

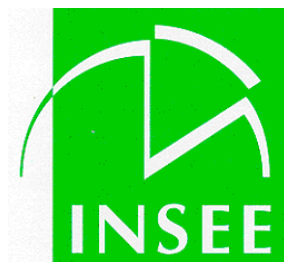
**Direction des Statistiques Démographiques et Sociales**

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**Heterogeneous Exposure to Labor Earnings Risk**

**Pierre Pora et Lionel Wilner**

**Document de travail**



**Institut National de la Statistique et des Études Économiques**

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## **Heterogeneous Exposure to Labor Earnings Risk**

PIERRE PORA ET LIONEL WILNER

**Document de travail**

**octobre 2017**

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# Heterogeneous Exposure to Labor Earnings Risk

## Abstract

We analyze labor earnings dynamics based on a large panel of French individuals issued from administrative records. We use the non-parametric approach of Guvenen, Karahan, Ozkan, and Song (2016), and first show labor earnings shocks to exhibit both strong asymmetry and high peakedness, so that (log)normality assumptions do not hold, and then show labor earnings responses to differ substantially between positive and negative shocks, so that non-linearities are at stake. Moreover, both earnings shocks and earnings dynamics are heterogeneous across the earnings distribution. We then get one step further by disentangling the risk related to annual working time from the risk specific to hourly wage. We prove non-Gaussian features and heterogeneity of the earnings shocks distribution to stem mostly from working time instability, rather than from wage shocks. Both wage and working time dynamics display non-linearities, but they do not vary much across the earnings distribution; heterogeneity in labor earnings dynamics arises from large working time shocks explaining a larger share of large labor earnings changes for low earnings workers than they do for high earnings workers. Our results imply that unemployment risk is a key factor of labor earnings risk.

**Keywords:** Labor earnings risk, earnings dynamics, non-Gaussian shocks, nonparametric estimation, skewness, kurtosis.

**JEL Classification:** E24, J24, J31.

## Volatilité des revenus salariaux : une exposition inégale au risque salarial

### Résumé

Nous analysons les dynamiques individuelles de revenu salarial à partir de données administratives longitudinales. Grâce à l'approche non-paramétrique de Guvenen, Karahan, Ozkan et Song (2016), nous montrons dans un premier temps la distribution des variations individuelles de revenu salarial est asymétrique vers le bas, et a des queues épaisses : l'hypothèse de log-normalité doit donc être rejetée. De plus, les dynamiques de revenu salarial sont non-linéaires et hétérogènes, de sorte que les effets à long terme des chocs positifs et des chocs négatifs ne sont pas les mêmes pour des salariés initialement semblables, et diffèrent aussi entre des groupes de salariés dont le revenu salarial passé est dissemblable.

Nous introduisons ensuite une distinction entre l'incertitude relative au volume de travail annuel et celle qui porte sur le salaire horaire, et montrons que le caractère non-gaussien des chocs de revenu salarial reflète pour l'essentiel celui des chocs de volume de travail. Les dynamiques de salaire et de volume de travail sont non-linéaires, mais relativement homogènes : si les dynamiques individuelles de revenu salarial sont hétérogènes, c'est parce que les chocs de volume de travail expliquent une part plus grande des chocs de revenu salarial pour les bas revenus salariaux que pour les hauts revenus salariaux. Nos résultats impliquent que le risque de perte d'emploi est un déterminant majeur du risque salarial.

**Mots-clés :** Risque salarial, dynamiques de revenu salarial, chocs non-gaussiens, estimation non-paramétrique, skewness, kurtosis.

**Classification JEL :** E24, J24, J31.

# Heterogeneous Exposure to Labor Earnings Risk\*

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October 26, 2017

## Abstract

We analyze labor earnings dynamics based on a large panel of French individuals issued from administrative records. We use the non-parametric approach of [Guvenen, Karahan, Ozkan, and Song \(2016\)](#), and first show labor earnings shocks to exhibit both strong asymmetry and high peakedness, so that (log)normality assumptions do not hold, and then show labor earnings responses to differ substantially between positive and negative shocks, so that non-linearities are at stake. Moreover, both earnings shocks and earnings dynamics are heterogeneous across the earnings distribution. We then get one step further by disentangling the risk related to annual working time from the risk specific to hourly wage. We prove non-Gaussian features and heterogeneity of the earnings shocks distribution to stem mostly from working time instability, rather than from wage shocks. Both wage and working time dynamics display non-linearities, but they do not vary much across the earnings distribution; heterogeneity in labor earnings dynamics arises from large working time shocks explaining a larger share of large labor earnings changes for low earnings workers than they do for high earnings workers. Our results imply that unemployment risk is a key factor of labor earnings risk.

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# 1 Introduction

Due to the scarcity of detailed and long longitudinal data on labor earnings, much is still ignored about earnings risk, i.e. the probability distribution of earnings changes conditional on earnings history. An original approach to learn more about it has been recently proposed by [Guvenen et al. \(2016\)](#): in an agnostic way they explore what data tell about earnings dynamics. Based on nonparametric estimation of the first moments of the distribution of earnings changes (or shocks, which can be either transitory when they correspond to one-year changes, or permanent when they correspond to five-year changes) and of impulse response functions, the authors put those statistics in close relation to the location in the distribution of recent earnings. The method contrasts with previous literature that has modeled earnings dynamics by resorting to sophisticated specifications combining both observed and unobserved heterogeneity as well as uncertainty (often approximated by random walks, autoregressive processes, ARMA, etc.). Instead of enriching the model to obtain a better fit of the data, this reverse engineering technique at stake leads to rather unexpected results. Their main empirical findings are the following: shocks on (log) earnings are not Gaussian, but they rather exhibit a strong negative asymmetry and a high peakedness, which questions log-normal models *à la* [Mincer \(1958\)](#); labor earnings dynamics are both asymmetric, non-linear and heterogeneous along the earnings distribution.

First, we replicate this approach on a French large longitudinal dataset. Thanks to administrative forms, the filling of which is mandatory for payroll taxes, longitudinal information on individuals' labor earnings is available. This dataset has large coverage in terms of sample size, and follows individuals all along their career. Focusing on men working in the private sector, we find similar results which are consistent with intrinsic features of labor earnings data; such empirical properties would not be country-specific but they might constitute stylized facts that apply to labor earnings in general. For instance, extremities of the distribution are much more exposed to earnings instability (or risk, or volatility), this dispersion being however lower in France than in the US. We find that annual earnings changes are negatively skewed (a notable exception concerns the bottom of the distribution) and exhibit a very high kurtosis. We also show that high positive (resp. negative)

earnings shocks are more persistent (resp. transitory) for low earnings individuals than they are for high earnings individuals.

Second, we propose a decomposition of the labor earnings volatility into a risk that is specific to the working time instability and into another risk that depends only on hourly wage shocks. This approach is meaningful to disentangle both risks and to analyze where the volatility comes from. Moreover, it sheds light on the reasons why labor earnings dynamics are heterogeneous along the earnings distribution. The main lessons that can be drawn from this exercise are: working time instability accounts for a large part of the labor earnings risk for low earnings individuals, but a smaller part at the top of the labor earnings distribution; the skewness of shocks on hourly wages is slightly positive in general and the kurtosis smaller than for labor earnings shocks, so that non-Gaussian features of the labor earnings shocks distribution stem from working time instability.

Third, we show that wage and working time dynamics are asymmetric: large negative wage (resp. working time) shocks are more transitory (resp. persistent) than large positive wage (resp. working time) shocks. Asymmetry in labor earnings dynamics – i.e. positive earnings shocks being more persistent than negative earnings shocks – therefore stems from working time changes. Heterogeneity in wage and working time dynamics across the distribution of earnings turns out to be limited. However, the share of labor earnings risk that can be explained by working time instability is higher for low earnings workers than for high earnings ones. Moreover, large wage and working time shocks are negatively correlated. Overall, these results imply that unemployment risk is key to the understanding of labor earnings risk and labor earnings dynamics.

The rest of the paper is organized as follows. Next section is devoted to a brief literature review. Section 3 presents our data. In section 4, we describe our empirical approach to the measure of labor earnings risk. Section 5 provides our results, and section 6 concludes.

## 2 Literature review

Numerous papers in the earnings dynamics literature model volatility thanks to parametric models, including e.g. [Moffitt and Gottschalk \(2002, 2011\)](#), [Baker and](#)



Solon (2003), Low, Meghir, and Pistaferri (2010), Altonji, Smith, and Vidangos (2013), Magnac, Pistoletti, and Roux (2017) and Ceci-Renaud, Charnoz, and Gaini (2014). Most of this literature relies on the assumption of Gaussian shocks. Few exceptions depart from this hypothesis, but they include Bonhomme and Robin (2009) who rely on copulas to model the transition probability of an AR(1) transitory component of log earnings, and Arellano, Blundell, and Bonhomme (2017) who model earnings dynamics as the sum of a general Markovian persistent component and a transitory innovation. In a recent work, Guvenen et al. (2016) propose to have an agnostic look at individual-level earnings data. In particular, they adopt a descriptive approach which involves a non-parametric estimation of earnings changes. They resort to comprehensive data issued from the US Social Security Administration (SSA) over the period 1978-2011. The Master Earnings File they use is derived from the W-2 form and presents at least three advantages: it has a large sample size, with low measurement error and no top-coding of annual labor earnings. Their main result is that labor earnings shocks are not log-normal, contrary to what most models *à la* Mincer posit. These annual variations are negatively skewed and display a very high kurtosis, which does not coincide with usual features of normal distributions. The asymmetry stems from the fact that upwards shocks are less likely than (large or disaster) downwards shocks. The high kurtosis means that most individuals experience very small earnings shocks, but also that a small and non-negligible number of individuals face very large shocks. Another lesson is that positive (negative) shocks tend to be transitory (permanent) for high income individuals; the reverse holds for low income individuals; large shocks tend to be more transitory than small shocks. However, two important *caveats* (that are due to data limitations) are worth being mentioned: they restrict their attention to men in the private sector and they do not dispose of any information regarding working time, which does not enable them to determine whether labor earnings risk comes from working time or wage dynamics.

Why are these non-Gaussian features of labor earnings dynamic potentially important? First, because non-linearities may lead to rare yet considerable shocks having first-order consequences. Hence, log-normality assumptions can result in dramatic underestimation of the welfare costs of idiosyncratic earnings fluctuations (Guvenen et al., 2016). Second, because they can lead to a wrong understanding

of the relationship between the business cycle and labor earnings dynamics: it is not so much that the variance of the shocks is countercyclical, but rather that the skewness is cyclical, i.e. downward asymmetry is stronger during recessions (Guvenen, Ozkan, and Song, 2014).

Why do we care about labor earnings uncertainty? Essentially because it has a direct impact on consumption and saving behaviors, as pointed out by Blundell and Preston (1998), Blundell, Pistaferri, and Preston (2008) and Arellano, Blundell, and Bonhomme (2017). A better understanding of income uncertainty and of the way households react to it may therefore help fill in the gap between income and consumption inequalities (Pistoiesi, 2014). In particular, a high volatility prevents individuals from smoothing their consumption. Hence inequality results in inefficient allocations. Furthermore, uncertainty on future earnings may influence labor market outcomes and behaviors, for instance in case of precautionary labor supply (Pijoan-Mas, 2006; Jessen, Rostam-Afschar, and Schmitz, 2016).

## 3 Data

### 3.1 The DADS panel

Our analysis is based on a large panel of French salaried employees of the private sector,<sup>12</sup> the longitudinal versions of the *Déclaration Annuelle de Données Sociales* (DADS). By law,<sup>3</sup> French firms have to fill in the DADS (an annual form that is the analogue of the W-2 form in the US) for every employee subject to payroll taxes. The panel contains information about individuals born on October of even-numbered years – a representative sample of the French salaried population at rate 1/24 since 1967. Since filling in the form for payroll taxes is mandatory, and because of the comprehensiveness of the panel with respect to individuals' careers, the data is of exceptional quality and has low measurement error in comparison with survey data. Some years are missing (1981, 1983 and 1990) because there was no data collection by INSEE during the 1982 and 1990 censuses. In 1994, the qual-

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<sup>1</sup>including State-owned companies

<sup>2</sup>We therefore neglect the implications of workers moving between private and public employment. However transitions between the private and public sectors are very infrequent (Flamand, 2016).

<sup>3</sup>The absence of a DADS as well as incorrect or missing answers are punished with fines.

ity is nevertheless questionable. Finally, our dataset contains detailed information about gross and net wages, work days, work hours,<sup>4</sup> other job characteristics from 1976 onwards (like the beginning and the end of an employment’s spell, seniority, a dummy for part-time employment), firm characteristics (industry, size, region) and individual characteristics (age, gender). Our variables of interest will be real annual earnings defined as the sum of all salaried earnings, working time measured in full-time equivalent and real wages defined as real earnings over working time.

In this paper, and to ensure meaningful comparison with [Guvenen et al. \(2015\)](#),<sup>5</sup> our working sample is composed of male salaried employees working in the private sector in metropolitan France and aged between 20 and 60 between 1967 and 2012, excluding agricultural workers and household employees. Four years are missing during our period of interest: 1981, 1983, 1990 and 1994. We then impute annual earnings to individuals who have a positive wage both preceding and following years with the average annual earnings of those years.<sup>6</sup> While we do use our imputed data to compute individual past earnings, and thus capture heterogeneity across the earnings distribution, we do not rely on them for the estimation of individual earnings changes in itself. Our results are however robust to a more conservative method of imputation (see Appendix [C.1](#)).

The empirical analysis described in section [4](#) requires to select individuals with a relatively strong attachment to the labor market. We rely on “relatively stable” workers to describe annual changes in earnings between year  $t$  and year  $t + k$  (see *infra*). We impose in particular that those individuals were also present at least two years between  $t - 5$  and  $t - 2$ , on top of being present in  $t - 1$  and in  $t$ . Finally, to deal with very low annual earnings, we focus only on individuals earnings more than  $1/8$  of the annual minimum wage  $w$ . We choose this censoring threshold to ensure good comparability with [Guvenen et al. \(2015\)](#). Our results are nevertheless robust to different choices of censoring thresholds (see Appendix [C.2](#)). We also winsorize labor earnings at quantile of order 0.99999, in order to avoid issues

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<sup>4</sup>in the DADS (private sector) and since 1995 only.

<sup>5</sup>For our replication, we focus on the NBER Working Paper ([Guvenen et al., 2015](#)) rather than on the more recent version ([Guvenen et al., 2016](#)), because the former restricts its results to salaried employees, while the latter includes self-employed workers that are excluded from our French dataset.

<sup>6</sup>In Figure [B.1](#) we represent our total number of observations for each year after the missing years have been imputed.

related to potential outliers.<sup>7</sup>

In Table 1, we give some descriptive statistics on the successive steps of the selection of "relatively stable" workers. First comes the censoring at  $\frac{1}{8}w$ . Second comes the restriction to individuals that were present two years between  $t - 5$  and  $t - 2$ , on top of being present in  $t - 1$  and  $t$ .

The first step mostly increases the share of industrial workers, and changes very slightly the age distribution of the sample by decreasing the share of very young workers. The effect of the second step, that mostly deals with an employment stability criterion, on the age distribution is more dramatic as it reduces a lot the share of very young workers. It also decreases the share of construction and services workers in the sample. These patterns are consistent with low earnings individuals being more numerous in the services industry and among younger workers, and a lower employment instability for older workers and in manufacturing.

**Table 1** – Descriptive statistics on the selection process

	Base sample		Censoring		Final selection	
$N$	16 788 890		15 901 358		11 205 959	
	Frequency (in %)	Average Earnings (2012 €)	Frequency (in %)	Average Earnings (2012 €)	Frequency (in %)	Average Earnings (2012 €)
<b>Industry</b>						
Manufacturing	33,9	22 660	35,1	23 030	37,7	25 340
Construction	14	16 490	14,4	16 890	13,9	19 360
Trade	14	20 680	14,2	21 500	14,3	24 680
Services	38,1	19 560	36,2	21 650	34,2	25 910
<b>Age</b>						
23-24	7,3	10 890	6,9	11 960	4,1	14 160
25-29	17,6	15 480	17,4	16 330	15,8	17 820
30-34	16,3	19 700	16,3	20 480	16,7	21 970
35-39	15,1	22 490	15,2	23 260	15,8	24 910
40-44	13,8	24 710	13,9	25 480	14,8	27 070
45-49	12,3	26 200	12,4	26 960	13,4	28 570
50-54	10,4	27 180	10,5	27 950	11,6	29 420
55-59	7,3	26 480	7,4	27 540	7,8	29 550

<sup>7</sup>We prove our results to be robust to the omission of this winsorization step, see Appendix C.3.

## 3.2 Some contextual elements on the French wage distribution

Before turning to the empirical analysis, we provide with a few results taken from previous studies on the French wage distribution. Indeed, in France wage inequalities have followed a quite distinctive path during the last decades.

In the US and in the UK at least, the rise in earnings inequality in the 80s-90s has been driven by skill-biased technical change, which has been extensively documented at least since the seminal work by [Katz and Murphy \(1992\)](#). By contrast, in France, most studies conclude that wage dispersion has not increased over the last 30 years. [Charnoz, Coudin, and Gaini \(2014\)](#) show that wage inequality has decreased over the 1967-2009 period, due to the increase of high-skilled labor supply that has hidden the effects of skill-biased technical change. These results are in line with those of [Verdugo \(2014\)](#), according to which wage inequality decreased continuously from 1969 to 2008. He too relates changes in the wage structure to changes in education levels. The increase in educational attainment after 1980 would have resulted in a large decline of the skill premium, which would account for between 1/3 and 1/2 of the decrease of inequalities at the top of the distribution. Since inequalities also decreased in the bottom with the rise of the minimum wage, that plays a role in compressing the earnings distribution – as documented by [Aeberhardt, Givord, and Marbot \(2012\)](#) –, this conjunction of phenomena resulted in a compression of the French wage structure. Moreover, these changes cannot be fully explained by selection into employment (at least at the top) as well as by changes in education and experience composition of the labor force.

## 4 Empirical analysis

We follow the same descriptive approach as [Guvenen et al. \(2016\)](#). In particular, we rely on nonparametric estimations of shocks on annual labor earnings. A decisive advantage of this methodology is not to posit any parametric assumption on the form of shocks, contrary to most of the literature devoted to earnings dynamics.

Let denote the logarithm of annual earnings of individual  $i$  on year  $t$  by  $\tilde{y}_{it}$ . We aim at measuring individual-level log earnings changes at a  $k$ -year horizon.

We consider a normalized version of log earnings net of age effect. Hence we regress individual log earnings on a full set of age, year and (year-of-birth) cohort dummies:

$$\tilde{y}_{it} = \sum_c \alpha_c \mathbb{1}[\text{cohort}_i = c] + \sum_a \beta_a \mathbb{1}[\text{age}_{it} = a] + \sum_T \gamma_T \mathbb{1}[t = T] + \epsilon_{it}. \quad (1)$$

The inclusion of year dummies is a slight difference with [Guvenen et al. \(2016\)](#). We introduce them because our sample only includes even-year born individuals. Even (resp. odd) ages are only observed in even (resp. odd) years, and our time period is 1967-2012. Hence even-aged workers earnings are observed later than odd ages earnings. Since earnings have grown in average on this time period, the omission of year dummies might result in a slight upward bias on  $\beta_{2n}$  with respect to  $\beta_{2n+1}$ .<sup>8</sup>

The estimates of (1) enable us to define our variable of interest, which we note  $y_{it} = \tilde{y}_{it} - \hat{\beta}_a$  and which can be interpreted as (log) earnings net of age effects.

Therefore the  $k$ -year change in normalized (log) earnings  $\delta^k y_{it} = y_{i,t+k} - y_{it}$  accounts for the relative evolution of individual  $i$ 's annual earnings between  $t$  and  $t+k$  with respect to his analogues of the same age.

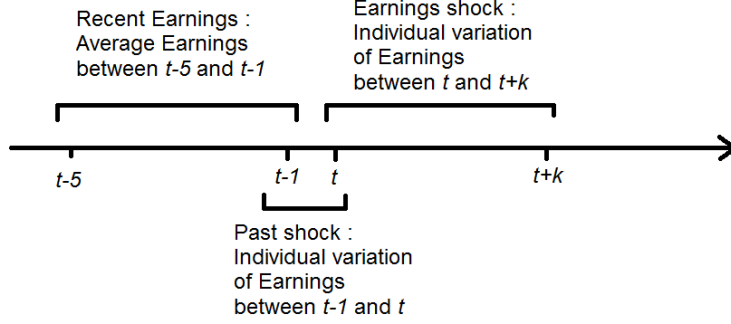
Figure 1 provides a synthetic view of the approach that we develop in the following subsections. We use earnings between  $t-5$  and  $t-1$  to depict heterogeneity along the earnings distribution, while focusing more specifically on the distribution of shocks between  $t$  and  $t+k$ , and its relationship to past shocks, i.e. changes between  $t-1$  and  $t$ . In the rest of the paper, we distinguish between labor earnings *risk*, that we consider to correspond to the cross-sectional distribution of individual labor earnings variation (conditional on recent earnings), and labor earnings *dynamics*, that refer to the relationship between past and future labor earnings shocks (conditional on recent earnings).

## 4.1 Cross-sectional distributions of earnings growth

We aim at comparing workers that have similar earnings histories. To do so, we introduce a measure of recent earnings  $Y_{it}$  similar to that of [Guvenen et al. \(2016\)](#).

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<sup>8</sup>Even though including these year fixed effects changes substantially the average lifecycle profile in earnings, it does not influence our results regarding labor earnings risk and dynamics: see Appendix C.4



**Figure 1** – General framework

This measure of recent earnings approximates average earnings net of age effects during the previous five years:

$$Y_{it} = \frac{\sum_{\tau=t-5}^{t-1} \exp(\tilde{y}_{it})}{\sum_{\tau=t-5}^{t-1} \sum_a \mathbb{1}[age_{i\tau} = a] \exp(\hat{\beta}_a)}$$

We then group workers into 8 age groups: 23-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54 and 55-59. For each year  $t$  and each age group, we rank workers according to their recent earnings  $Y_{it}$ . This allows us to constitute 100 percentile groups.

In the end, we estimate various features – moments and quantiles – of the distribution of  $\delta^k y_{it}$  for each percentile group times age group times year  $t$ , and finally average those features across all years  $t$ . This allows us to characterize labor earnings risk as the distribution of  $k$ -year earnings changes  $\delta^k y_{it}$  conditional on (the rank in the distribution of) recent earnings  $Y_{it}$  and age (group).

Hence we resort to local statistical indicators in order to describe the heterogeneity of annual individual changes in normalized earnings, in the sense that they are net of age composition effects and specific to the location in the distribution of recent earnings. Those statistical indicators correspond to the second to fourth moments (variance, skewness and kurtosis) – or to different quantile-based measures of the same concepts – of the distribution of evolutions. The variance describes the dispersion (or volatility, instability, uncertainty, risk, etc.) of  $k$ -year earnings changes. A quantile-based measure of dispersion is the log difference between the 90th and 10th percentiles ( $P90$  and  $P10$ , respectively) of earnings change.

The skewness, i.e. the third moment of the standardized variable accounts for the degree of asymmetry in these earnings shocks. A related quantile-based

measure is Kelley’s measure of skewness (Kelley, 1947), defined as the relative share of P90-P10 that can be explained by P90-P50 and P50-P10:

$$\text{Kelley's Skewness} = \frac{P90 + P10 - 2P50}{P90 - P10}$$

It is constant and equal to 0 for Gaussian distributions.

The kurtosis, that is to say the fourth moment of the standardized variable, finally measures the peakedness and the heaviness of the tails of the distribution of those shocks. We consider the normalized kurtosis, which is constant and equal to 0 for Gaussian distribution. A quantile-based measure of the heaviness of tails is Crow-Siddiqui’s measure of kurtosis (Crow and Siddiqui, 1967). It is defined as:

$$\text{Crow-Siddiqui's kurtosis} = \frac{P97.5 - P2.5}{P75 - P25}$$

It is constant and equal to 2.91 for Gaussian distributions.

Overall, we tend to privilege quantile-based measures of dispersion, asymmetry and heaviness of tails, over their related moment-based measures for their robustness.

## 4.2 Hourly wages and working time instability

As of year 1995, our data includes a measure of worked hours for private sector workers. We use it to compute working time expressed in full time equivalents with FTE wage (see Appendix A for more details). Most of our results are nevertheless robust to either expressing working time in paid hours with hourly wage, or in full time equivalent with FTE wage (see Appendix C.5).

This allows us to compute log-wages  $\widetilde{w}_{it}$  and log-working time  $\widetilde{l}_{it}$ , such that  $\widetilde{y}_{it} = \widetilde{w}_{it} + \widetilde{l}_{it}$ . As for earnings, we are interested in wages and working time net of age effect. Hence we replicate our strategy: we regress independently log-wages and log-working time on a set of age, year and cohort dummies, and use the estimates to compute  $w_{it}$  (resp.  $l_{it}$ ) log-wages (resp. log-working time) net of the systematic age component.

We keep conditioning on age and recent earnings, and focus on various features of the distributions of  $\delta^k w_{it} = w_{i,t+k} - w_{it}$  and  $\delta^k l_{it} = l_{i,t+k} - l_{it}$ .

Note that as numerous workers do not experience changes in their working time



during those years, for instance full time working workers who do not experience any unemployment several years in a row,<sup>9</sup> the distribution of  $\delta^k l_{it}$  contains mass points. For this reason, we do not directly exhibit results on this distribution *per se*, but only introduce it occasionally, for instance when investigating how correlated wage changes and working-time changes might be.

### 4.3 Impulse response function

We are also interested in the impulse response function of labor earnings, that we want to estimate non-parametrically, in order to allow for non-linearities. We also want to account for potential heterogeneity in labor earnings dynamics across the earnings distribution.

First, we consider the 25-34 age group. Within this group, we rank workers according to their recent earnings  $Y_{it}$  in order to create 21 groups: P0-P5, P5-P10, P10-P15,..., P90-P95, P95-P99 and P99-P100.

We then compute labor earnings shocks between  $t - 1$  and  $t$ :  $\delta^1 y_{i,t-1} = y_t - y_{t-1}$ . Within each year  $\times$  recent earnings groups, we rank workers according to this shock to create 20 past shock groups of the same size. For each year  $t$ , this gives us  $21 \times 20 = 420$  recent earnings  $\times$  past shock groups.

For each of these groups and each year  $t$ , we estimate the average past shock (between  $t - 1$  and  $t$ ), denoted as  $\delta^1 y_{t-1}$ , and the average future shock between  $t$  and  $t + k$ , namely  $\delta^k y_t$ , for various choices of  $k$ , and then average across years. Plotting  $\delta^k y$  against  $\delta^1 y_{\bullet-1}$  for various age times percentile groups represents an impulse response function that does not have to be linear nor symmetrical between positive and negative shocks, and that can be heterogeneous across the distribution of recent earnings.

We proceed the same for the other age group, namely workers aged between 35 and 50.

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<sup>9</sup>See Appendix B.4.

## 5 Results

### 5.1 Replication of Guvenen et al. (2015)

We first replicate the empirical results of Guvenen et al. (2015), focusing on male workers of the private sector to ensure meaningful comparison.

#### 5.1.1 Lifecycle earnings profile

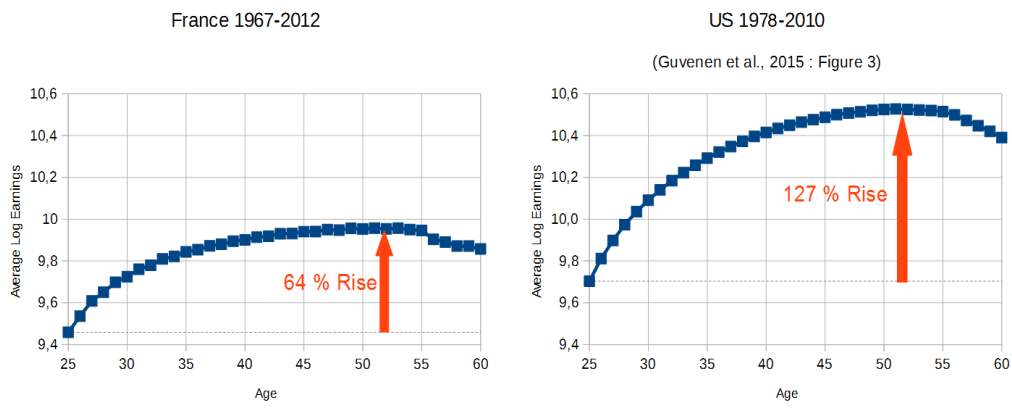
Let us first start with the systematic age trend in labor earnings. Figure 2 displays the estimated age coefficients  $\widehat{\beta}_a$  and therefore represents the average life-cycle profile of log earnings, both for France (our computation) and for the United States (Guvenen et al., 2015).

Younger workers earnings grow much faster with age than older workers: in France, average earnings at 30 are 30% higher than average earnings at 25; average earnings at 51 are 26% higher than they are at 30. This corresponds mostly to the gradual entrance of youth in the labor market, which comprises non full-time work periods; in other words, the rise in the annual job duration helps explain the rapid growth. On top of cumulating more experience, young salaried workers may also see their hourly wage increase rapidly due to an iterative improvement of the worker-firm matching, which results in a better recognition of their working abilities (Topel and Ward, 1992).

Then we observe an hump-shaped pattern that peaks at age 51 where individual earnings are about 64% higher than those at 25; this pattern is consistent with diminishing marginal returns of experience and seniority (Becker, 1964). Guvenen et al. (2015) found on US data that the rise in earnings between 25 and 51 was about 127%. Earnings decrease slightly from 54 to 60, probably because of a gradual exit of the labor workforce that may occur during the year, and hence lowers the working time.

The profile is flatter in France than it is in the US. This may stem from year fixed effects being included in our estimation of the lifecycle earnings profile, whereas Guvenen et al. (2015) do not include them (see Appendix C.4). The dramatic change in lifecycle earnings profile that results from the inclusion of year fixed effects may arise from the share of older workers having increased between 1967 and 2012, when average earnings (net of the age composition effect) increased

too.



**Figure 2** – Age profile of average annual earnings (men in the private sector):  
France vs. US.

### 5.1.2 Earnings growth dispersion

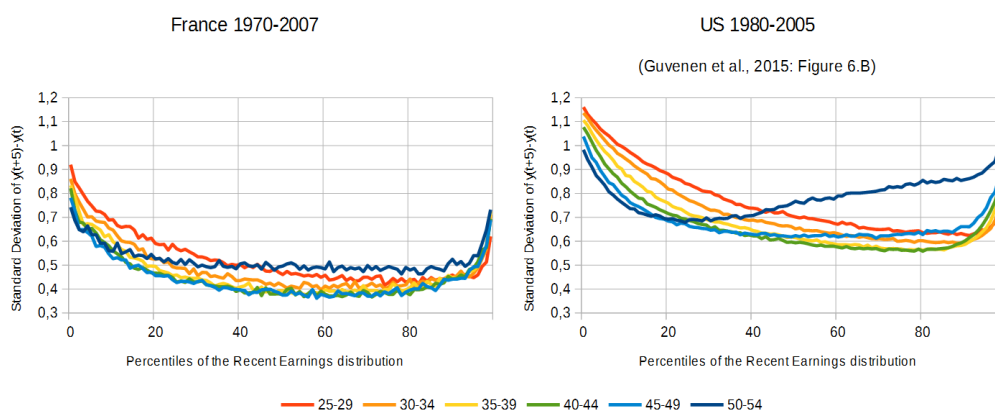
We now turn to the estimation of labor earnings risk *per se*, as represented by the cross-sectional distribution of earnings changes.

Figure 3 plots the standard deviation of 5-year earnings changes against the distribution of recent earnings for various age groups, both for France (our calculation) and the US (Guvenen et al., 2015). In other words, it represents the dispersion of 5-year earnings changes that we interpret as describing uncertainty on future earnings.

At every age and for every rank in the distribution of recent earnings, standard deviation of 5-year labor earnings changes is lower in France than it is in the US. To put it differently, uncertainty on future earnings is systematically higher in the US than it is in France.<sup>10</sup> This striking difference may stem from a higher job protection of the French labor market which moderates the risk of unemployment for insiders.

In both countries, labor earnings risk exhibits the same U-shape pattern across the distribution of recent earnings: volatility is stronger for low earnings individuals in the one hand, and very high earnings individuals in the other hand, than it is for medium workers.

Finally, except for the 50-54 age group on the one hand, and the very top of the earnings distribution on the other hand, the dispersion of earnings changes decreases with age. In other words, volatility decreases along the lifecycle.



**Figure 3** – Standard Deviation of 5-year earnings changes (men in the private sector): France vs. US.

<sup>10</sup>We directly compare standard deviation and do not rely on the coefficient of variation because mean earnings changes are very close to 0 and can be negative.

### 5.1.3 Asymmetry of earnings changes

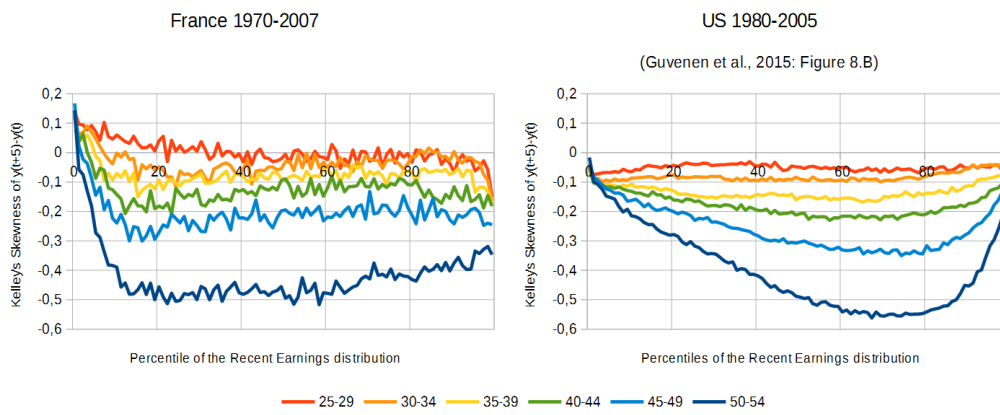
Figure 4 represents Kelley’s measure of skewness of 5-year earnings changes across the distribution of recent earnings for different ages, both for France (our calculation) and the US (Güvenen et al., 2015).

While this measure of asymmetry is systematically negative along the whole distribution in the US, this is not the case in France. Indeed, there is evidence of positive asymmetry for French workers in the lowest part of the distribution of recent earnings – beneath the first percentile of recent for workers aged 50-54, but up to the 25th percentile for workers aged 25-29. To put it differently, whereas in the US large negative earnings changes are always more frequent than large positive earnings changes, we provide evidence that in France, for very low earnings workers, large positive changes can be more frequent than large negative changes.

This exception aside, we conclude however rather to a similar diagnosis: earnings shocks are negatively skewed in France. Kelley’s measure of skewness varies between -0.007 for younger workers, and -0.45 for older workers. The asymmetry is less pronounced, especially for younger workers, than it is in the US where Kelley’s measure of skewness for median earnings workers varies between -0.09 for younger workers and -0.49 for older workers. The log-normality assumption is therefore not likely here since it would imply a skewness of zero.

What is more, the age pattern is the same in both countries: for every given rank in the earnings distribution, Kelley’s skewness decreases with age. In other words, large negative earnings changes get more and more frequent – with respect to large positive growth – as workers grow older. This also implies that log-normality assumptions become less and less plausible as age increases.

Another difference between France and the US is the rank for which downward asymmetry is maximum: whereas in the US, Kelley’s skewness is at its lowest for relatively high earnings individuals, around the 70th percentile of the distribution of recent earnings, in France it reaches its lowest value for relatively low earnings individual, near the 20th percentile. The dependence of Kelley’s skewness on recent earnings for high earnings individuals is also flatter in France than it is in the US, so that at the very top of the recent earnings distribution, downward asymmetry is stronger in France, especially for older workers.



**Figure 4** – Kelley's Skewness of 5-year earnings changes (men in the private sector): France vs. US.

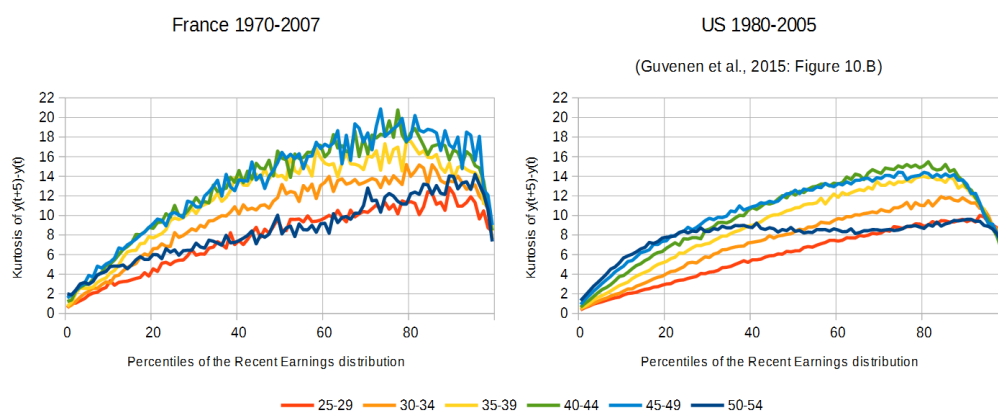
### 5.1.4 Peakedness of the distribution and heaviness of tails

Figure 5 displays the kurtosis, that is to say the fourth moment of the distribution, of 5-year earnings changes, both for France (our calculation) and the US (Güvenen et al., 2015).

Whereas kurtosis is constant and equal to 0 for Gaussian distribution, it is positive for both countries and for every age and every position in the distribution or recent earnings. To put it differently, 5-year earnings changes exhibit higher peakedness, and heavier tails than the normal reference.

Both in France and the US, and for approximately every age group, the kurtosis gets higher as one focuses on higher levels of the recent earnings distribution, at least up to the 80th percentile. In other words, the higher the recent earnings, the heavier the tails of the distributions of 5-year earnings growth. The kurtosis is higher in France than it is in the US: (conditional) log-normality assumptions are even less likely when it comes to French earnings dynamics than they are in the US.

Finally, the age pattern for a given rank in the distribution is approximately the same in France and in the US: with the exception of older workers, the kurtosis grows as workers get older, at least until age 45. In other words, extreme labor earnings shocks weight more and more in labor earnings volatility as workers grow older.



**Figure 5** – Kurtosis of 5-year earnings changes (men in the private sector): France vs. US.

### 5.1.5 Labor earnings dynamics: impulse response function

We now report the impulse response function of earnings shocks (see Subsection 4.3 for more details). We focus on prime-age workers, i.e. workers aged 35-50 at year  $t$ .

Figure 6 displays earnings growth at various time horizons for three different positions – low, median and high – in the recent earnings distribution, for various values of the past earnings shock  $y_{it} - y_{i,t-1}$ , both for France (our calculation) and for the US (Güvenen et al., 2015).

First, note that in both countries, labor earnings changes display some kind of mean reversion: the higher the past shock, the lower the future changes. Negative past shocks tend to come along with positive future changes, while positive past shocks are rather associated with negative future changes. What is more, the higher the magnitude of past shocks, the higher the magnitude of future changes: workers that experienced large shocks between  $t-1$  and  $t$  tend to experience larger changes between  $t$  and  $t+k$  than those that were submitted to smaller shocks.

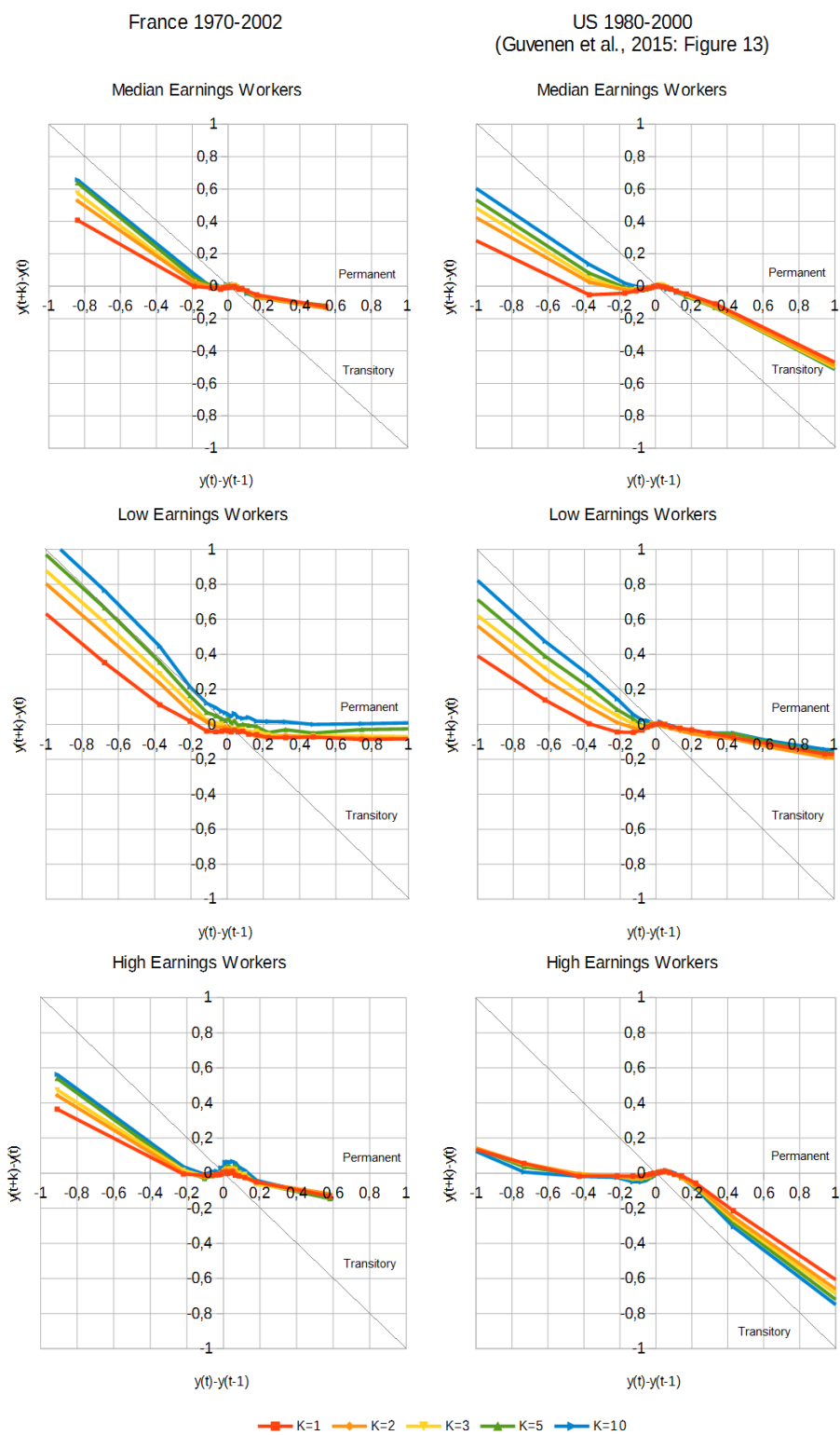
Impulse response function tells us about the persistence of shocks: the closer one is to the case where  $\delta^k y_{it} = -(y_{it} - y_{i,t-1})$ , the more transitory the shock. To put it differently, if  $\delta^k y_{it} = -(y_{it} - y_{i,t-1})$ , then between  $t-1$  and  $t+k$ , the shock has been erased after  $k$  years: worker  $i$ 's earnings have only grown according to the systematic age component. Reversely, the closer one is to the situation where  $\delta^k y_{it} = 0$ , the more persistent the shock between  $t-1$  and  $t$  is.

Both in France and in the US, large past shocks are more transitory than small ones. In France, negative past shocks are much more transitory than positive ones whereas the reverse occurs in the US high earnings group.

This is a dramatic difference between France and the US: whereas large negative shocks that affect low earnings American workers are nearly as transitory as those affecting their French counterparts, and slightly less transitory when it comes to median earnings individuals, high earnings American workers submitted to large negative shocks do not seem to recover at the same rate as their French peers. In other words, in the US large negative shocks affecting well paid workers are quite persistent, while they are quite transitory in France. For instance, in France, high earnings workers that experienced a 60 log-points earnings loss between  $t-1$  and  $t$  (with respect to the age trend) recover more than half of their loss within 10



years; in the US, similar workers recover less than 10% of their losses. Reversely, for the high earnings group, large positive shocks are quite permanent in France whereas they are transitory in the US.



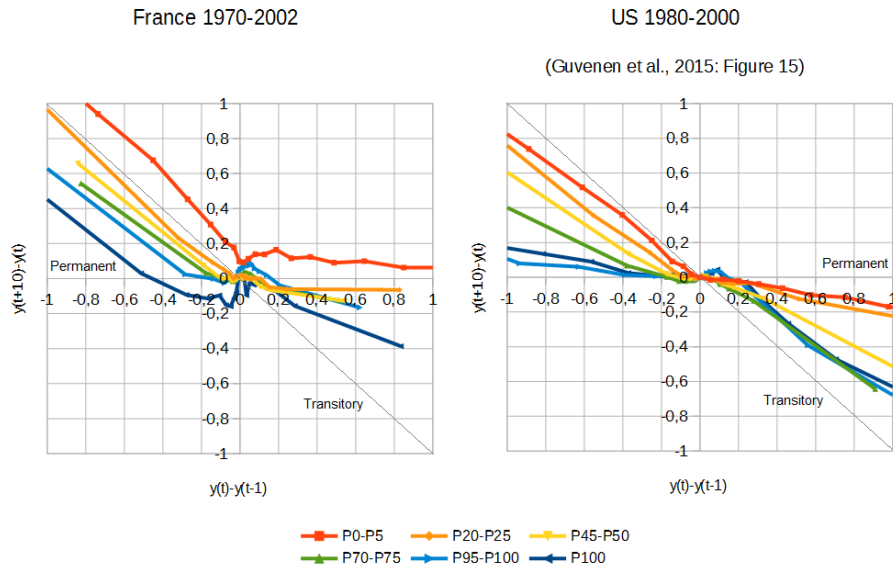
**Figure 6** – Impulse response function of earnings shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector): France vs. US.

Figure 7 plots 10-year earnings growth, i.e.  $\delta^{10}y_{it} = y_{i,t+10} - y_{it}$  against past earnings shocks  $y_{it} - y_{i,t-1}$ , for various positions in the distribution of recent earnings, both for France (our computation) and the US (Guvenen et al., 2015).

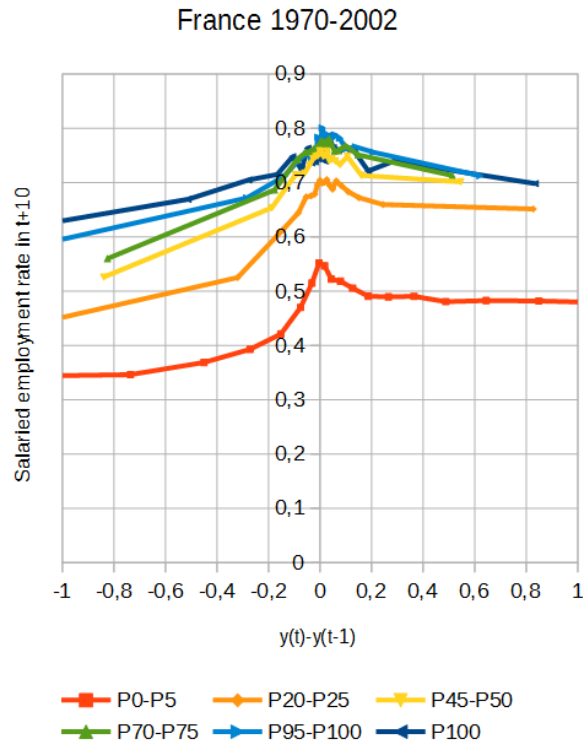
Both in France and the US, highly negative shocks are more transitory for low earnings individuals, and less so for high earnings workers. The opposite is true of high positive shocks, that are more persistent for low earnings individuals, and less so for high earnings individuals. Hence, impulse response functions exhibit a butterfly pattern for both countries. To put it differently, for a given level of past shock, the impulse response function varies with earnings in the same direction for both countries, even though there is evidence that in the US, large negative shocks can be persistent and large positive shocks can be transitory – for high earnings workers – but not in France.

Besides, in France very low earnings workers submitted to highly negative earnings shocks experience earnings growth between  $t - 1$  and  $t + 10$  that is higher than the systematic age component:  $\delta^{10}y_{it} > -(y_{it} - y_{i,t-1})$ . In other words, those disaster shocks have not only been erased after 10 years: in the end it looks like those workers earn more in  $t + 10$  than they would have had the disaster shock never occurred in the first place. This could be considered as evidence of strong resilience of low earnings workers with respect to disaster shocks

This may be due to selection into employment. Figure 8 plots the probability of earnings more than 1/8 of the minimum wage in  $t + 10$  against past shocks, for French prime-age workers, for various positions in the distribution of recent earnings. First, this probability increases as one looks higher in the distribution of recent earnings: low earnings individuals are more often evicted of salaried employment than high earnings workers are. Second, for a given position in the distribution of recent earnings, and among workers submitted to negative past shocks, the more negative the shock, the lower the probability of earning more than 1/8 of the minimum wage after 10 years. To put it differently, if low earnings workers submitted to extreme negative shocks seem to recover so well, it might stem from the most affected of them no being taken into account. This is more generally true of the whole earnings distribution. We may therefore overstate the transient nature of disaster earnings shocks by only taking into account those with continued labor workforce participation.



**Figure 7** – Impulse response function of earnings shocks for prime-age workers and at a 10-year horizon (men in the private sector): France vs. US.



**Figure 8** – Probability of earnings more than 1/8 of the minimum wage in  $t + 10$  (men in the private sector)

## 5.2 Wage risk and working time volatility

We now use the information on working time provided by our dataset to disentangle the risk that stems from hourly wage changes from working time instability. To do so, we start by comparing cross-sectional distributions of earnings growth and cross-sectional distributions of wage growth, conditional on recent earnings.

### 5.2.1 Lifecycle profiles of wage and working time

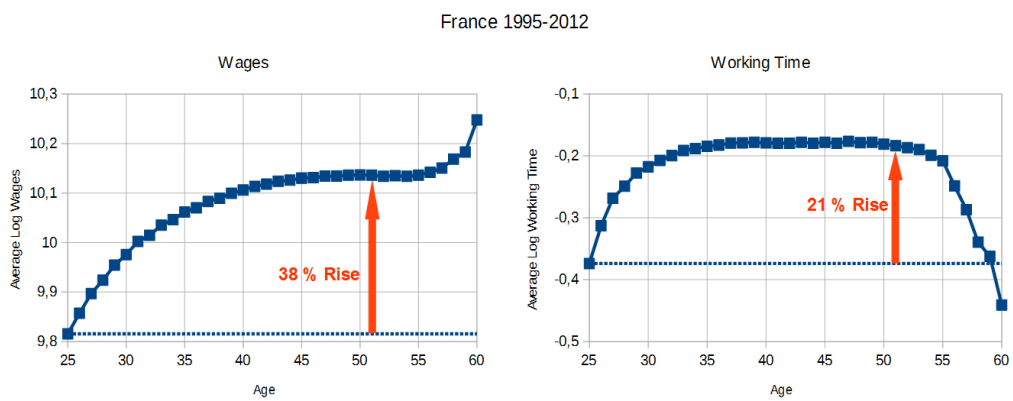
Figure 9 displays the estimated age coefficient  $\widehat{\beta}_a$  both for both wage and working time expressed in FTE.

Wages grow along the lifecycle, but their growth with age gets slower and slower as one focuses on older workers. Average wages at age 30 is 17% higher than average wages at age 25; the growth is pretty much the same between age 30 and age 50 (18%). The strong growth after age 55 might be due to selection into employment, since our number of observations decreases with age for older workers (see Table 1; see also Appendix B.2): older workers with high wages are more likely to have strong labor force attachment than their low wage counterparts.

Overall wages grow slower with age than earnings do. Average wages at age 51 are 38% higher than average wages at age 25. When it comes to earnings, the difference is 64%.

Working time increases rapidly at the beginning of the lifecycle: at age 30, working time in full-time equivalent is 30% higher in average than it is at age 25%. However, this fast growth slows down rapidly, and merely stops after age 35: between ages 35 and 52, average working time remains approximately the same, between 21% and 22% higher than average working time at age 25. Finally, working time drops after age 55, presumably due to a gradual exit of the labor workforce that may occur during the year.

In the end, the strong increase in average earnings at the beginning of the lifecycle (see Figure 2) arises equally from a fast growth in average wages and a fast growth in working time. After 35, the trend slows down, because wages grow slower for prime-age workers than for their younger counterparts, and because their working time remains constant in average. At the end of the lifecycle, earnings decrease in average, even though wages increase due to selection into employment, because working time drops at a steeper rate.



**Figure 9** – Age profile of average earnings and average wages (men in the private sector)

### 5.2.2 Wage growth dispersion

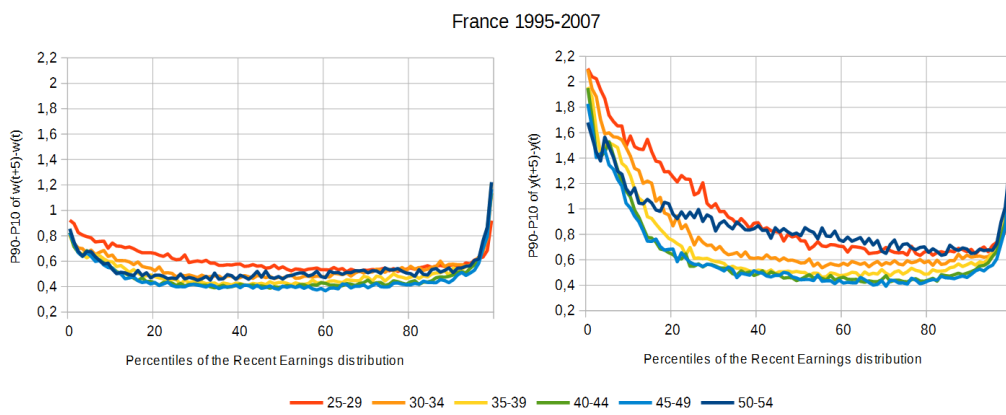
Once the systematic age trend has been subtracted from (log)wages, we take a closer look at wage risk, i.e. at the distribution of individual wage growth.

Figure 10 plots the dispersion, measured by the P90-P10, of 5-year changes in wage and in earnings against the distribution of recent earnings, for the time period 1995-2007. From now on we privilege quantile-based measure – here P90-P10 – over their moment-based analogous – here standard deviation – because they prove to be more robust.

First, for the lower part of the recent earnings distribution, and for all age groups, uncertainty on future earnings growth is much stronger – about two times higher at the very bottom of the distribution – than uncertainty on future wage growth. Hence, the high labor earnings risk for low earnings individuals is the result of a high working time instability, rather than of a high wage volatility.

This is less true of the upper part of the distribution. For very high earnings individuals, labor earnings risk and wage risk are closer than they are for low earnings workers. While uncertainty on their future wages is higher than it is for every other groups of workers, working time instability might therefore be smaller for these very well paid workers. Hence at the top of the recent earnings distribution, wage risk contributes to labor earnings risk to a larger extent than it does for the rest of the workers.

The age pattern for a given rank of the distribution of recent earnings, finally, is somehow the same for earnings risk and for wage risk. In other words, both earnings and wage risk decrease with age at any given point in the recent earnings distribution, with the exception of the very top of the distribution for which the opposite is true.



**Figure 10** – P90-P10 of 5-year changes: earnings vs. wage (men in the private sector)

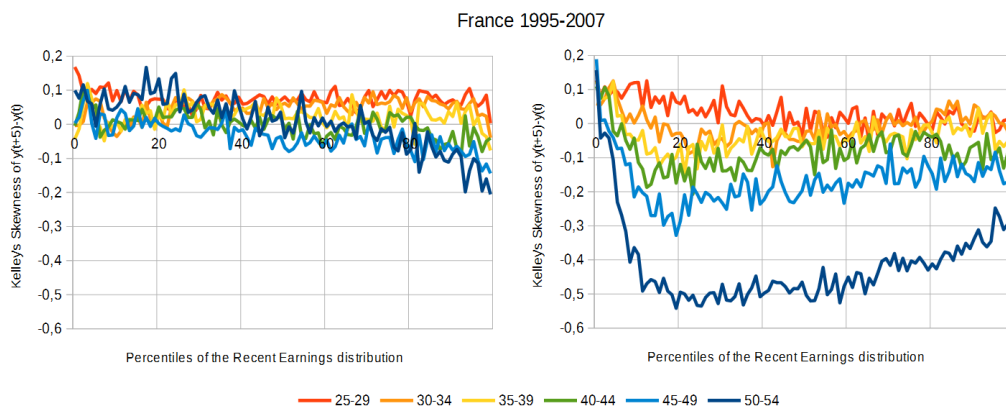


### 5.2.3 Asymmetry of wage changes

Figure 11 compares Kelley's measure of skewness of 5-year changes in wage and earnings conditional on rank in the recent earnings distribution and age. Whereas, with the exception of the bottom of the distribution, downward asymmetry, i.e. negative skewness, is a striking feature of earnings shocks, this is not true of wage shocks. Kelley's skewness of 5-year wage changes is in general close to 0, and slightly positive for younger workers. To put it differently, the distribution of wage growth is approximately symmetric: the dispersion of the most favorable wage shocks is quite similar to the dispersion of the least favorable wage shocks. This may stem from the existence of a quite high minimum wage that restricts potential wage drops, whereas wage rises are theoretically left unrestricted. Reversely, log FTE working time has no lower bound, but has upper bound equal to 0 (for individuals working full time without experiencing any unemployment).

While for the larger, lower part of the recent earnings distribution, Kelley's skewness of 5-year earnings growth decreases rapidly with age – i.e. the distribution of labor earnings changes displays more and more downward asymmetry – the age pattern is less clear when it comes to wage growth. Hence, strong downward asymmetry in labor earnings dynamics does not stem from wages. It is therefore plausible that a huge amount of this striking, non-Gaussian feature of labor earnings risk is related to working time changes. To put it differently, the probability of downward disaster earnings shocks increases – with respect to that of large upward earnings shocks – as workers grow older because large working time drops become more probable along the lifecycle, but not because wage drops are more frequent for older workers than for their younger counterparts.

This is less true of the very top of the recent earnings distribution. For very high earnings individuals, Kelley's skewness of 5-year earnings changes may be closer to that of 5-year wage changes. For these very well paid workers, at least for the older ones, there is evidence of negative skewness, that is to say downward asymmetry, of the wage growth distribution. Hence, working time contributes less to their earnings changes than it does for other workers. This is consistent with a weaker working time instability at the top of the earnings distribution. Our estimates are nevertheless quite noisy so that it remains difficult to conclude.



**Figure 11** – Kelley’s measure of skewness of 5-year changes (men in the private sector): earnings vs. wage

#### 5.2.4 Peakedness of the distribution of wage changes and heaviness of the tails

Figure 12 plots Crow-Siddiqui's measure of kurtosis of 5-year changes in wage and earnings against the distribution of recent earnings for various ages.

Both for earnings and wages, Crow-Siddiqui's kurtosis of the distribution of individual growth is always positive, and actually nearly always greater than 1.<sup>11</sup> Hence, deviations from normality, both for earnings growth and wage changes are not negligible.<sup>12</sup>

At the very bottom of the distribution, and to a lesser extent at the very top, the heaviness of tails, as measured by Crow-Siddiqui's kurtosis, is quite comparable between earnings and wages. This is not true of the larger part of the recent earnings distribution: regardless of age, the tails of the distribution of earnings changes are much heavier than those of the distribution of wage growth. Hence a significant share of deviations from normality in earnings growth does not stem from wage dynamics, but is related to working time instability. Overall, as this can also be said of asymmetry, this decomposition of labor earnings between wages and working time provides evidence that whereas log-normality assumptions might be problematic for the study of labor earnings dynamics, they do not bear such limitations for the study of wage dynamics.

The distribution of working time changes therefore displays heavy tails, and very high peakedness. This arises from many workers having constant working time over the years, for instance workers that work full-time several years in a row without experiencing any unemployment. As a matter of fact, the proportion of workers working full time during the whole year both in  $t$  and  $t+k$  is always higher than 50% in the upper half of the earnings distribution (see Appendix B.4).

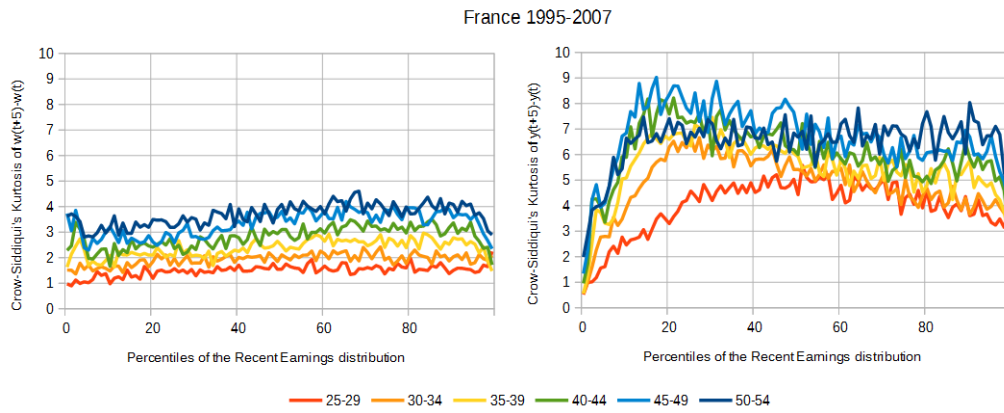
It is also worth noting that variations along the distribution of recent earnings are way stronger when it comes to earnings changes than they are for wage growth: the tails of the distribution of wages changes are not much heavier for high earnings individuals than those of low earnings individuals. Since this is also true of

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<sup>11</sup>Actually, for the Gaussian reference, Crow-Siddiqui's measure of kurtosis is constant and equal to 2.91. Figure 12 plots Crow-Siddiqui's measure of kurtosis minus 2.91 so that a positive value means the tails of the distribution are heavier than those of the normal distribution.

<sup>12</sup>It may look puzzling that Crow-Siddiqui's measure of kurtosis of 5-year earnings changes exhibits a different pattern than that of our previous, quantile-based measure (see Figure 5). This does not arise from a different subperiod being investigated: see Appendix B.3.

dispersion and asymmetry (with the exception of the very top of the recent earnings distribution), it may be regarded as evidence that there is less heterogeneity in wage risk than there is in working time instability.



**Figure 12** – Crow-Siddiqui's measure of kurtosis of 5-year changes (men in the private sector): earnings vs. wage

### 5.2.5 Labor earnings shock decomposition

In order to confirm our previous claims that working time instability accounts for a large share of labor earnings risk, we propose another decomposition exercise. More specifically, within age groups of workers with similar recent earnings, we rank them according to their past labor earnings shock  $y_{it} - y_{i,t-1}$ . For each of these groups, we relate earnings shocks to wage and working time shocks. This gives us an idea what shares of labor earnings shocks stem from working time changes or individual wage variations, allowing these shares to depend on the sizes and directions of the shocks, and workers' rank in the recent earnings distribution.

Figure 13 plots these past average wage and working time shocks against past labor earnings shocks for various positions in the recent earnings distribution.

When it comes to very low earnings workers, wage shocks are on average approximately the same regardless of the labor earnings shocks they are exposed to. Reversely, their individual working time variation is on average almost equal to the labor earnings shock they received. As one looks higher in the recent earnings distribution, the pattern changes slightly.

On the one hand, small labor earnings shocks, whether positive or negative, tend to come with equally small wage shocks; but wage shocks seem to account for only a small share of large labor earnings shocks. The share of labor earnings changes that can be attributed in average to wage changes increases along the recent earnings distribution, so that at the very top of the distribution, small labor earnings changes look very correlated with small wage variations, and wage shocks can account for a non-negligible, yet smaller than 1, share of large labor earnings changes : at the very top of the earnings distribution, this share may still not be larger than 50%.

On the other hand, small labor earnings changes, regardless of their sign, seem less and less correlated with working time shocks, while large working time shocks tend to explain large labor earnings changes to quite a large extent. The share of labor earnings shocks that can be attributed to individual changes in working time decreases as workers' rank in the recent earnings distribution increases, so that at the very top of the distribution, this share is minimum. It is nevertheless far from negligible: actually, even among top 1% worker, the share of large labor earnings shocks that can be attributed in average to working time shocks seem at least as

high, if not higher, than the share attributable to wage shocks, especially when it comes to large, downward labor earnings shocks.

This is overall consistent with our previous results: while wage risk accounts for a larger and larger share of labor earnings volatility as one looks at workers placed higher and higher in the recent earnings distribution, even at the top of the recent earnings distribution, wage shocks cannot account neither for the downward asymmetry nor for the heaviness of the tails of the earnings changes distribution. In other words, rare but considerable labor earnings changes, even among high earnings individuals, tend to be related to working time instability, and this is especially true of downward shocks.

Figure 14 takes the opposite view at the same question. More specifically, within age groups of workers with similar recent earnings, we rank them according to their past labor wage (resp. working time) shock  $w_{it} - w_{i,t-1}$  (resp.  $l_t - l_{t-1}$ ). For each of these groups, we relate earnings shocks to wage and working time shocks. This gives us a sense of how much of wage (resp. working time) shocks translate into simultaneous labor earnings shocks, this quantity being allowed to depend in an unrestricted manner of the sizes and directions of wage (resp. working time) shocks.

First note that there is substantial heterogeneity along the earnings distribution in how much of wage shocks translate into simultaneous labor earnings shocks; when it comes to working time shocks, heterogeneity is much more limited. More precisely, the pattern at the bottom of the distribution is very distinct from that of the rest of the distribution when it comes to wage shocks; reversely, the pattern is quite homogeneous when it comes to working time shocks.

With the exception of the bottom and the very top of the earnings distribution, labor earnings shocks are a non monotonous function of wage shocks. Indeed, large negative wage shocks come along with substantial albeit smaller downward earnings changes. Smaller wage shocks – those with magnitude inferior to 10 log-points, whether positive or negative – seem to translate into labor earnings shocks of similar size and direction. However, workers who experience large positive wage changes, those superior to 20 log-log points, experience labor earnings changes that are inferior to those of their counterparts who faced smaller positive wage changes. Some of them may even experience labor earnings drops (with respect

to the average lifecycle profile). This implies that they experienced substantial working time drops between  $t$  and  $t - 1$ . Among very low earnings workers, labor earnings changes seem to depend very little on wage changes, which implies that their working time changes tend to compensate the shocks on their wage rate they experience. For very high earnings individuals, labor earnings changes reflect wage changes more than for every other individuals.

As for working time shocks, the pattern remains approximately the same all along the earnings distribution. Labor earnings changes are increasing in working time changes, so that individuals who experience large negative (resp. positive) working time shocks experience simultaneous large and negative (resp. positive) labor earnings changes. Note however that large positive working time changes come along with positive earnings changes of decreasing magnitude as one focuses on individuals with higher earnings.

France 1996-2002

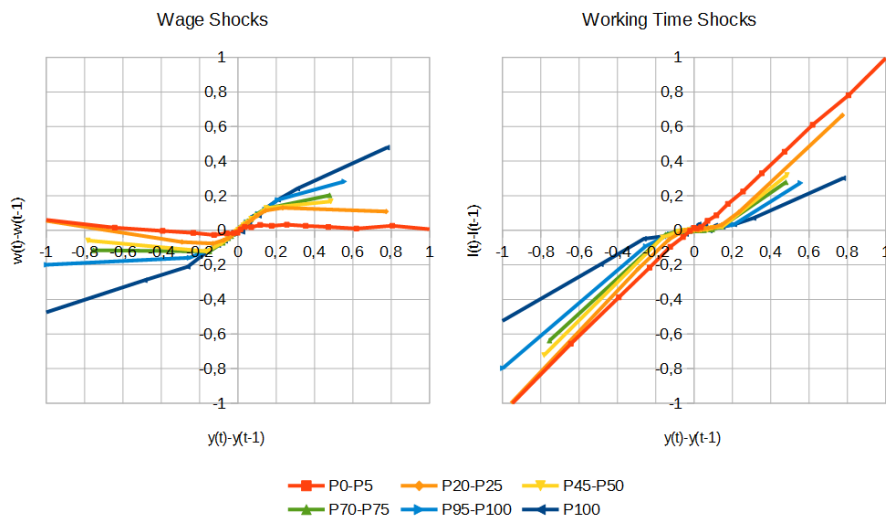


Figure 13 – Average labor earnings, wage and working time shocks, prime-age workers (men in the private sector)

France 1996-2002



Figure 14 – Average wage, working time and labor earnings shocks, prime-age workers (men in the private sector)



## 5.3 A dynamical point of view

We now get one step further in our decomposition of labor earnings between wage and working time by implementing our impulse response function framework to the dynamics of earnings, wage and working time.

### 5.3.1 Earnings response to wage and working time shocks

We first compute partial impulse response functions, in order to relate changes in earnings to past wage and working time shocks. To do so, within age groups of workers with similar recent earnings, we rank them according to their past wage (resp. working time) shock  $w_t - w_{t-1}$  (resp.  $l_t - l_{t-1}$ ). We then relate future earnings changes  $y_{t+k} - y_t$  to these past shocks. Figure 15 displays these partial impulse response functions for workers aged 35-50 and different ranks in the recent earnings distribution. The opposite of past earnings shocks  $y_t - y_{t-1}$  is represented in dashed line, while future earnings shocks  $y_{t+k} - y_t$  are represented in plain lines. Therefore, up to a change of sign, dashed lines are equivalent to Figure 14. When plain lines are above the dashed line, individuals experience earnings growth (relative to the average lifecycle profile) since  $y_{t+k} - y_t > y_{t-1} - y_t$ . When plain lines are very close to the dashed line, individuals experience transitory labor earnings shocks:  $y_{t+k} - y_{t-1} = 0$ .

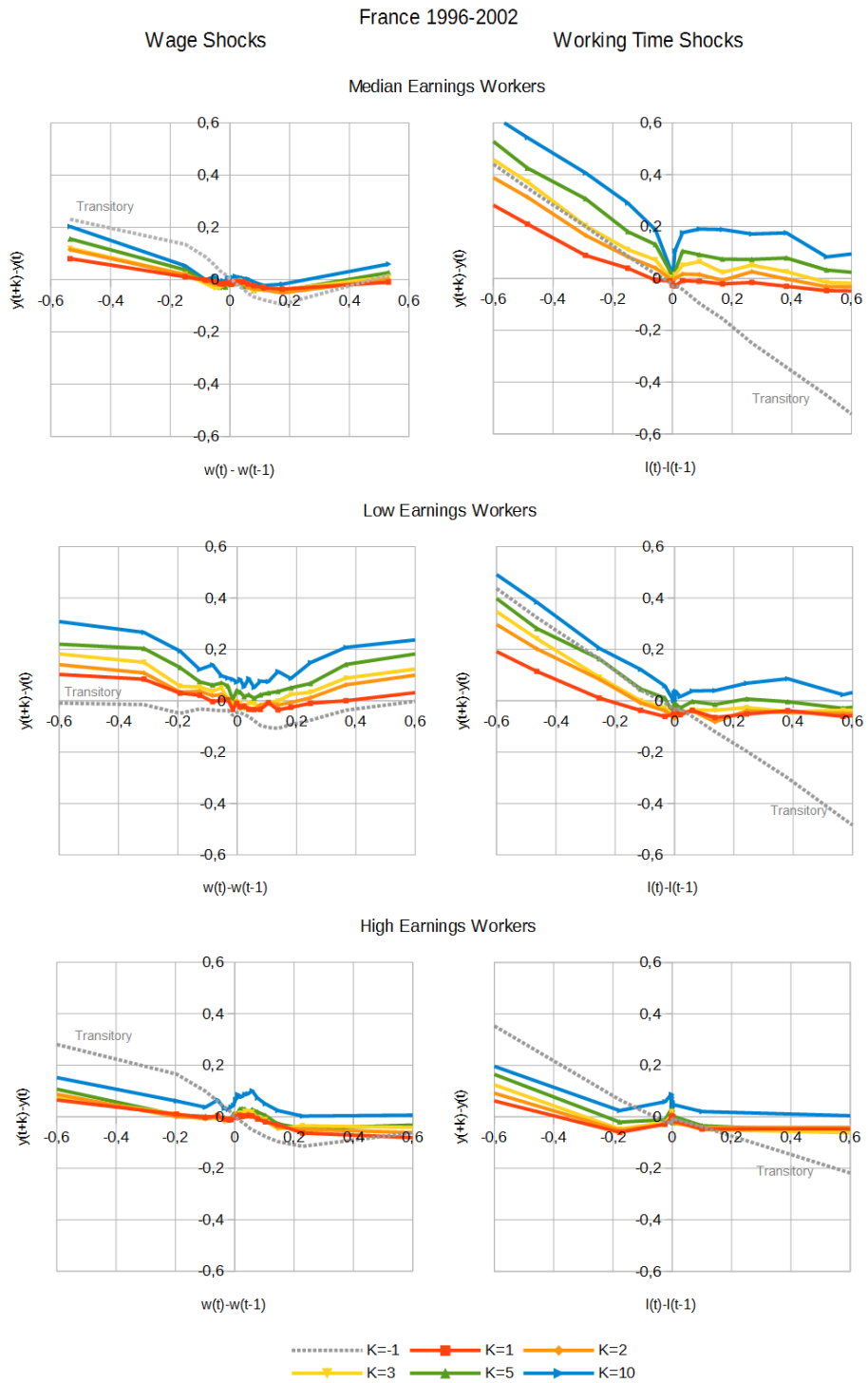
Heterogeneity in earnings response to wage shocks is more pronounced than heterogeneity in response to working time shocks. When it comes to working time shocks, the scenario is rather simple: positive working time shocks come along with positive earnings changes that turn out to be very persistent, while negative working time shocks come along with negative earnings changes that appear quite transitory – even though less so for high earnings workers. When it comes to wage shocks, the pattern is less obvious.

Among low earnings workers, large wage shocks seem to come with no earnings gain on average between  $t-1$  and  $t$ ; however workers who experienced those large wage changes seem to benefit of them in the long run, as their earnings increase at a steeper rate than their counterparts who experienced smaller wage shocks. Still, these low earnings workers who experienced small wage shocks also experienced positive earnings changes between  $t-1$  and  $t$ , especially those who experienced small positive wage shocks, and these small earnings changes turn out to be quite

persistent.

Among median earnings workers, small wage shocks translate pretty well into small earnings changes, which is consistent with our previous results. These small and wage-related earnings changes, whether positive or negative, look quite persistent. Workers who experienced dramatic wage losses also received substantial negative earnings shocks between  $t - 1$  and  $t$  – even though less dramatic than their wage losses. These earnings losses however turn out to be rather transitory, even though the recovery pace is not very fast: it takes them 10 years to get back where they were in the first place. Workers who experienced massive and positive wage shocks actually experienced nearly no earnings changes between  $t$  and  $t + 1$ . In the long run, their earnings may rise slightly.

Among high earnings workers, small wage shocks also translate well into small earnings changes that are quite persistent. Workers who experienced massive wage losses also experienced substantial earnings losses – even though less pronounced than their wage changes. They turn out to recover some part of their losses, but these earnings losses are still less transitory than those experienced by their median earnings counterparts. Workers who experienced massive wage gains actually experienced earnings gains that are much closer to 0. In the long run their earnings increase slightly.



**Figure 15** – Partial impulse response function of earnings to wage and working time shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector)

### 5.3.2 Wage and working time dynamics

We now focus on the individual dynamics of wage and working time. We replicate our flexible estimation of the impulse response function for earnings shocks, that allows responses to shocks to depend on their sizes and directions, and to be heterogeneous across the distribution of recent earnings. We simply replace earnings shocks by wage (resp. working time) shocks in the approach described at subsection 4.3 (which results are displayed at 5.1.5). In other words, within groups of workers with similar past earnings, we first rank individuals according to their wage (resp. working time) shock, that is to say their individual change between  $t - 1$  and  $t$ . We then group them into similar past shock groups, and finally estimate average past shocks and average responses – i.e. wage (resp. working time) changes between  $t$  and  $t + k$  – for each of these age  $\times$  recent earnings  $\times$  past shock groups.

Figure 16 plots individual wage (resp. working time) growth between  $t$  and  $t + k$  for various value of the time horizon  $k$  against the past wage (resp. working time) shock, for low, median and high earnings workers.

First note that, consistent with our previous findings, past working time shocks systematically exhibit larger dispersion than past wage shocks do, and that the dispersion is stronger for low earnings individuals.

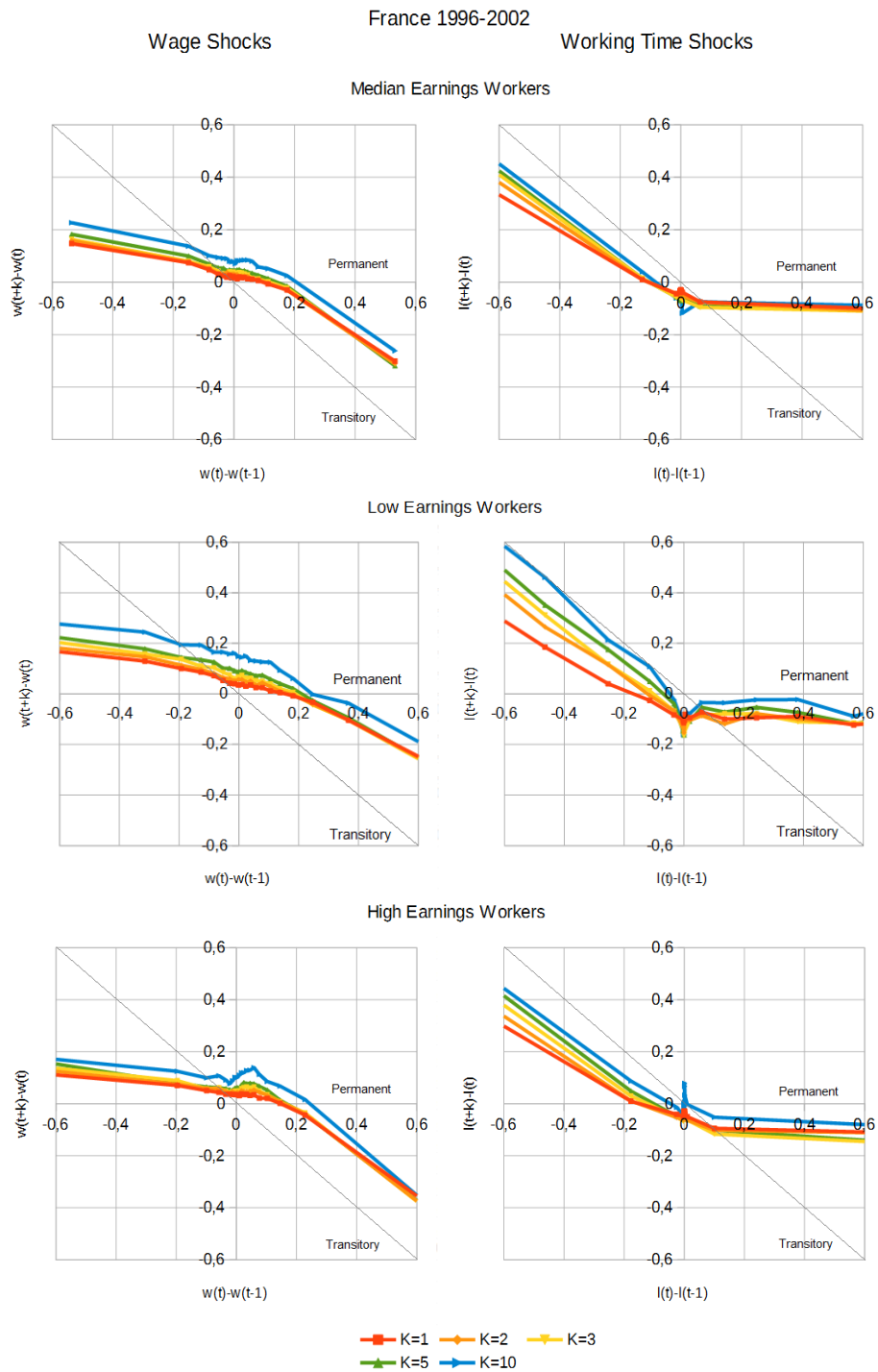
Overall, our findings can be summarized in one sentence: regardless of the position in the recent earnings distribution, large positive working time (resp. wage) shocks are more persistent (resp. transitory) than large negative working time (resp. wage) shocks.<sup>13</sup> When it comes to working time dynamics, heterogeneity across the distribution of recent earnings seems quite limited. It looks slightly stronger for wages: the persistence of large negative wage shocks and the transitory nature of large positive wage changes are both stronger for high earnings individuals than they are for workers placed lower in the distribution of recent earnings.

At least some part of the transient nature of large working time drops surely reflects some selection issues. Indeed, we only compute average working time responses for individuals with continued labor workforce participation. Should these

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<sup>13</sup>Even though the difference in persistence between positive and negative shocks is less pronounced for wage than it is for working time.

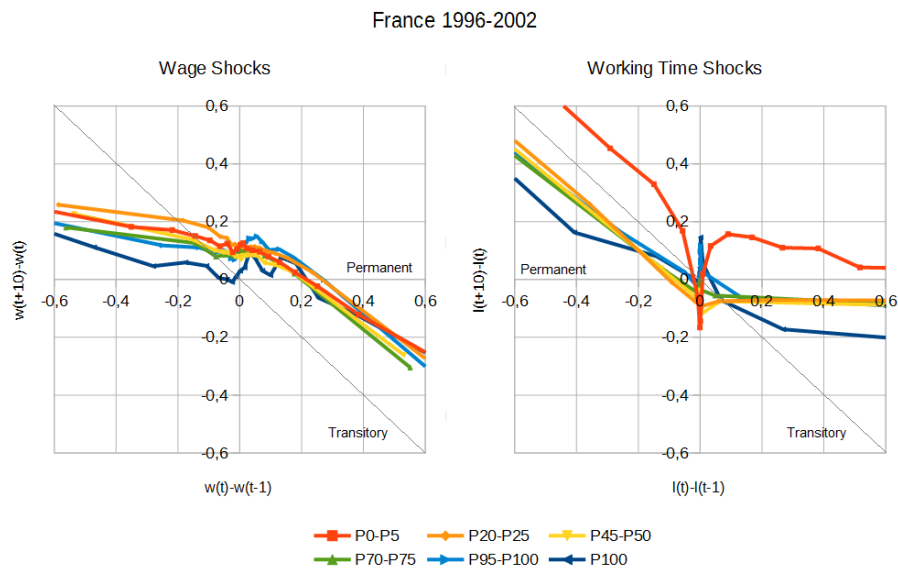
working time drops stem from unemployment, those for which these drops are the most persistent, i.e. workers who do not get back to salaried employment in  $t + k$ , are not taken into account. This does not mean however that our results do not contain any valuable information. Actually, this transient nature of large working time drops means tells us that, conditional on continued labor workforce participation, individuals who experience downward working time shocks, presumably because of job loss, do not find themselves stuck into part-time jobs or short-duration jobs.



**Figure 16** – Impulse response function of wage and working time shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector)

Trying to replicate the butterfly pattern that we obtained for earnings dynamics (see 5.1.5) confirms our statement about how limited heterogeneity is across the distribution of recent earnings. Figure 17 plots 10-year wage (resp. working time) growth against past wage (resp. working time) shocks for various ranks in the recent earnings distribution. Consistent with our claim, regardless of past earnings, large favorable wage (resp. working time) shocks are more transitory (resp. persistent) than unfavorable shocks. Plus, the variation in impulse response function along the recent earnings distribution is limited both for wages and working time, especially when compared to what it was for earnings dynamics (see Figure 7).

To put it differently, wage and working time individual dynamics do exhibit asymmetry and non-linearity, but are not so different between low and high earnings workers.



**Figure 17** – Impulse response function of wage and working time shocks for prime-age workers and at a 10-year horizon (men in the private sector)

### 5.3.3 Working time response to wage shocks

After investigating separately the dynamics of wage and working time, we now investigate how intricate these dynamics may be. We maintain the impulse response estimation approach that we used to study independently the dynamics of wage and working time (see 5.3.2) except instead of focusing on average wage response  $\delta^k w_{it} = w_{i,t+k} - w_{it}$  to past wage shock  $w_{it} - w_{i,t-1}$ , we now estimate average working time response  $\delta^k l_{it} = l_{i,t+k} - l_{it}$  conditional on  $w_{it} - w_{i,t-1}$  (and the position in the distribution of recent earnings). Within groups of workers with similar ages and similar past earnings, we first rank individuals according to their past wage change between  $t-1$  and  $t$ . We then group them according to this wage shock, and finally estimate average wage shock and average working time shock between  $t-1$  and  $t$ , and average individual working time changes between  $t$  and  $t+k$  for each of these age  $\times$  past earnings  $\times$  wage shock groups.

Figure 18 plots average working time changes, average past working time shock and probability of having earnings superior to  $1/8$  of the minimum wage  $\underline{w}$  against past wage shock for workers aged 35-50, for various time horizons  $k$  and various ranks in the recent earnings distribution. This allows us to capture dynamic working time changes at both the intensive and extensive margin.

First note that even though the size of the shocks may differ, the pattern is pretty much the same across the earnings distribution, that is to say for low, median and high earnings individuals. Regardless of recent earnings, workers submitted to large positive (resp. negative) wage shocks also receive large negative (resp. positive) working time shocks. The pattern looks more dramatic for low earnings individuals. This is consistent with working time and wage changes being negatively correlated (see Appendix B.5).

For workers who experienced large negative wage shocks in the past, working time does not change much between  $t$  and  $t+k$ . Reversely, for workers who faced large positive wage shocks between  $t-1$  and  $t$ , working time increases notably between  $t$  and  $t+k$ , at a quite fast rate since working time changes between  $t$  and  $t+1$  are nearly as big as working time changes between  $t$  and  $t+10$ . Salaried employment rate is higher for individuals submitted to small wage shocks, and lower for those who face large shocks regardless of the sign of the shocks. The rate decreases as  $k$  grows, which can mean more and more individuals leave the labor



force with time.

Remember that, according to our previous results (see 5.3.2), large negative wage shocks are persistent, and large positive wage shocks transitory, and the reverse holds for working time shocks. This is consistent with these new results, and with our claim that wage and working time changes are negatively correlated.

On the one hand, consider workers who faced large, positive wage shocks between  $t-1$  and  $t$  – that we proved to be rather transitory. As we show, they also tend to receive large, negative working time shock between  $t-1$  and  $t$ . However, their working time also increases substantially between  $t$  and  $t+k$ , so that,  $k$  years later, this negative working time shock has, at least partially, vanished. In other words, those workers face large, negative and transitory working time shocks.

On the other hand, focus on their counterparts, who received large, negative wage shocks between  $t-1$  and  $t$  – that we showed to be quite persistent. They also tend to face large, positive working time changes between  $t-1$  and  $t$ . Since, as we show, their working time changes very little between  $t$  and  $t+k$ , so that between  $t-1$  and  $t+k$ , their working time growth is approximately equal to this past working time shock (plus the systematic age trend). To put it differently, they were submitted to a persistent, positive working time shock.

Hence, large positive wage shocks, that are quite transitory, tend to come along with large negative working time changes that are also transitory, whereas large negative wage shocks, that are rather persistent, are associated with large, positive working time changes that also persist over the years. This gives us an interesting insight as to why, as we showed at 5.1.5, large negative labor earnings shocks tend to be more transitory, whereas large positive shocks are more persistent. Indeed, we provided evidence that large labor earnings shocks tend to coincide with large individual working time variations (see 5.2.5).

On the one hand, then, large downward labor earnings shocks tend to result of large, negative working time shocks, i.e. shocks that we proved to be rather transitory, and associated with transitory wage changes. On the other hand, large positive earnings changes are related to large positive working time changes, that are quite persistent and generally associated with persistent wage shocks.

Why, then, do both the persistence of positive shocks and the transitory nature of negative shocks weaken as one looks at workers placed higher and higher in the

distribution of recent earnings ? Simply because the extent to which labor earnings growth can be attributed to working time changes lowers as one gets higher in the earnings distribution. Hence, labor earnings dynamics get closer to wage dynamics, i.e. dynamics where negative shocks are more persistent than positive shocks are.<sup>14</sup>

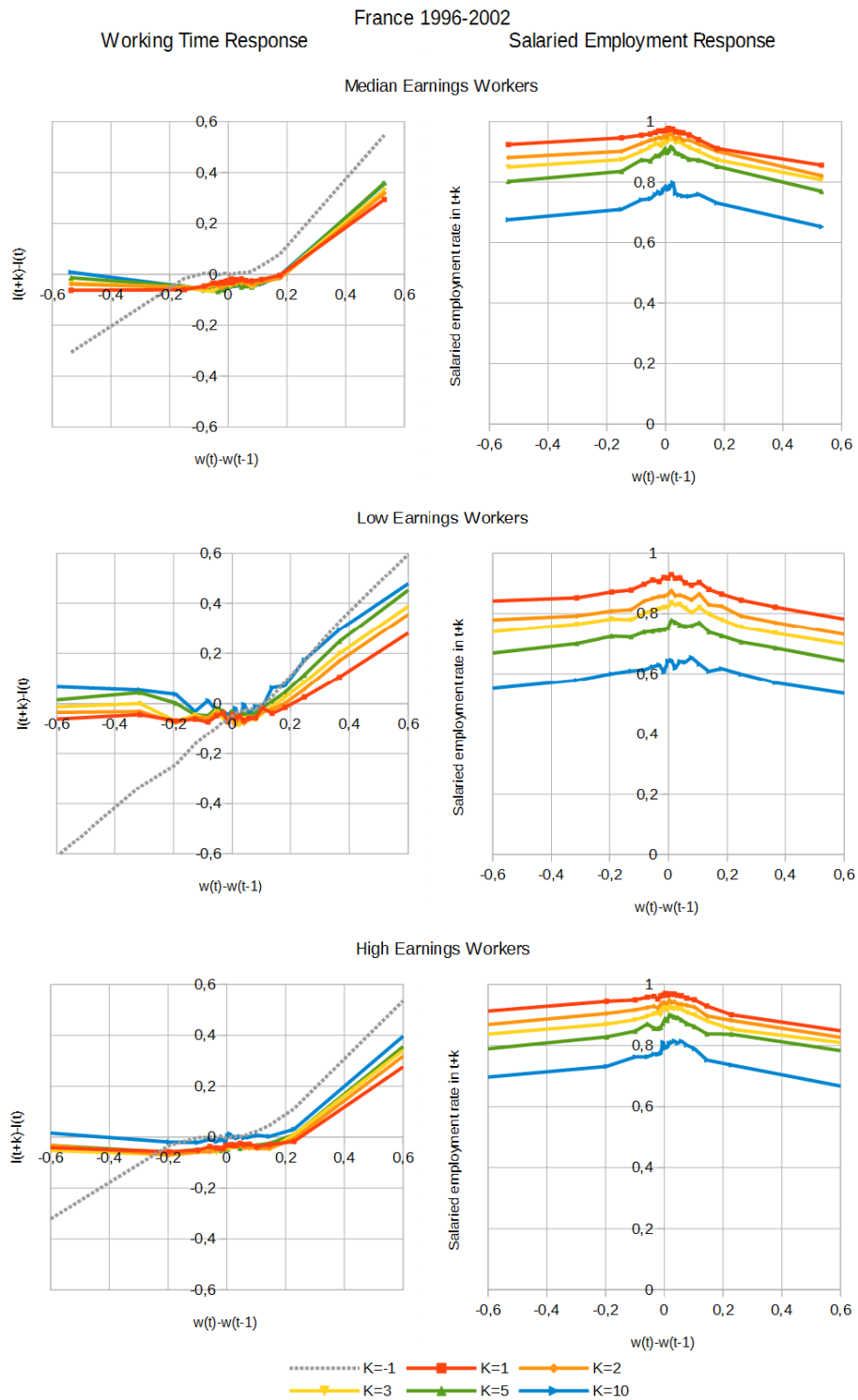
We previously showed that this heterogeneity in labor earnings dynamics is stronger in the US than it is in France (see 5.1.5). We showed that even for very high earnings workers, the share of labor earnings shocks that can be attributed to working time changes is not negligible. Should our results regarding wage and working time dynamics extend to the American case, this would arise from working time changes contributing to a larger extent to individual earnings shocks of high earnings individuals in France than they do in the US, or, to put it differently, wage shocks accounting for a small share of their labor earnings risk. Since overall labor earnings risk is higher in the US than it is in France, it is therefore plausible that wage rigidities at the individual level may be stronger in France at the top of the earnings distribution than they are in the US.

These results also have implications in terms of labor supply. Across the whole earnings distribution, large wage changes are associated with more workers flowing out of the labor workforce; large negative and persistent (resp. positive and transitory) wage changes come along with substantial positive and persistent (resp. negative and transitory) working time changes. When it comes to labor participation decisions, it could be that disaster downward wage changes leads a substantial fraction of workers to fall beneath their reservation wage, which results in them leaving the labor workforce. However, extreme positive wage growth leading to labor workforce outflows is puzzling. The most likely explanation is that our measure of earnings includes severance package, so that laid off workers may experience massive FTE wage growth. The exact same fact may explain why, conditional on continued labor workforce participation, large positive wage shocks come along with substantial working time drops. It may also be that the income effect is larger than the substitution effect (Cahuc, Carcillo, and Zylberberg, 2014), which may also explain why rather permanent downward wage shocks are associated with quite long-lasting working time rises. Even though without any data on non-earned income and leisure it remains difficult to conclude, we do not find evidence

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<sup>14</sup>Even though neither positive nor negative shocks can be said to be perfectly persistent or transitory.

to support the claim that for workers with continued labor workforce participation, the substitution effect might be larger than the income effect, i.e. that working time rises (resp. drops) in response to positive (resp. negative) wage changes. This may however arise from our measure of working time aggregating changes at the intensive margin – how many days individuals work each day – and at the extensive margin – the duration of employment spells – that do not bear the same implications.



**Figure 18** – Working time response and probability of salaried employment by past wage shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector)

## 6 Conclusion

We replicated our approach on a sample of men and women working in both the public and private sectors, based on the same dataset we use. We find our main stylized facts to hold for women; figure are available upon request. However, because labor participation and labor supply decisions may be more difficult to disentangle from risk for women than they are for men, we believe they deserve some specific attention. In ongoing research we investigate differences between genders in labor earnings risk and dynamics along the lifecycle and their implications, for instance labor earnings shocks being more negatively skewed for younger women than they are for their male counterparts.

Our empirical analysis reaches several conclusions. Firstly, most of [Guvenen et al. \(2016\)](#)'s empirical results do hold for France. In particular, in France like in the US, labor earnings changes do exhibit downward asymmetry and heavy tails. Since these results are also in line with those of [Druehl and Munk-Nielsen \(2017\)](#) for Danish males, these non-Gaussian features of labor earnings risk may constitute rather robust stylized facts that apply to labor earnings in general, as opposed to US specific labor market institutions. As pointed out by [Guvenen et al. \(2016\)](#), these empirical patterns might be generated by job ladder models.

Our investigation of labor earnings dynamics, however, allows us to point out a dramatic difference between France and the US. Indeed, while [Guvenen et al. \(2016\)](#) show that, for American high earnings workers large positive earnings shocks tend to be very transitory and large negative earnings shocks tend to be very persistent, we provide evidence that, for their French counterparts, large positive earnings shocks are more persistent than large negative earnings shocks are. In France actually, large positive earnings shocks being more persistent than large negative earnings shocks is true of the entire earnings distribution, even though the lower the earnings, the more persistent (resp. transitory) large positive (resp. negative) earnings shocks are.

Secondly, we provide with a decomposition of labor earnings between wage and working time that allows us to distinguish how much of labor earnings risk stems from changes in the wage rate versus working time instability. This decomposition fills a gap in the literature since [Guvenen et al. \(2016\)](#)'s American data does not provide information on working time. It allows us to show that non-Gaussian fea-

tures of labor earnings risk arise from changes in working time rather than changes in the wage rate. This is because large changes in earnings mostly reflect changes in working time, while small changes in earnings stem from changes in wage. This finding gives support to the job ladder hypothesis since it implies that unemployment risk may be sufficient to generate non-Gaussian labor earnings risk without wage rate changes displaying substantial non-Gaussian features themselves. See for instance [Hubmer \(2016\)](#).

Thirdly, we show that regardless of past earnings, wage and working time dynamics exhibit opposite patterns: large positive (resp. negative) working time shocks are persistent (resp. transitory), while the reverse holds for wage shocks. Since large changes in earnings mostly stem from working time changes, this allows us to understand why large positive earnings shocks tend to be more persistent than large negative earnings shocks. Furthermore, as working time changes account for a decreasing share of labor earnings changes as one focuses on workers with higher past earnings, large upward (resp. downward) earnings shocks tend to be more persistent (resp. transitory) for low earnings workers than for high earnings workers. Should this stylized fact hold for the US, this would provide us with a simple explanation of the difference in labor earnings dynamics that we encountered between French and American high earnings workers: such a gap may stem from large changes in wage overcoming large changes in working time at the top of the earnings distribution in the US, while this is not the case in France.

Finally, we show that regardless of the position in the earnings distribution, large positive and transitory (resp. negative and persistent) wage rises tend to come along with substantial momentary working time drops (resp. long-lasting working time rises) and outflows from the labor workforce. On top of being in line with our previous findings, this suggests that a substantial share of massive wage rises may reflect severance packages that are included in our measure of earnings. This results in large positive wage shocks being quite transitory, and failing at generating substantial earnings growth.

Overall, these findings substantiate the claim that working time dynamics, presumably driven by unemployment risk, are key to the understanding of labor earnings risk and dynamics. Indeed, working time changes explain much of the non-Gaussian features of labor earnings risk and the asymmetric mean reversion

that characterizes labor earnings dynamics, i.e. earnings drops being more transitory than earnings rises. Moreover, through severance packages, unemployment risk also explains several features of wage dynamics, namely extreme wage rises coming along with working time drops and outflows from the labor workforce and being somehow transitory.

These results come however with several limitations. Some of them stem from the data we use. First of all, our data only allows us to deal with salaried earnings, as opposed to total labor earnings that would include self-employment. Still, the stylized facts documented by [Guvenen et al. \(2016\)](#) are robust to the omission of self-employment income, since [Guvenen et al. \(2015\)](#) that only included salaried earnings yields very similar results. This tends to make us confident that our empirical results may be robust to the inclusion of French self-employed workers.

Besides, by solely studying income that is earned through employment, we may not get a proper view of the income risk associated to labor market participation. Indeed, we showed that changes in working time explains a substantial share of labor earnings risk and labor earnings dynamics. Since these working time changes likely stem from unemployment risk, omitting to account for unemployment benefit may arguably provide with a biased view of labor market-related income risk and dynamics.

What is more, we only focus on individual earnings, as opposed to household income, which can be problematic if we try to derive consumption and saving implications of labor earnings risk. Indeed, labor market behavior of a particular member of a given household is likely to depend on labor market expectations and outcomes of the other members of the household (see for instance [Bertrand, Kamenica, and Pan \(2015\)](#)), so that household income risk may no simply reflect individual earnings risk. Hence consumption and saving decisions taken at the household level may differ from those that would be derived from individual labor earnings risk.

In a recent paper, [Busch and Ludwig \(2016\)](#) deal with both these issues in the case of Germany. They provide evidence of within-household insurance against the transitory labor earnings shocks of males, but not against permanent shocks, and prove the German tax and transfer system, which includes unemployment benefits, to provide insurance against both shocks. Should these results hold in

the French case, this would imply that individual labor earnings risk is likely to overstate the actual household net income risk that is relevant for consumption and saving choices.

Another limitation stems from our approach rather than from the data we rely on. Indeed, our descriptive framework focuses on cross-sectional distributions of labor earnings, wage and working time changes on the one hand, on the correlation between two subsequent changes on the other hand. This approach is questionable because the first shock itself, or at least some part of it, is likely to be a response to another previous shock that we do not take into account. For instance, we show massive wage rises to be rather transitory, whereas large wage drops are quite more persistent. It is therefore likely that at least some part of these wage drops are the consequence of past wage rises, so that their persistence results from the transient nature of massive wage increase rather than from a long-lasting nature that would be intrinsic to wage drops. By its very construction, our reverse-engineering framework fails at tackling this issue. It is likely that this problem can only be solved properly by estimating the whole wage and working time process.



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## A Appendix: Working time measure

We decompose labor earnings of worker  $i$  at year  $t$  as the product of working time  $l_{it}$ , expressed in FTE, i.e. as a fraction, comprised between 0 and 1, of a full year of full-time employment, and wages  $w_{it}$  expressed as the earnings worker  $i$  would have had at year  $t$  had he worked full-time during a whole year with the same wage rate.

As of 1995, paid hours are available. Our working time measure is based on: paid days of work during year  $t$ , a full-time dummy and paid hours. More specifically, let  $d_{it}$  (resp.  $h_{it}$ ) denote the number of paid days (resp. hours) of work of worker  $i$  during year  $t$ . Then:

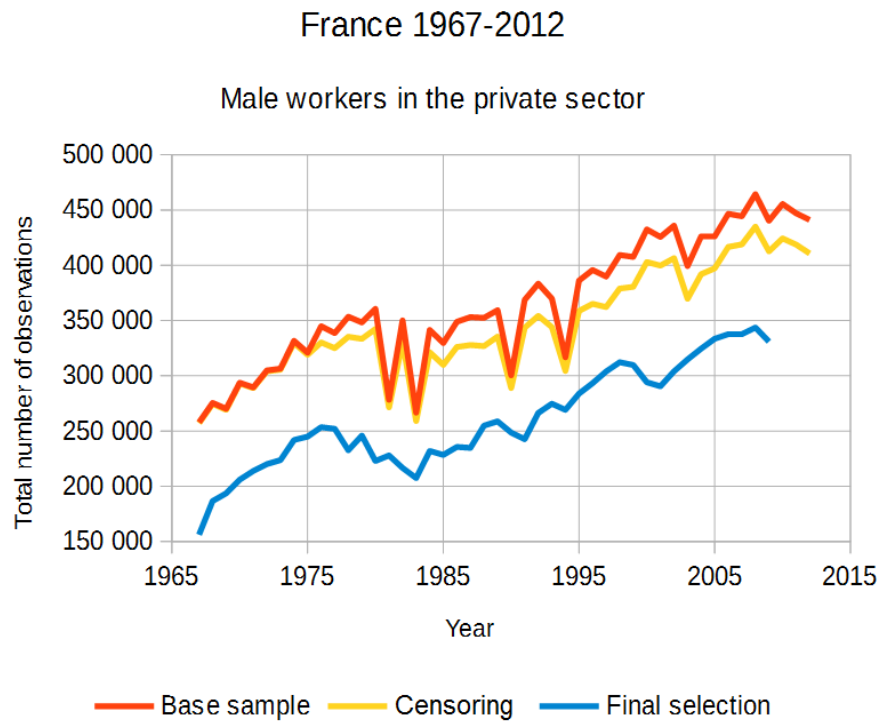
$$l_{it} = \begin{cases} 1 & \text{if worker } i \text{ is a full-time worker and } d_{it} \geq 360 \\ \frac{d_{it}}{360} & \text{if worker } i \text{ is a full-time worker and } d_{it} < 360 \\ \frac{h_{it}}{med_{it}^h} & \text{if worker } i \text{ is a non full-time worker} \end{cases}$$

with  $med_{it}^h$  the median of paid hours for full-time workers working the complete year  $t$  (that is to say with  $d_t \geq 360$ ) that have the same occupation and work in the same industry as worker  $i$ .

This measure of working time therefore allows us to workaround two issues related to the measurement of paid hours in our data: first, the fact that some occupations, that only gather full-time workers, are allowed to have paid hours equal to 0; second, the change in legal duration of work at the beginning of the 2000s that can lead to breaks in working time that do not reflect individual-level dynamics. Our results are nevertheless robust to the choice of using working time measured in worked hours and wage expressed in hourly wages (see Appendix C.5).

## B Additional figures

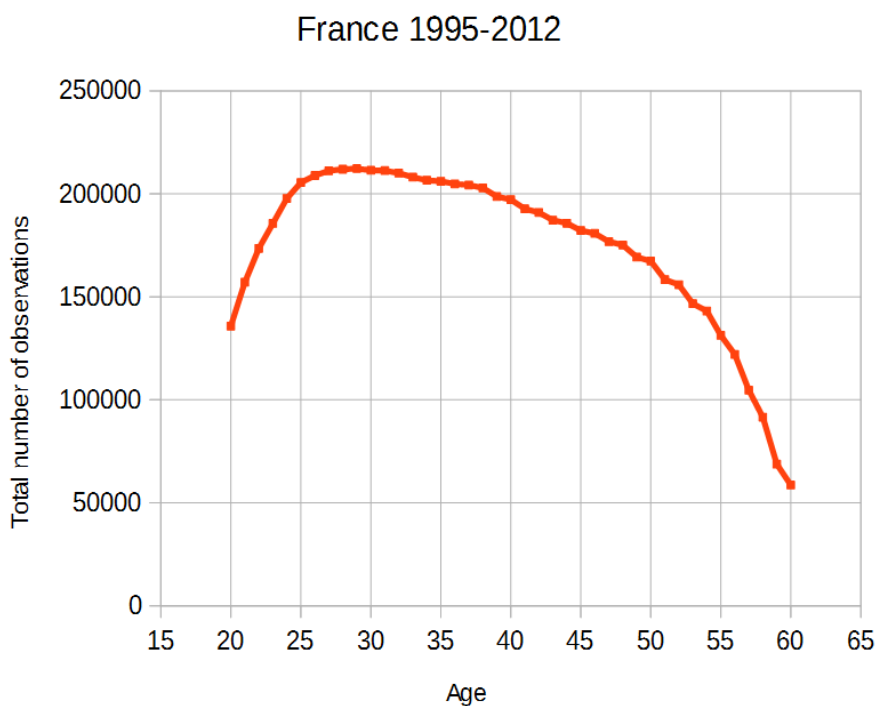
### B.1 Sample size



**Figure B.1** – Sample size by year 1967-2012

## B.2 Number of observations by age

According to Figures 2 and 9, after age 55, cross-sectional earnings tend to decrease while cross-sectional wages increase. We attribute the decrease in cross-sectional earnings to workers leaving the labor force, and the increase in cross-sectional wages to employment selection. Indeed, as represented by Figure B.2 the number of individuals that are present in the data decreases at a fast rate after age 55. Hence, labor force exit that occur during the year can result in decreasing cross-sectional working time, and therefore in decreasing cross-sectional earnings, while well paid workers leaving the labor force later than their poorly paid counterparts may cause cross-sectional wages to increase.

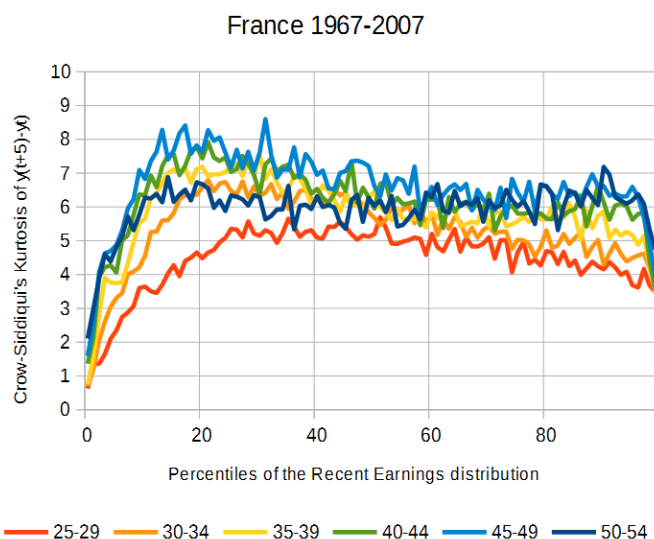


**Figure B.2** – Total number of observation by age: male workers in the private sector 1995-2012

### B.3 Crow-Siddiqui's kurtosis of earnings changes

Figure 12 displays Crow-Siddiqui's measure of kurtosis of 5-year earnings changes conditional on recent earnings. It may seem puzzling that the pattern differs slightly from that of moment-based kurtosis that is displayed at Figure 5: both figures show 5-year earnings changes distribution to have heavier tails than the Gaussian reference, but while moment-based kurtosis increases from the bottom of the recent earnings distribution to the 80th percentile, Crow-Siddiqui's kurtosis increases rapidly at the bottom of the distribution and remains approximately constant or decreases from the 20th percentile to the top.

On top of the measure being different, the two figures differ in the period they focus on: namely, Figure 5 covers 1970-2007 while Figure 12 covers 1995-2007. Figure B.3 displays Crow-Siddiqui's measure of kurtosis of 5-year earnings changes for the period 1970-2007. The pattern is very similar to that of Figure 12. Hence differences between Figure 5 and Figure 12 are not driven by differences in the covered years but rather by differences between the two measures. More precisely, while every changes are taken into account by the moment-based kurtosis, Crow-Siddiqui's measure of kurtosis relies on quantiles of order 0.025, 0.25, 0.75 and 0.975. Hence extreme changes, below P2.5 and P97.5 may play a part in increasing fourth moment but not in our quantile-based measure of the heaviness of the tails, which might explain the diverging patterns.

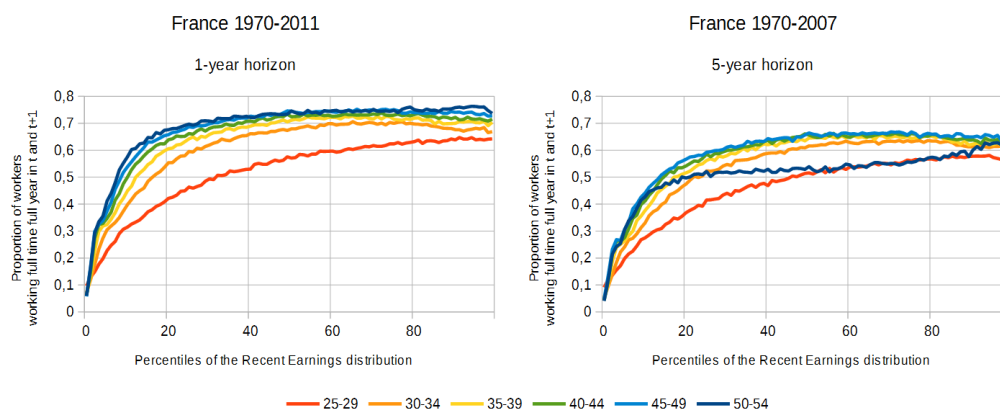


**Figure B.3** – Crow-Siddiqui's Kurtosis of 5-year earnings changes: male workers in the private sector

## B.4 Full-time workers with no unemployment

Figure B.4 displays the share of workers with FTE working time equal to 1 in  $t$  and  $t + k$ . This proportion is quite low at the very bottom of the recent earnings distribution, but increases rapidly. Beneath the median of the recent earnings distribution, it is higher than 50% for every age group. With the exception of workers aged 50-54, it increases with age.

Therefore, there is a substantial amount of workers for which the change in working time between  $t$  and  $t + k$  accumulates on few mass points  $\widehat{\beta}_{a+k} - \widehat{\beta}_a$ . Remember that according to Figure 9, the systematic age trend in working time is approximately constant between age 35 and age 50. Hence, many workers (over 60%) will concentrate around working time changes approximately equal to 0, which may result in extreme peakedness of the distribution of working time changes.



**Figure B.4** – Proportion of workers working full-time without experiencing any unemployment in  $t$  and  $t + k$ : male workers in the private sector 1970-2011



## B.5 Cross-sectional correlation between wage growth and working time changes

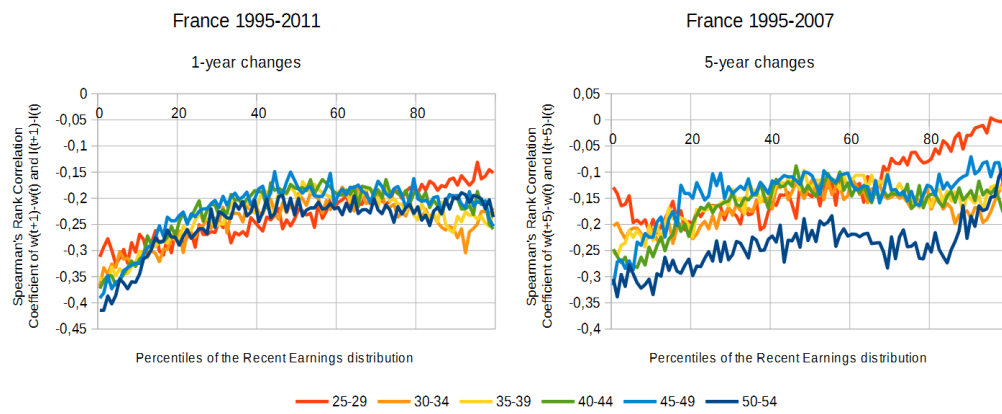
We have shown that working time instability accounts for a significant share of labor earnings risk, even though this share decreases as workers' past earnings increase. As a result, the extent to which labor earnings changes are related to wage shocks is higher for high earnings workers than it is for low earnings workers. There is however a possibility that those two dimensions are themselves correlated. Should this correlation vary along the recent earnings distribution, this would even result in additional heterogeneity.

To investigate this, we first take a closer look at the cross-sectional correlation of wage and working time changes at 1-year and 5-year time horizons. Consistent with our insistence on non-linearities, and our preference for quantile-based measures over moment-based measures, we privilege Spearman's rank correlation coefficient (Spearman, 1904) over Pearson's correlation coefficient. Figure B.5 plots the rank correlation of  $\delta^k w_{it} = w_{i,t+k} - w_{it}$  and  $\delta^k l_{it} = l_{i,t+k} - l_{it}$ , for  $k = 1$  and  $k = 5$ , against the distribution of recent earnings.

First of all, for both time horizons and regardless of age and rank in the distribution of recent earnings, the rank correlation coefficient is never positive. It is actually nearly always negative, with the exception of younger workers at the top of the recent earnings distribution, presumably because labor market entrance is associated with wage and working time rises that may occur simultaneously. To put it differently, the least (resp. the most) favorable wage changes seem to be associated with the most (resp. the least) favorable working time changes.

This association however varies slightly along the distribution of recent earnings. Regardless of age, it is stronger at the bottom of the distribution of recent earnings, that is to say for low earnings workers, and gets weaker as one looks higher in the distribution, at least up to median earnings workers. For younger workers, it continues to lower for high earnings individuals, up to the very top of the distribution; at a 5-year time horizon, it vanishes for the workers aged 25-29 with the highest past earnings. For older workers, it gets stronger as one looks at workers with higher recent earnings – for 1-year changes – or remains approximately the same all along the upper half of the distribution of recent earnings – for 5-year changes. However heterogeneity in the correlation between wage and

working time shocks is not very strong.



**Figure B.5** – Spearman's rank correlation coefficient of  $k$ -year wage and working time changes for  $k = 1$  and  $k = 5$

## C Appendix: Robustness checks

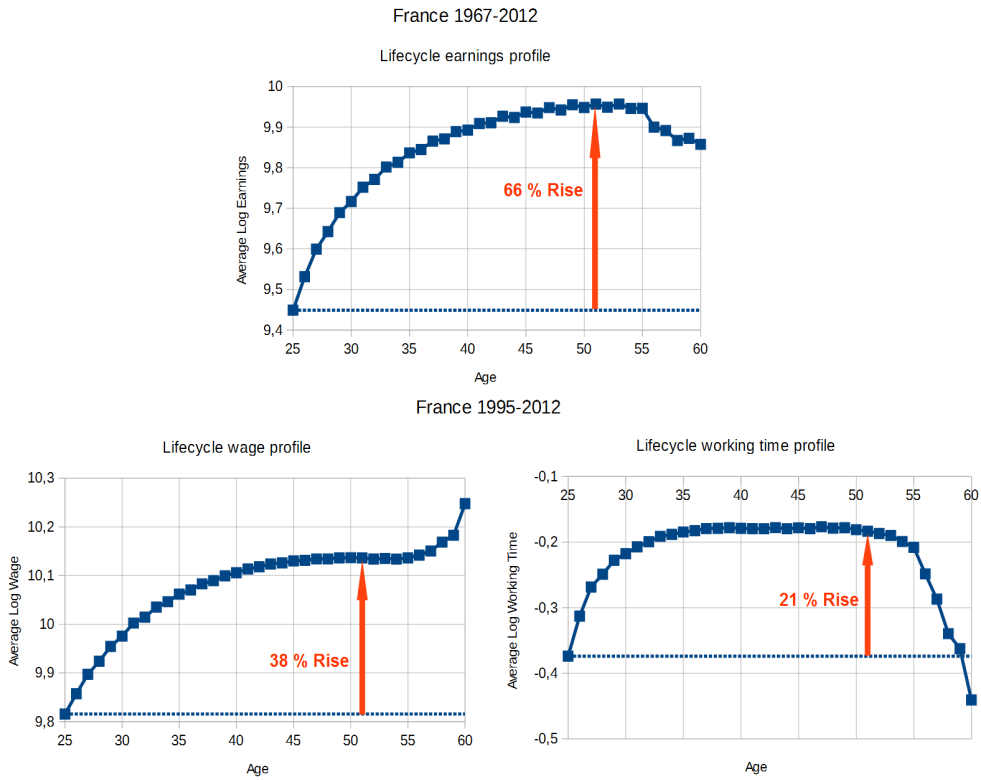
We now provide a few robustness checks in order to get sure of the validity of our results.

### C.1 Imputation method

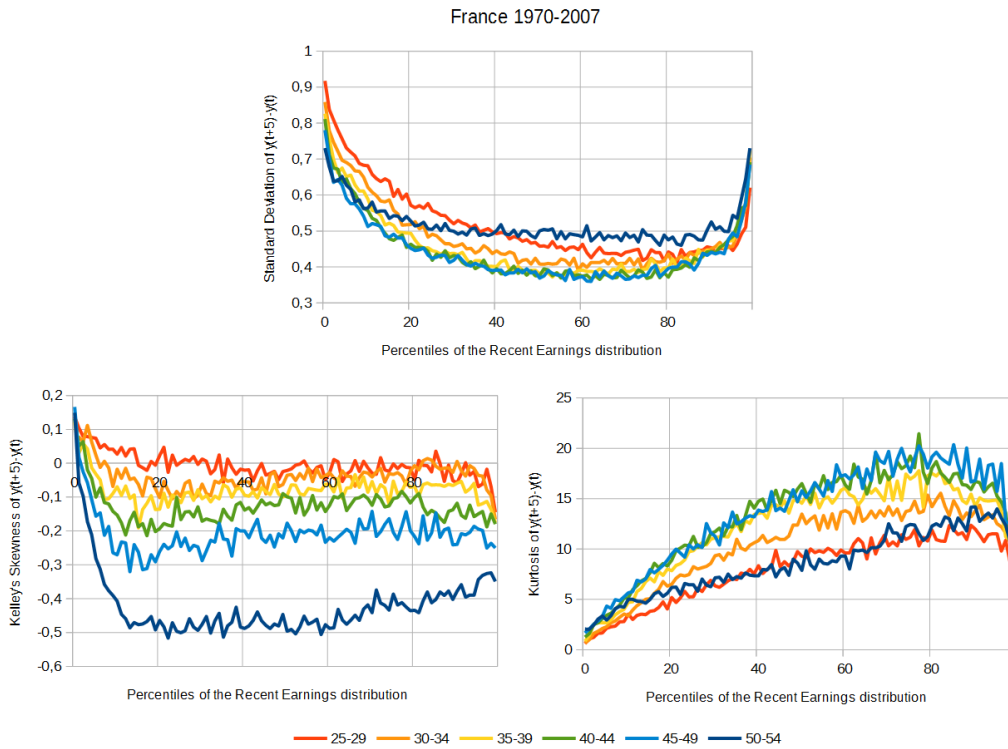
As we mention in Section 3, in our dataset, years 1981, 1983 and 1990 are missing, because due to 1982 and 1990 censuses, INSEE did not produce the data. Moreover, the quality of the data for year 1994 is questionable, so we do not use it. We impute the data for those years: for individual that are present in the data – that is to say for individual that had positive earnings – in year  $t - 1$  and  $t + 1$ , we impute labor earnings at year  $t$  as the geometrical average of labor earnings at years  $t - 1$  and  $t$ .

Another, more conservative, imputation method, does not change much our results. In this more conservative framework, we only impute labor earnings for individuals that had the same main employer – i.e. the employer where the largest share of the paid days of work were realized – for year  $t - 1$  and  $t$ . For these individuals again we consider labor earnings at year  $t$  to be the geometrical average of labor earnings at years  $t - 1$  and  $t$ .

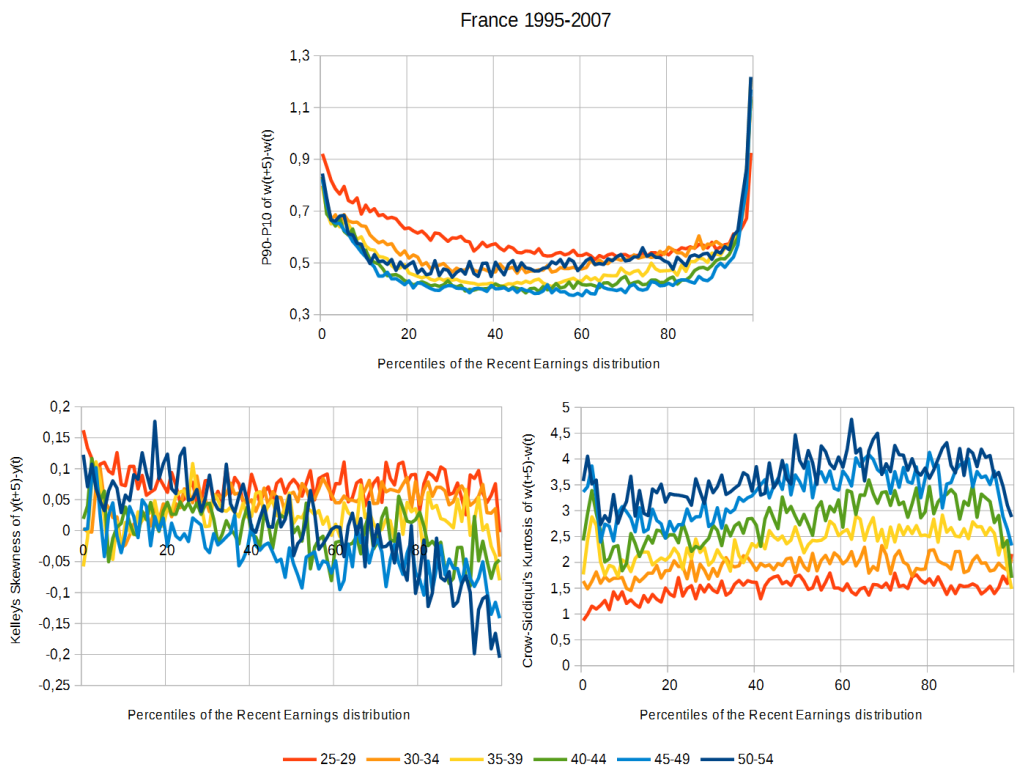
Figures C.1, C.2 and C.3 replicate the lifecycle profiles of earnings, wage and working time and the distribution of 5-year earnings changes of Figure 2, 3, 4, 5, 9, 10, 11 and 12 with this conservative imputation procedure. Overall our results are very similar, which means that our results are quite robust to our imputation of missing and bad quality data.



**Figure C.1** – Lifecycle profile for earnings, wage and working time (men in the private sector): conservative imputation



**Figure C.2** – 5-year earnings changes distribution (men in the private sector): conservative imputation



**Figure C.3** – 5-year wage changes distribution (men in the private sector): conservative imputation

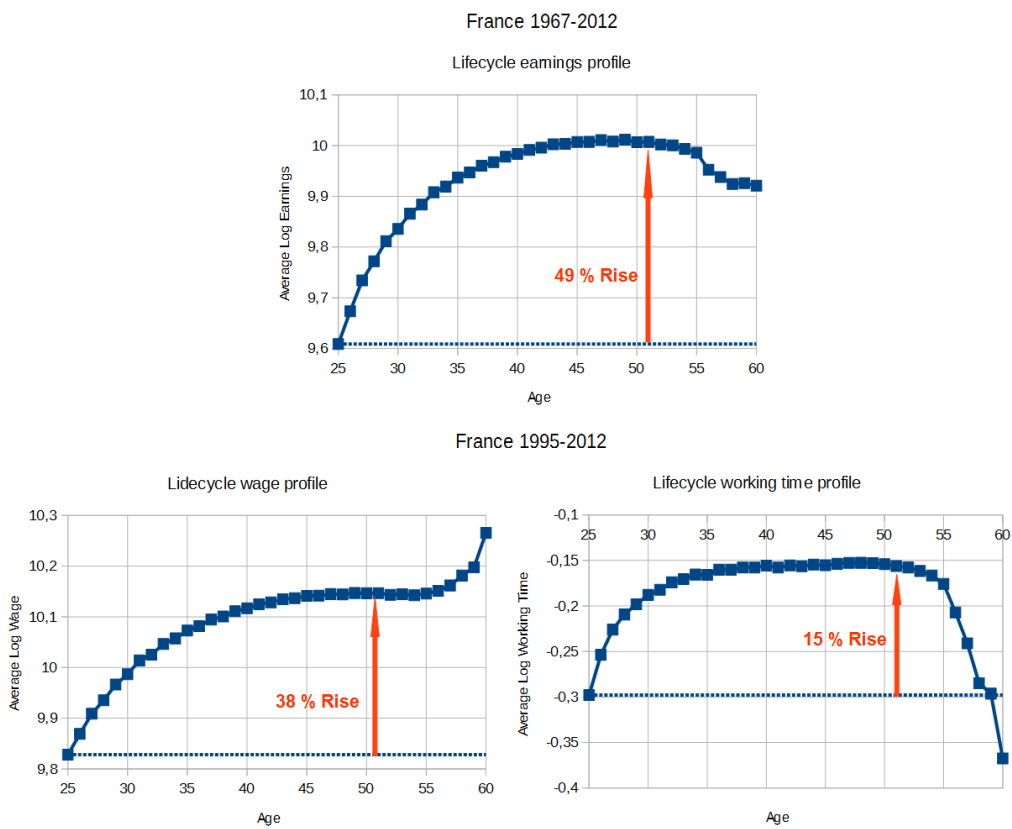
## C.2 Censoring

In order to focus on individuals that have reasonable labor force attachment, we restricted ourselves to workers whose earnings exceed  $1/8$  of the annual minimum wage. While this choice of censoring threshold is the same as [Guvenen et al. \(2015\)](#), and therefore ensures maximum comparability between our results and theirs, it is nevertheless quite arbitrary. However, we are able to replicate our results with different choices of censoring threshold.

Figures [C.4](#), [C.5](#) and [C.6](#) replicate the lifecycle profiles of earnings, wage and working time and the distribution of 5-year earnings changes of Figure [2](#), [3](#), [4](#), [5](#), [9](#), [10](#), [11](#) and [12](#) with censoring threshold equal to  $\frac{1}{4}$  of the minimum wage  $\underline{w}$ . Figure [C.7](#), [C.8](#) and [C.9](#) do the same with censoring threshold equal to  $\frac{1}{16}$  of the minimum wage  $\underline{w}$ .

First note that the most striking features of labor earnings risk, that we commented in the paper – i.e. U-shape of the dispersion of earnings shocks, strong downward asymmetry with the exception of the bottom of the recent earnings distribution, high peakedness and heavy tails of the distribution of individual earnings variations – do not depend on the censoring choice, since they appear with both choices of censoring threshold.

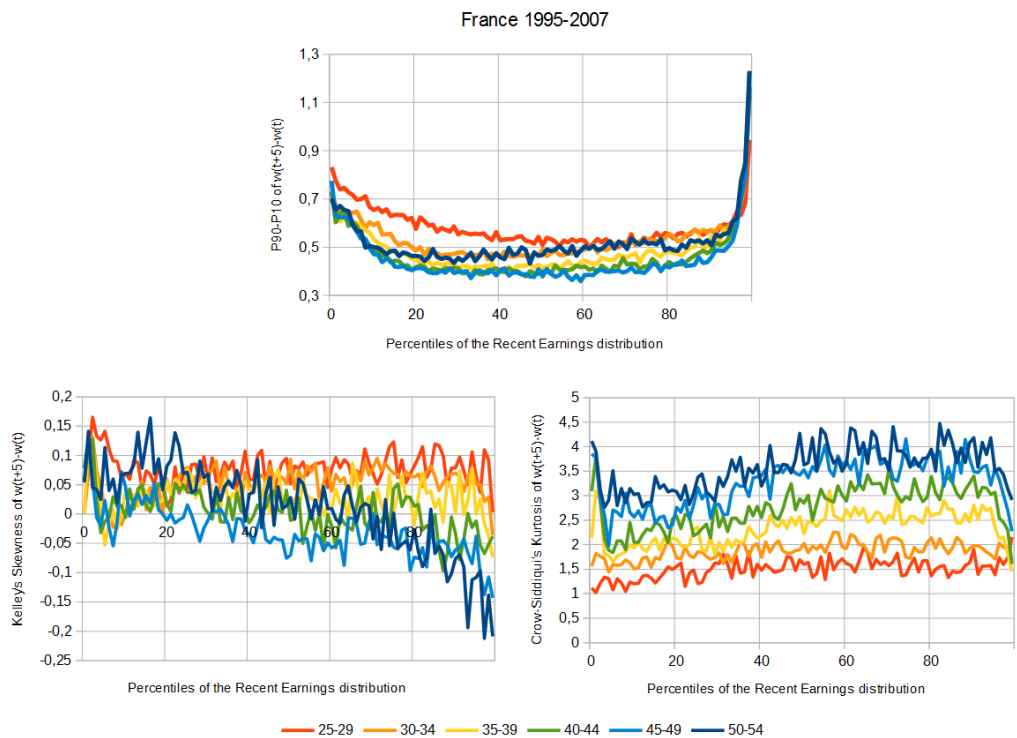
There are however some differences in labor earnings risk pattern that occur when the censoring threshold varies. They mostly deal with levels of the measure, and not so much with how these measure vary with age and recent earnings. Consistent with the rationale, these differences occur at the bottom of the recent earnings distribution. However, our results seem overall quite robust to the choice of censoring threshold.



**Figure C.4** – Lifecycle profile for earnings, wage and working time (men in the private sector): censoring at  $\frac{1}{4}$  of the minimum wage

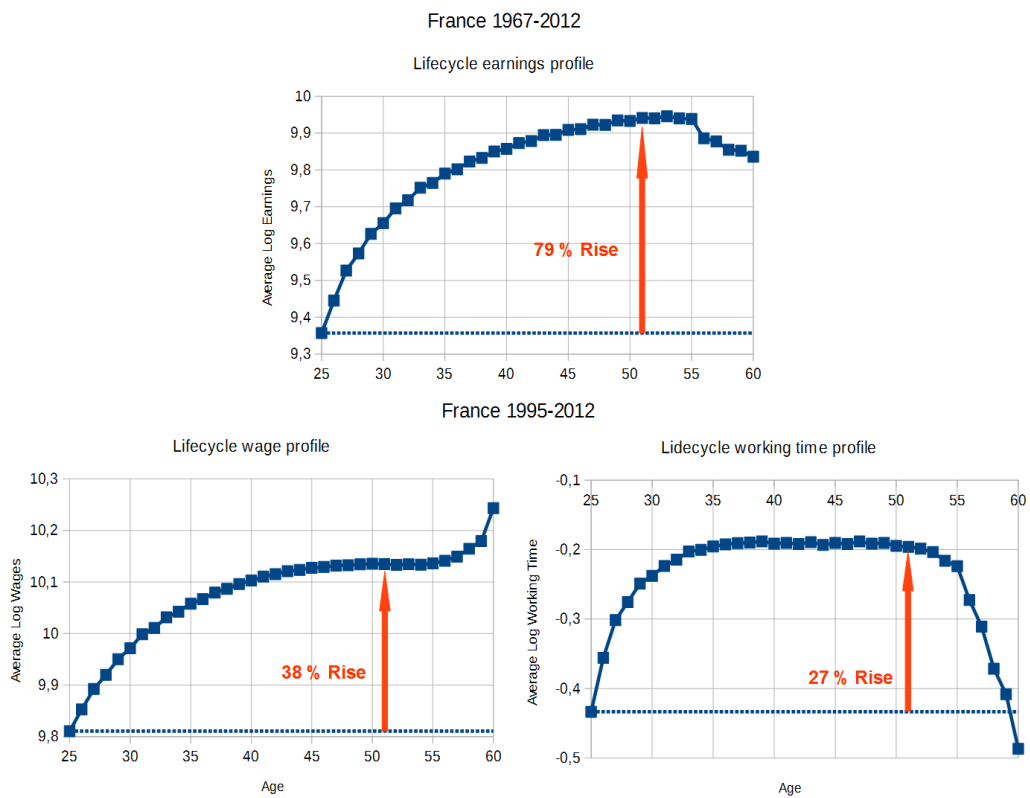


**Figure C.5** – 5-year earnings changes distribution (men in the private sector): censoring at  $\frac{1}{4}$  of the minimum wage

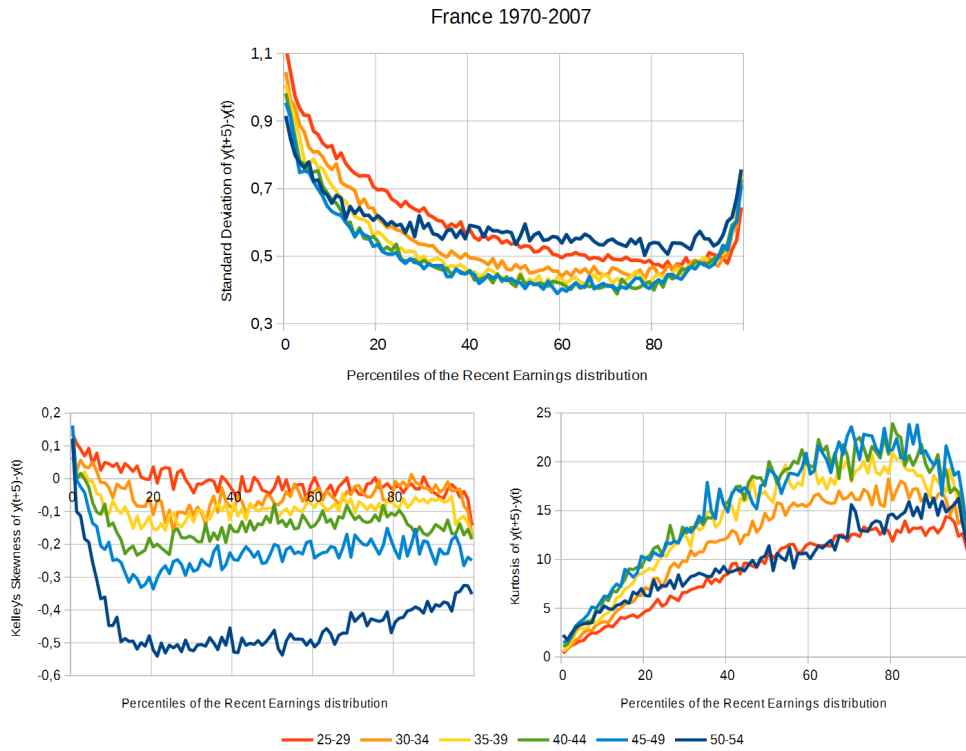


**Figure C.6** – 5-year wage changes distribution (men in the private sector): censoring at  $\frac{1}{4}$  of the minimum wage

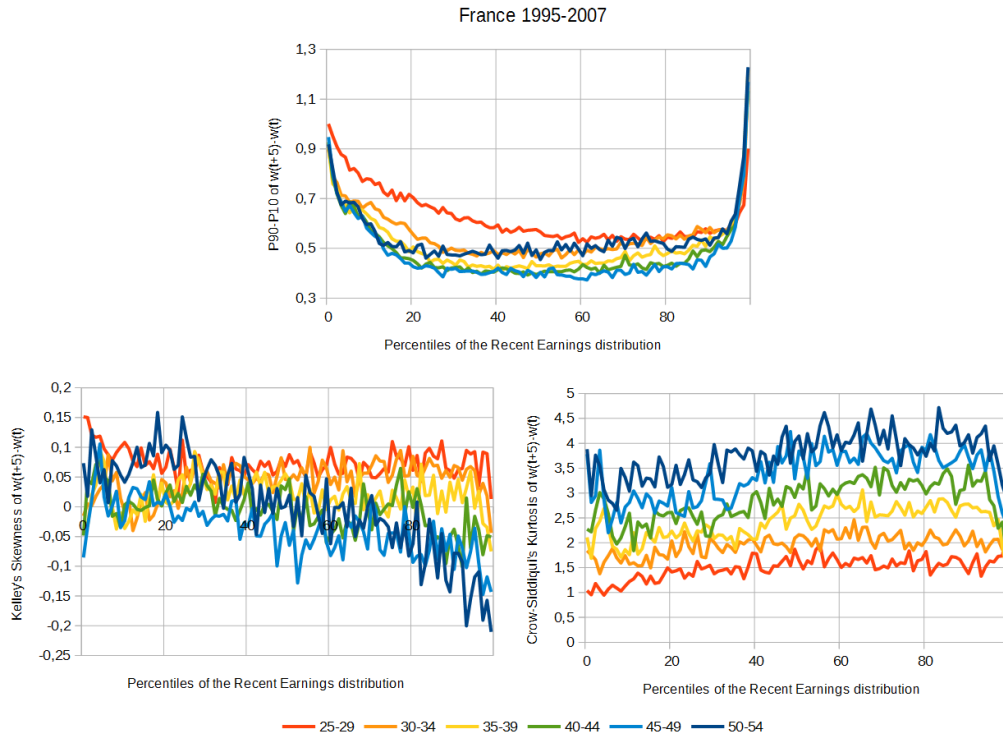




**Figure C.7** – Lifecycle profile for earnings, wage and working time (men in the private sector): censoring at  $\frac{1}{16}$  of the minimum wage



**Figure C.8** – 5-year earnings changes distribution (men in the private sector): censoring at  $\frac{1}{16}$  of the minimum wage



**Figure C.9** – 5-year wage changes distribution (men in the private sector): censoring at  $\frac{1}{16}$  of the minimum wage

### C.3 Winsorization

Consistent with [Guvenen et al. \(2015\)](#), we winsorize labor earnings at quantile of order 0.99999, in order to avoid problems with potential outliers. We may however omit this winsorization step. Figures C.10, C.11 and C.12 replicate the lifecycle profiles of earnings, wage and working time and the distribution of 5-year earnings changes of Figure 2, 3, 4, 5, 9, 10, 11 and 12 without winsorizing labor earnings. Overall the results are very similar, which indicates that our results are robust to our choice of winsorizing earnings at the level of quantile of order 0.99999.

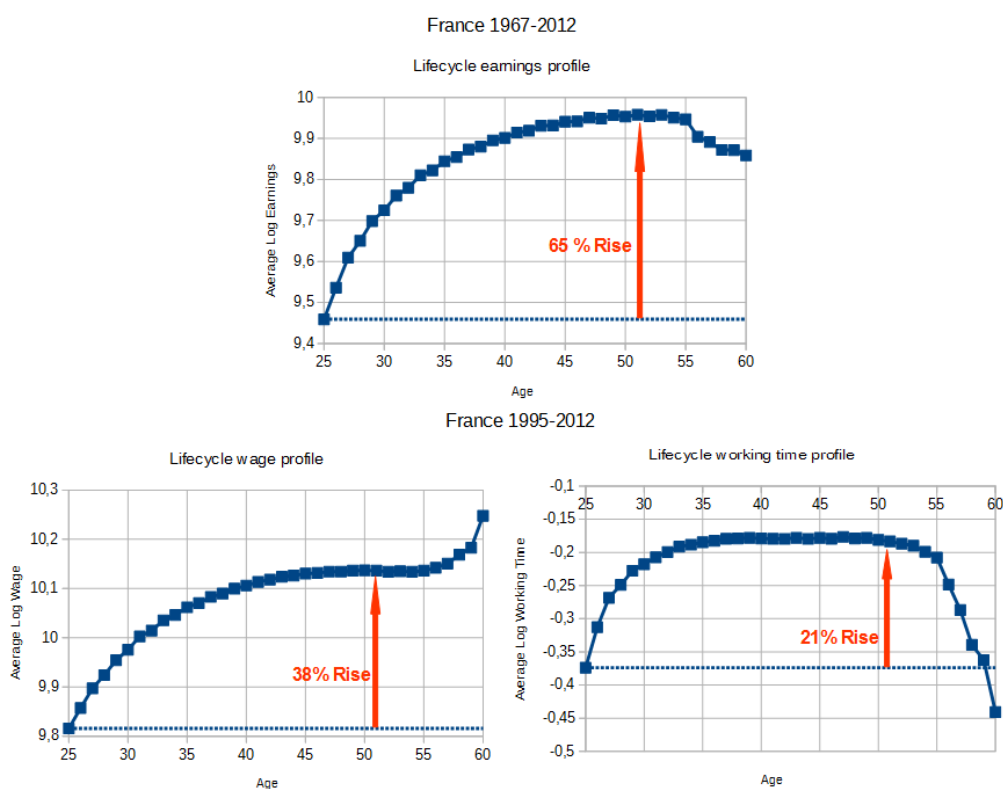
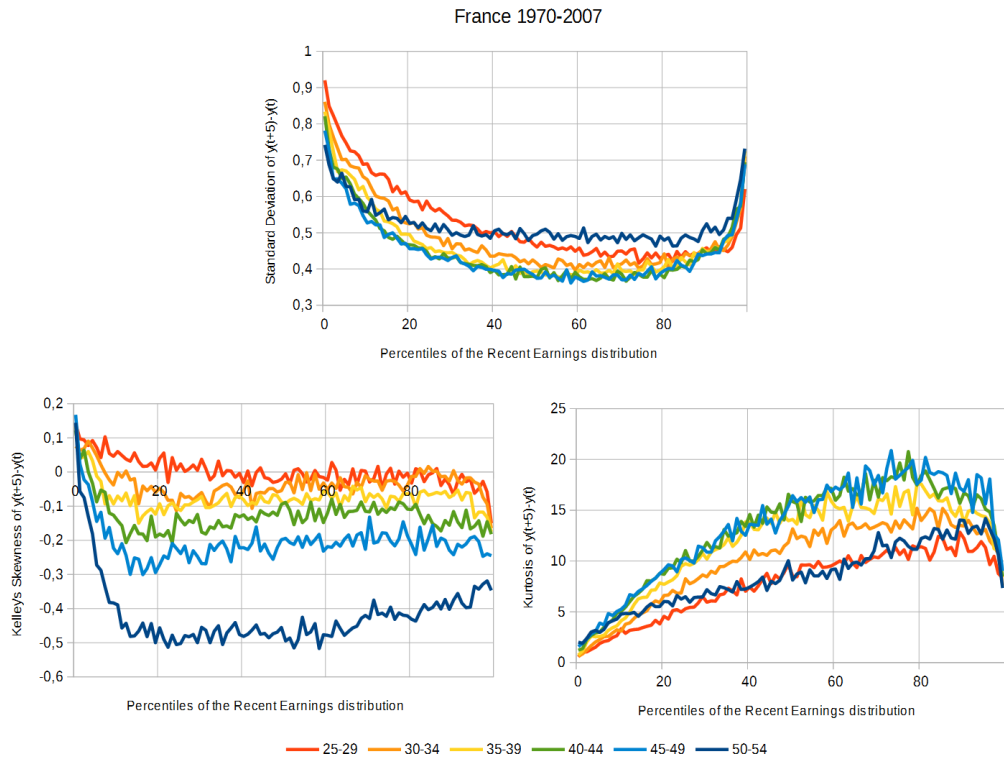
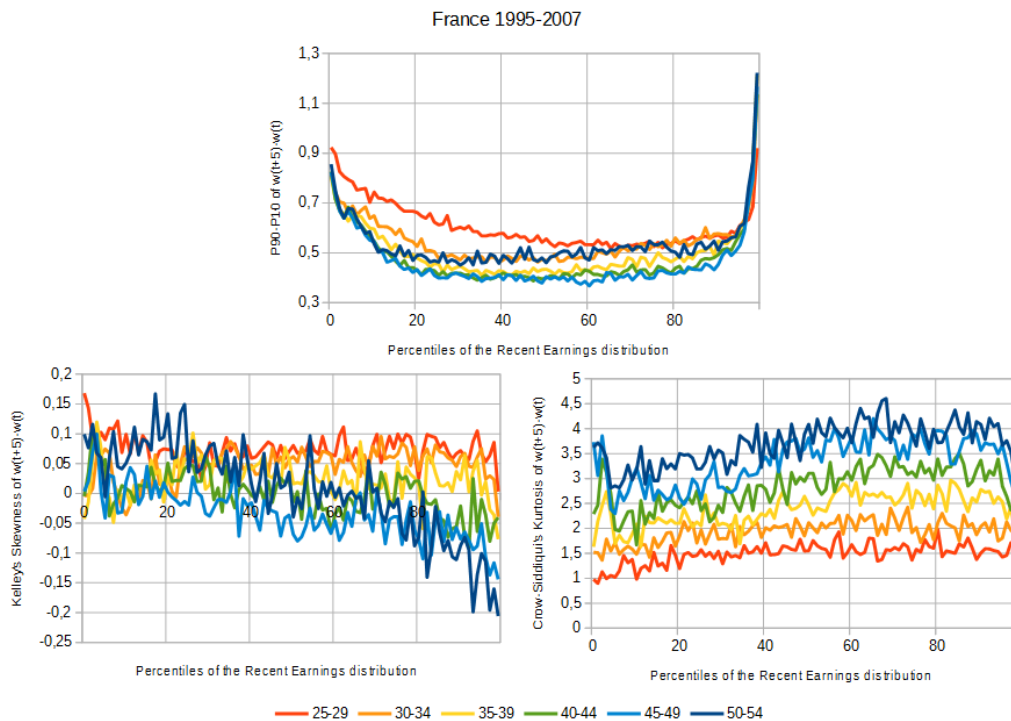


Figure C.10 – 5-year earnings changes distribution: omitted winsorization



**Figure C.11** – 5-year earnings changes distribution: omitted winsorization



**Figure C.12** – 5-year earnings changes distribution: omitted winsorization

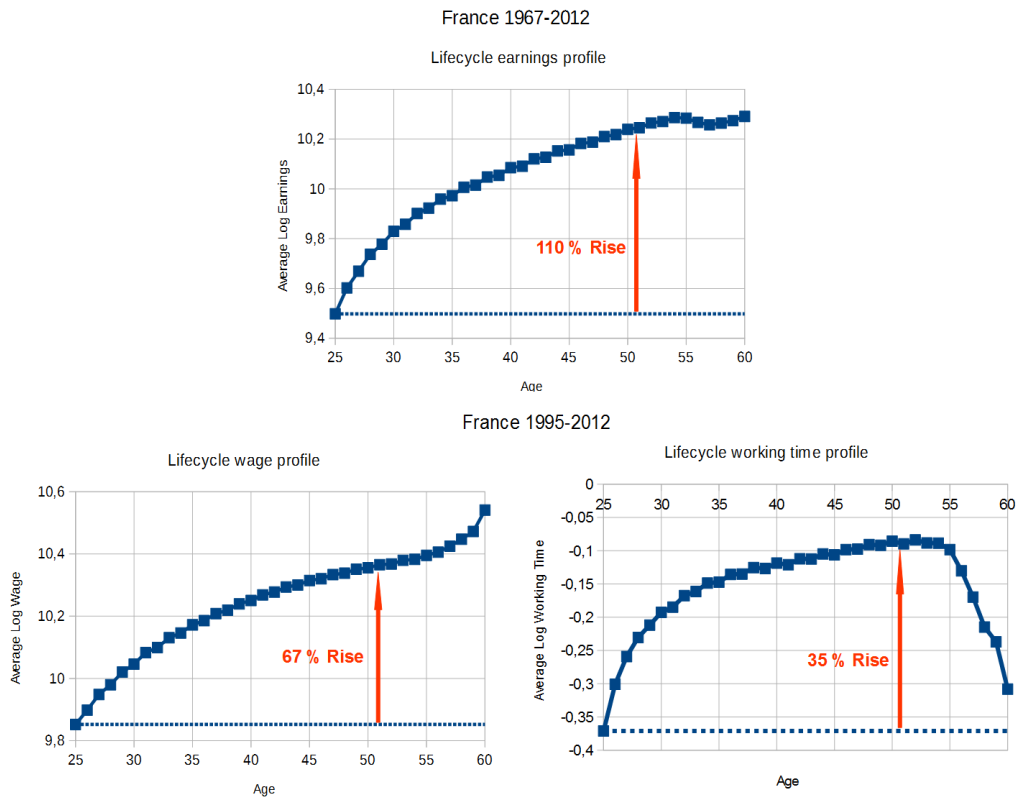
## C.4 Omission of year fixed effects

In order to deal with the age composition of our sample being biased (because our sample only includes even-year born individuals), we included year fixed effects when estimating the average lifecycle profiles of earnings, wage and working time. [Guvenen et al. \(2016\)](#) do not do so.

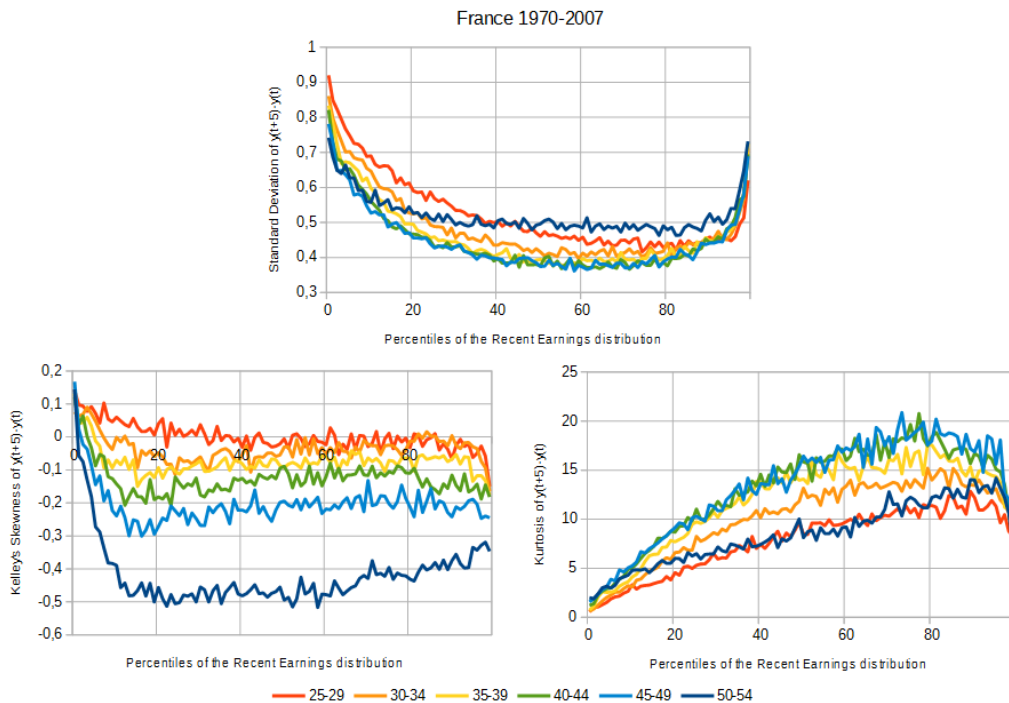
Figures [C.13](#), [C.14](#), [C.15](#), [C.16](#), [C.17](#), [C.18](#) replicate the lifecycle profiles, the distribution of 5-year earnings and wage changes, the (partial) impulse response functions of earnings, wage and working time of Figure [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [9](#), [10](#), [11](#), [12](#), [15](#) and [16](#).

The omission of year fixed effects results in a dramatic change in the lifecycle profiles. The increase in average earnings between age 25 and age 51 is 110%, much closer to what [Guvenen et al. \(2015\)](#) estimate in the US (127%), whereas it is only 64% when they are included. The same is true of the average lifecycle profiles of wage and working time: the average rise in wages between age 25 and 51 is 67% (against 35% when year fixed effects are included) and the average rise in working time is 35% (against 21%). Hence omitting year fixed effects leads to biased estimates of the average lifecycle profiles because it includes the effect of the changing age composition of the sample between 1967 and 2012.

However, this change in average lifecycle profiles changes very little our results when it comes to labor earnings risk and dynamics. Indeed our results regarding the distribution of 5-year changes in earnings and wage, and the impulse response of earnings, wage and working time are very similar to those we present in the paper. Hence our results are not driven by the inclusion of year dummies in the estimation of the average age trend in earnings, wage and working time.



**Figure C.13** – Lifecycle profile for earnings, wage and working time (men in the private sector): omitted year fixed effects



**Figure C.14** – 5-year earnings changes distribution (men in the private sector): omitted year fixed effects

France 1970-2002

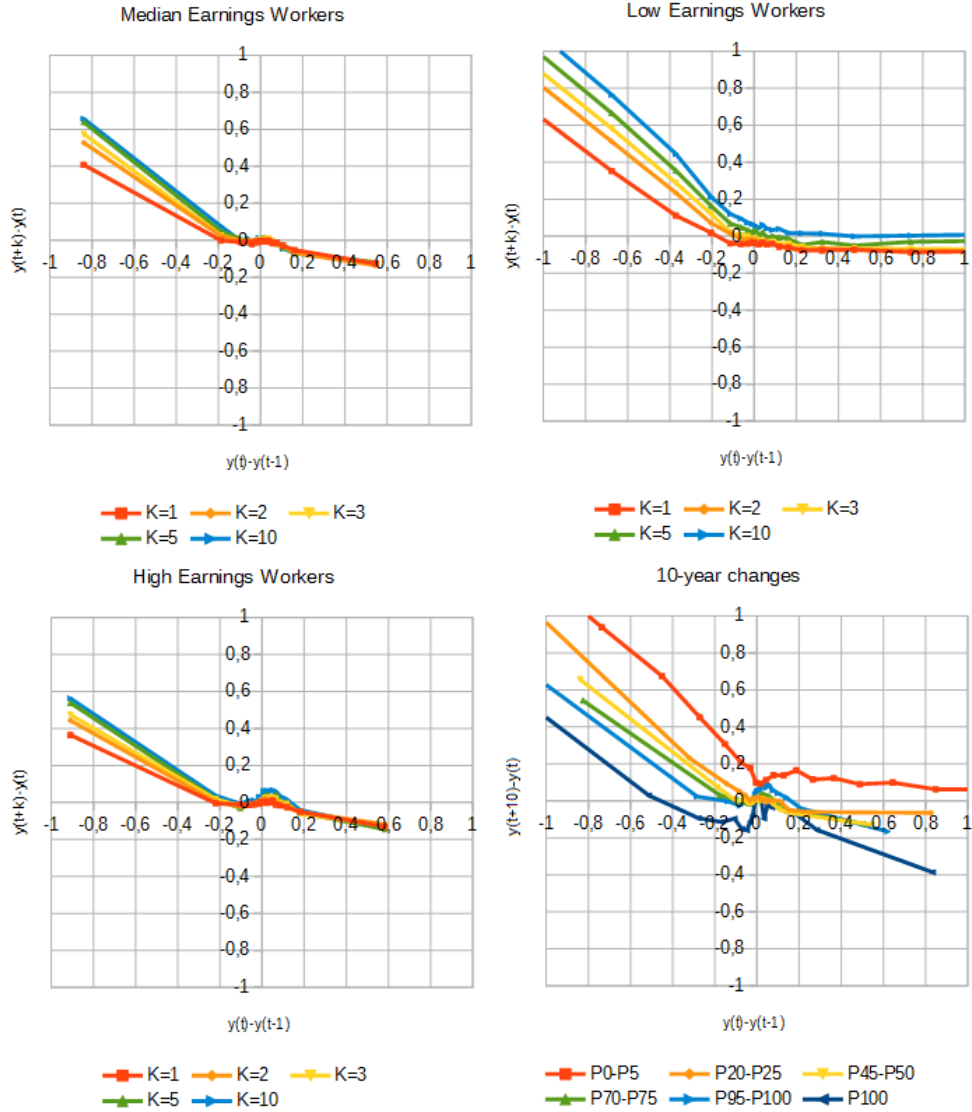
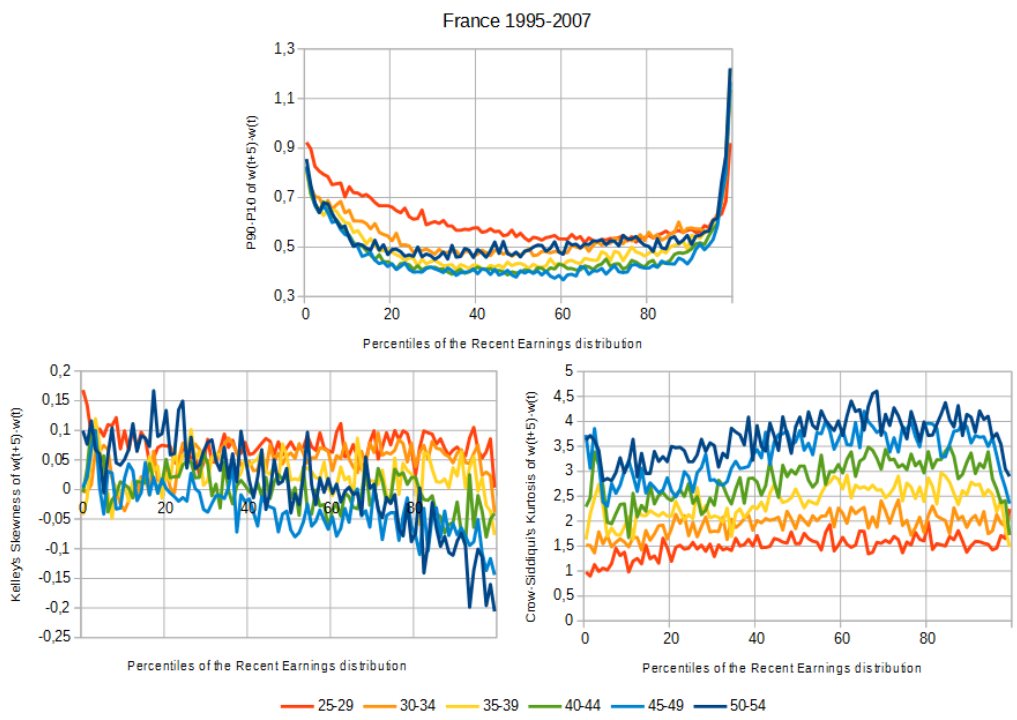
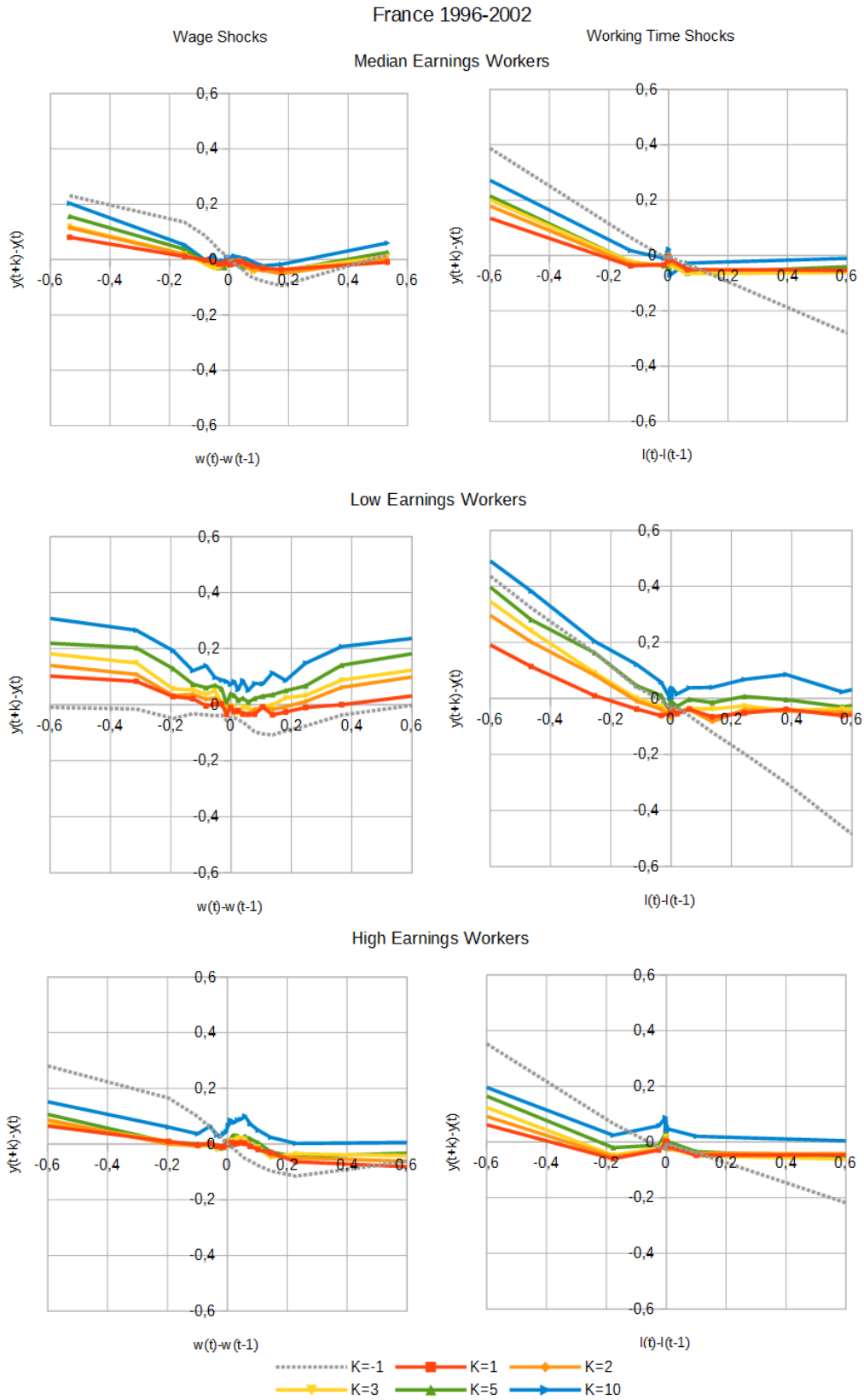


Figure C.15 – Impulse response function of earnings (men in the private sector): omitted year fixed effects

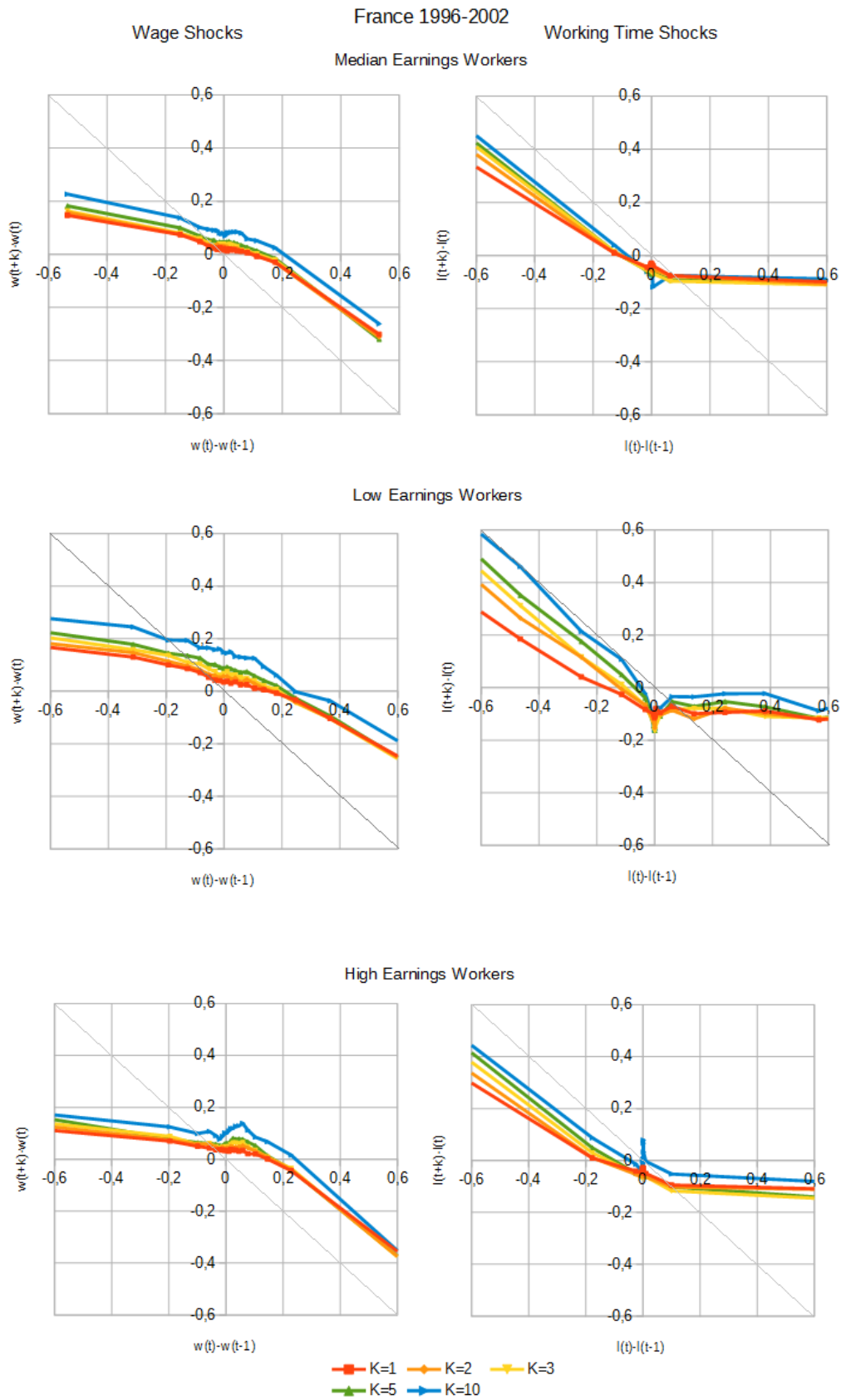


**Figure C.16** – 5-year wage changes distribution (men in the private sector): omitted year fixed effects





**Figure C.17** – Partial impulse response function of earnings to wage and working time shocks (men in the private sector): omitted year fixed effects



**Figure C.18** – Impulse response function of wage and working time shocks (men in the private sector): omitted year fixed effects

## C.5 Choice of working time and wage measure

As of year 1995, our data includes a measure of paid hours, thus allowing the computation of hourly wage and working time individual variations. However, as we stated in subsection C.5, we prefer not to use this direct measure of working time, and rather rely on a working time expressed in full-time equivalent (see Appendix A for more details). In order to make sure that our results are robust to this particular choice of working time measure, we replicate most of our findings regarding wage and working time risks and dynamics with the more classical measurement.

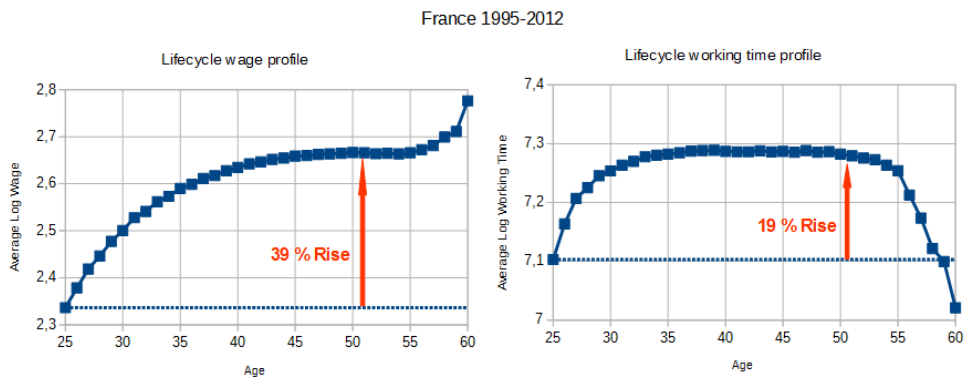
First, in Figure C.19 we replicate the lifecycle wage and working time profiles of Figure 9. The profiles are very similar to those based on FTE, even though the rise in wage between age 25 and age 51 is slightly more pronounced and the rise in working time slightly less so.

Figure C.20, we plot P90-P10, Kelley's measure of skewness and Crow-Siddiqui's measure of Kurtosis 5-year wage changes, similar as Figure 10, 11 and 12, but with hourly wages instead of FTE wages. As far as the cross-sectional distribution of wage changes is concerned, both measurement bear the same implications: wage risk is higher for very high earnings workers than it is for lower earnings workers, the asymmetry is limited, slightly positive at the bottom of the recent earnings distribution and slightly negative for high earnings older workers, the heaviness of the tails is smaller than it is for earnings changes and does not vary much along the earnings distribution.

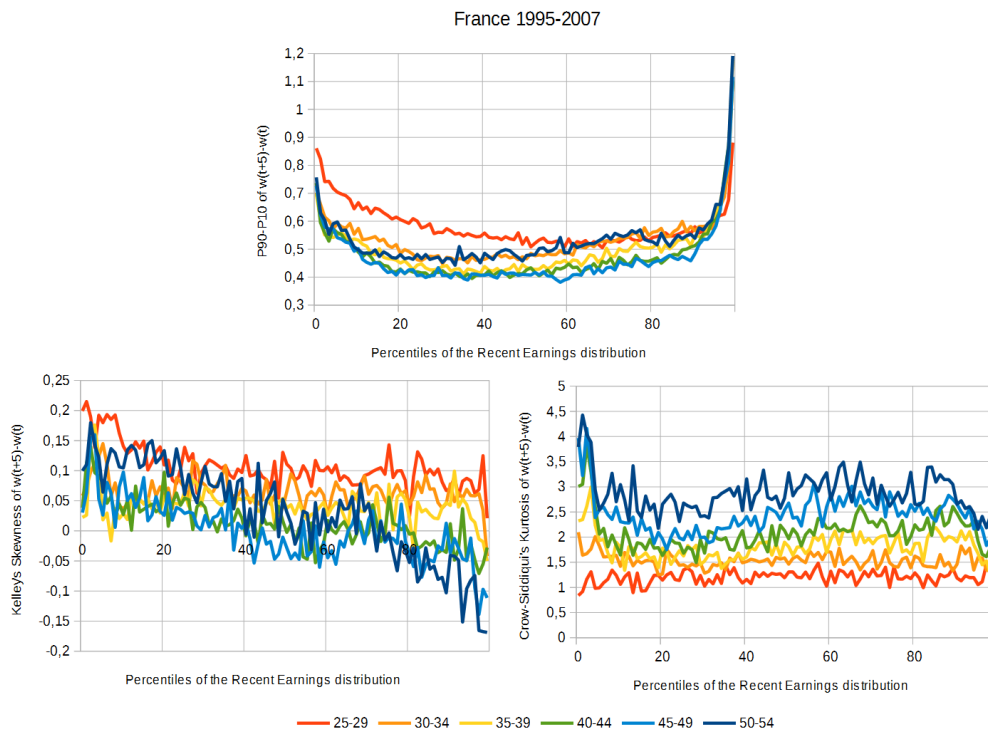
There are however a few differences: when relying on paid hours, upward asymmetry is slightly more pronounced for low earnings younger workers, and the heaviness of the tails is higher than it is when relying on our preferred measure of working time.

Figure C.21 replicates Figure 13, using working time measured in paid hours rather than our preferred measurement. Overall, our findings are the same: large labor earnings shocks are explained to quite a very large extent by large working time shocks, even though less so for very high earnings workers; wage changes mostly contribute to small labor earnings shocks, and the share of labor earnings changes explained by individual wage variations increases as rank in the recent earnings distribution increases.

Figure C.22 replicates the partial impulse response function of earnings to wage



**Figure C.19** – Lifecycle wage and working time profiles (men in the private sector): working time measured in worked hours



**Figure C.20** – 5-year wage changes distribution (men in the private sector): working time measured in paid hours

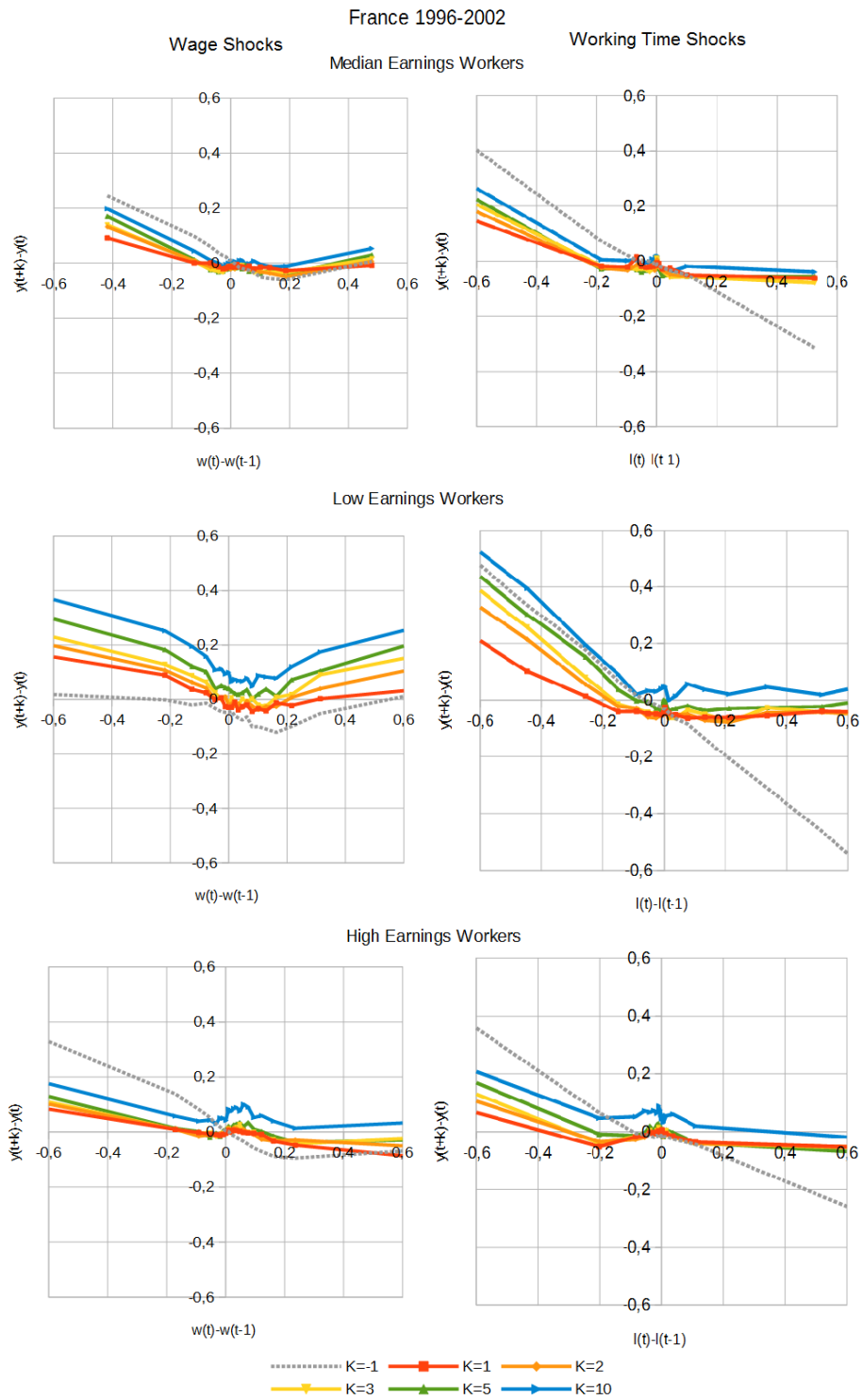


**Figure C.21** – Average labor earnings, wage and working time shocks, prime-age workers (men in the private sector): working time measured in paid hours

and working time shocks of Figure 15. Our results are very similar to those we computed using FTE wage and FTE working time.

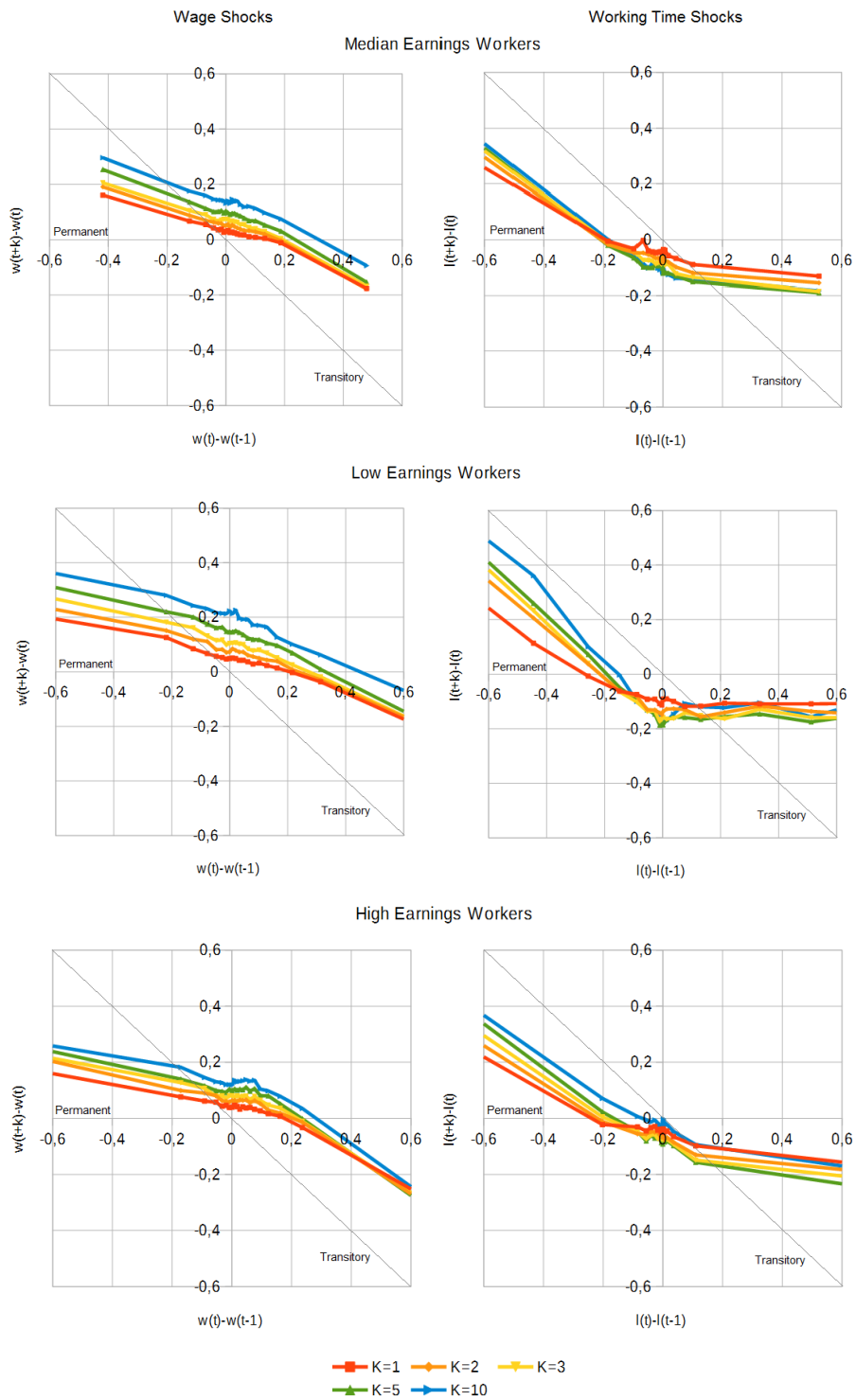
Figure C.23 attempts at replicating the impulse response function to wage and working time shocks that is displayed at Figure 16. Even though the patterns are quite similar – large positive (resp. negative) working time shocks are rather persistent (resp. transitory), and the reverse holds for wage shocks, and heterogeneity across the earnings distribution turns out to be limited – there are nevertheless a few differences. Note for instance that non-linearities in wage dynamics are more limited than they were with our privileged measure of working time: while large negative wage shocks are not much more persistent than large positive wage shocks, the difference was more important at Figure 16, especially among low and median earnings workers. However our most important results appear to keep their validity when changing our working time measure. Moreover, Figure C.24, that replicates Figure 17 confirms that our statement about how limited heterogeneity in wage and working time dynamics can be still holds when using the classical measure of working time in paid hours.

Finally, Figure C.25 displays working time responses to wage shocks, similar as Figure 18, this time with working time measured in paid hours. It substantiates

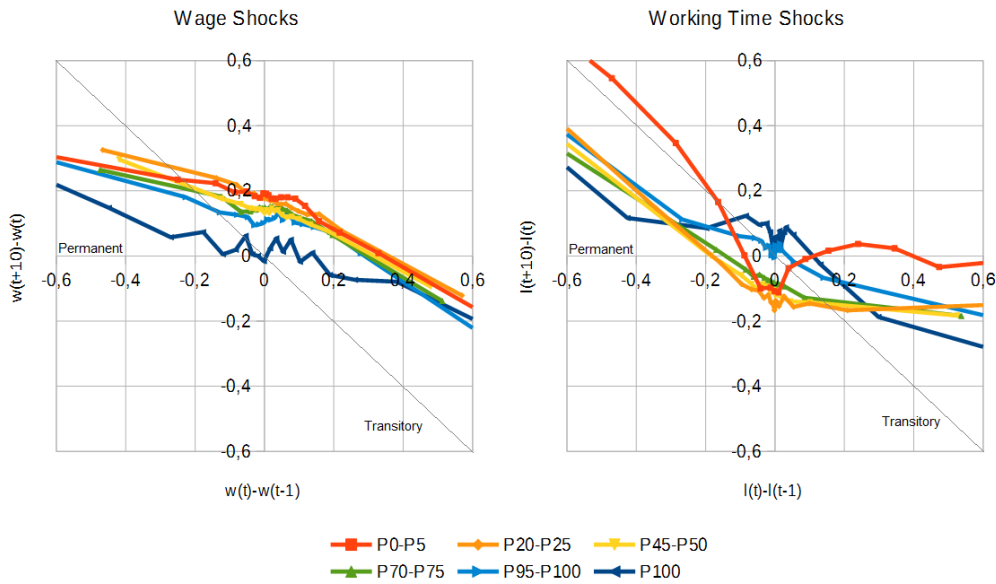


**Figure C.22** – Partial impulse response function of wage and working time shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector): working time measured in paid hours

France 1996-2002



**Figure C.23** – Impulse response function of wage and working time shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector): working time measured in paid hours



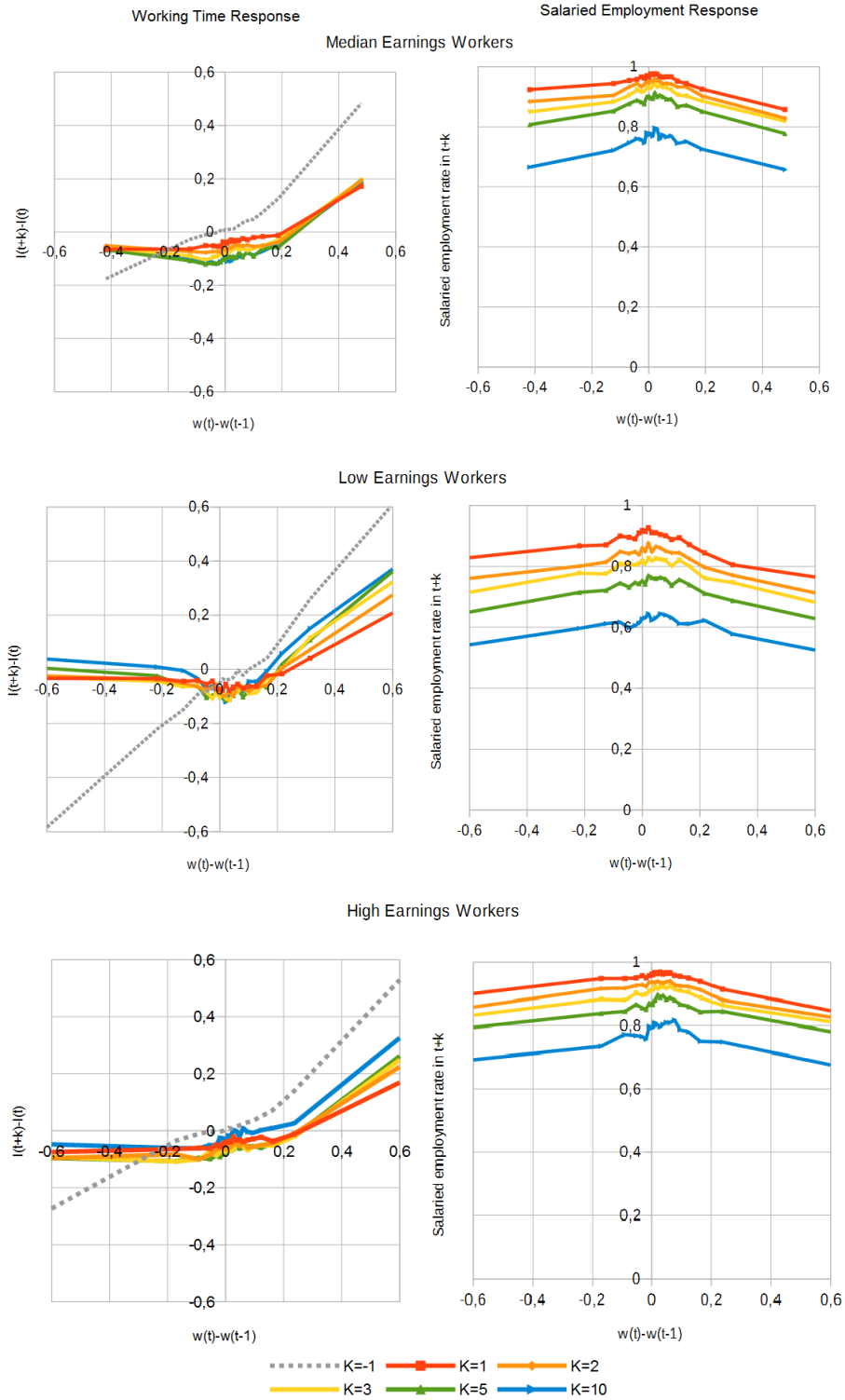
**Figure C.24** – Impulse response function of wage and working time shocks for prime-age workers and at a 10-year horizon (men in the private sector): working time measured in paid hours

our claim that large negative (resp. positive) wage shocks tend to come along with large positive (resp. negative) working time changes that are quite persistent (resp. transitory) over the time, regardless of the position in the distribution of recent earnings. Hence our results regarding the dynamic of the correlation between wage and working time changes proves robust to the choice of different working time and wage measurement.

Why then do we privilege our measure of working time in FTE over the more classical choice working time measured in paid hours ? Firstly, because our data allows paid hours to be equal to 0 for some specific occupations. This makes working time changes and hourly wage changes impossible to compute for some individuals. Plus, the share of individuals for which this is the case is not constant, neither across ages, nor along the recent earnings distribution, resulting in potential bias. Figure C.26 plots the share of workers for which 5-year hourly wage changes are missing, among those for which our measure of working time is available. Even though this share is limited, it is not necessarily negligible when we focus on rare shocks, especially when dealing with the heaviness of the tails of the distribution of wage shocks.



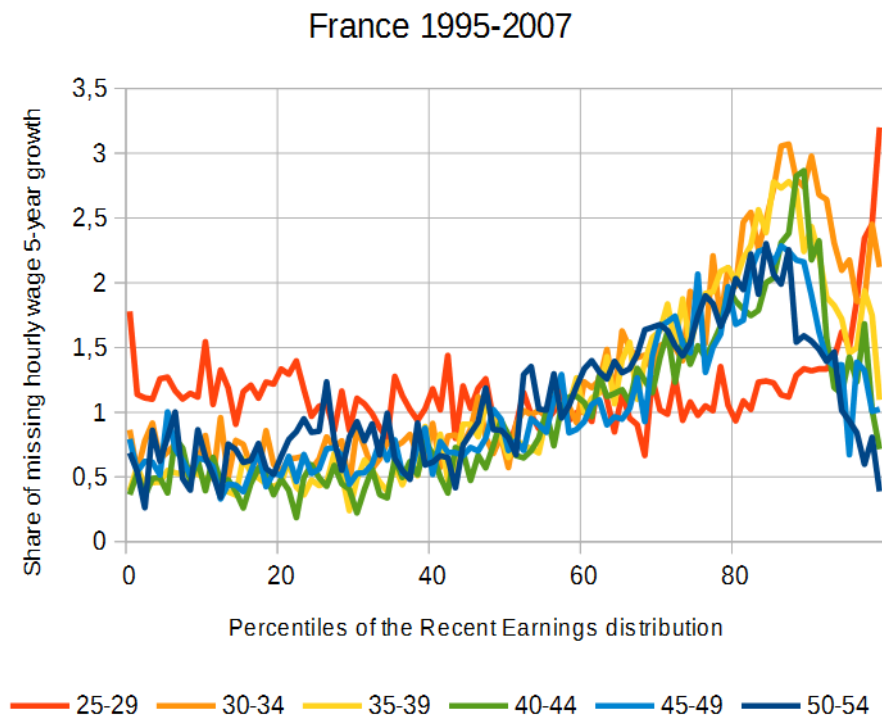
France 1996-2002



**Figure C.25** – Working time response and probability of salaried employment by past wage shocks for prime-age workers for Median ( $Y_{it} \in [P45 - P50]$ ), Low ( $Y_{it} \in [P5 - P10]$ ) and High ( $Y_{it} \in [P90 - P95]$ ) Recent Earnings (men in the private sector): working time measured in paid hours

Secondly, the way our data deals with this issue is not constant over the time period we study. Before 2001, paid hours could be systematically put to 0 for occupations for which 0 paid hours were authorized, whereas as of year 2002, this is only the case for jobs for which the employer declared the number of paid hours to be equal to 0. Figure C.27 displays the share of observations with missing paid hours for each year in our base sample of men working in the private sector.

Finally, our working time measure allows us to workaround the change in legal work duration that occurred in France at the beginning of the 2000s. Since this change did not occur at the same date in all firms, it may result in bias in the estimation of paid hours and hourly wage dynamics. Reversely, with our preferred measure the cross-sectional distribution of working time is more stable around the change in the legal duration of work, as can be seen at Figure C.28.



**Figure C.26** – Share of Missing 5-year Hourly Wage Shocks (men in the private sector)

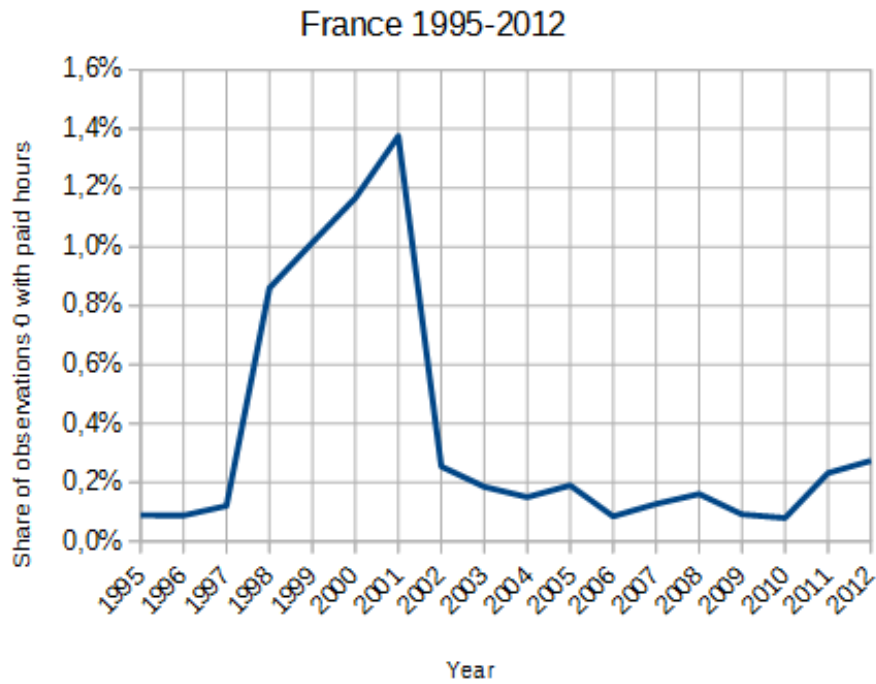


Figure C.27 – Cross-sectional Share of Missing Paid Hours (men in the private sector)

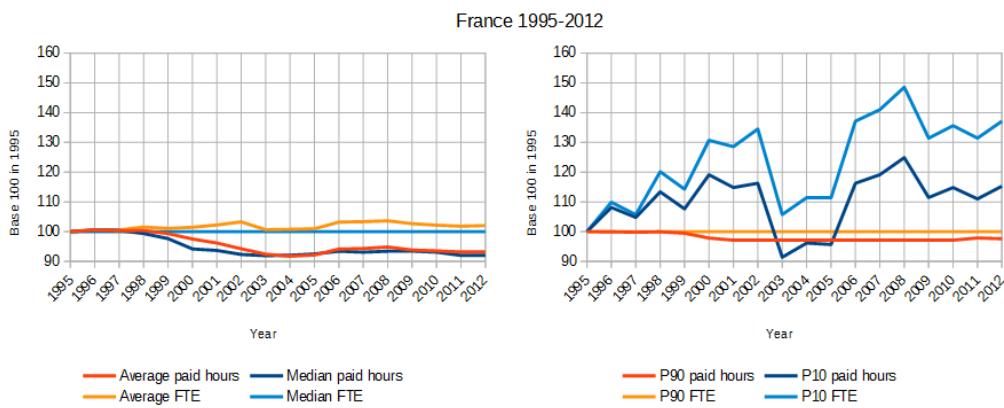


Figure C.28 – Cross-sectional distribution of working time (men in the private sector)

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