research is needed to explore and test this assumption at the plant level. We expect that French plant-level data

with detailed monthly information on turnover, skills and seniority will help provide answers to questions about firms' decision to lay off workers and about the technological causes of these decisions.

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Appendix A

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 10 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. In particular, French firms, when firing workers, must include as one of their criteria the seniority of their employees (see Couturier, 1996, article L. 321-1-1). Furthermore, a worker can be made redundant without dismissal notice or redundancy payment if he/she has under 6 months seniority, whereas laying off a worker with 2 years seniority requires that the employer gives 2 months notice and the right to redundancy payment. For workers who have between 6 months and 2 years seniority, the legal dismissal notice is 1 month (article L. 122-6). 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 2 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 10 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 "autorization administrative de licenciements" (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 4 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 negociate social plans with personnels' representative before any mass redundancies (i.e., before any redundancies involving more than 10 workers).

For short-duration jobs, firms can use fixed-term labor contracts (FTC). The legal maximum duration of fixed-term contracts varies from 9 months to 18 months depending on the nature of the job (Article L. 122-1-2). In practice, administrative reports show that almost all of them (95%) do not last 1 year (Goux and Maurin, 2000). As a matter of fact, a fixed-term contract can only be signed to meet increased activity or to replace a temporarily absent worker. These restrictions plausibly explain why it is almost impossible to sign an FTC lasting more than 1 year.

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 was 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 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 2002. 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 $\frac{1}{300}$, meaning about 150 000 respondents each year. The following standard information is completed for each interviewee: educational attainment, occupation (4 digit code, 450 items), age, job tenure, labor market status (in employment, unemployment, not in the labor force), industry. Also, the French Labor Force surveys provide information on whether unemployed workers became unemployed after a voluntary quit or after an involuntary job loss.

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.

B.1. The method for estimating transition intensities

Let us consider a worker that can move between four possible states: employment, voluntary unemployment, involuntary 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 $l \neq k$, τ_{kl} will represent the instantaneous intensity of transition between l and k. By definition, τ_{kl} is the limit of $p_{kl}(s, s+\mathrm{d}s)/\mathrm{d}s$ when $\mathrm{d}s \to 0$, where $p_{kl}(s, s+\mathrm{d}s)$ stands for the probability to be in the state l at time $s+\mathrm{d}s$ conditionally at being in state k at time s. Under the continuous-time homogeneous Markovian, the τ_{kl} are constant and we have for all k, $\tau_{kk'} \geqslant 0$ when $k' \neq k$ and $\sum_l \tau_{kl} = 0$. Furthermore, if T denotes the (4,4) matrix which components are the τ_{kl}s' and P the corresponding (4,4) annual transition probabilities' matrix, we have (see for instance Doob, 1953), $P = \sum T^k/k! = \exp(T)$.

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 $\hat{p}_{ij} = n_{ij}/n_{i.}$, 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 $\hat{P} = \exp(\hat{T})$, then $\hat{T}$ represents a maximum-likelihood estimator of T. Let us emphasize that this equation 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 diagonalizable and has four distinct positive real eigen values $(\lambda_1, \lambda_2, \lambda_3, \lambda_4)$, we have however,

$$\hat{T} = \ln \hat{P} = Q \,\mathrm{diag}(\ln \lambda_1, \ln \lambda_2, \ln \lambda_3, \ln \lambda_4) Q^{-1}, \tag{2}$$

where Q is the matrix composed by the eigenvectors. 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.

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