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Mobility During Deep Recessions**

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# **Wage Dynamics and Workers' Mobility During Deep Recessions**

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## Abstract

Wage rigidity generates higher unemployment volatility in matching models. By comparing the wage dynamics and workers' mobility during the period 2004-11 in Spain and Latvia we provide empirical evidence to this effect. We find that wages in Spain were rigid even during periods of rising and high unemployment. In contrast, Latvian wages were reduced by about 10 percent and wage cuts affected 60 percent of jobs. At the same time, the elasticity of finding and separation rates to productivity shocks was four times higher in Spain than in Latvia, and these responses were more persistent in Spain. We use finding and separation conditions from a matching model to show that these empirical results are in line with what a model would predict. We also emphasize that separations are very responsive to shocks, more so in a rigid-wage economy, a fact that has not been highlighted in theoretical literature.

# Introduction

Wage rigidity tends to amplify any shock to the labor market. In a recession, a fall in real wages ameliorates the decline in employment, whereas if wages were to be rigid, any transitory shock would lead to a persistent decline in employment, capital and consumption, thereby generating a jobless recovery (Shimer 2012b). The importance of wage rigidity is even more apparent in countries with fixed exchange rate arrangements. With fixed nominal exchange rates, any negative external shock that requires a decrease in the relative price of non-tradables necessitates a cut in prices and wages. In such a situation the real depreciation will only take place slowly, causing high unemployment (Schmitt-Grohe and Uribe 2011). The conclusion is the same with frictions in the labor market. If wages are fixed in a recession, there are fewer incentives for firms to create jobs, and wage rigidity is associated with unemployment volatility (Hall 2005). The lack of flexible wages leads to a decrease in the number of workers and an adjustment that is unevenly distributed among them.

Given its importance from many points of view and its widespread presence in different economies, wage rigidity has been extensively analyzed, both theoretically and empirically. Theoretically, the effect of wage rigidity over labor markets has been identified using frictional labor market models. The empirical literature, on the other hand, has measured the incidence of wage rigidity in different ways, mainly focusing on the distribution of wage changes in the same job to show that there are a few wage cuts. However, the effects of wage rigidity on labor market performance and unemployment volatility are difficult to identify empirically.

Ideally, these effects would be identified empirically through an experiment that compares two sets of ex-ante identical

economies — one with flexible wages and the other imposing a rigid wage structure — under a common shock. Even though this experiment is not available to us, our intention is to analyze two countries that experienced a related cyclical shock.

In this paper we analyze the effects of wage rigidity both on labor market dynamics and on unemployment volatility by comparing two economies with very different wage settings. We study Latvia (2004-12) and Spain (2004-11). Both countries experienced a similar boom, fuelled by the real estate sector, and both were hit by the global financial crisis at the end of 2007. Both saw a sharp rise in unemployment at the beginning of the recession. Among the many differences between the two countries, a crucial one at the time was that real wages in Spain were far from flexible, while wages in Latvia went down by about 10 percent.

Many conditions make this comparison between Spain and Latvia particularly relevant. First, both countries have detailed administrative data, which we use to construct different measures of wage rigidity and workers' mobility. Second, both countries were affected by a strong recession during which unemployment rose by more than 10 percentage points in two years. This major shock helps us identify the differences between the two economies with regard to wage dynamics and workers' mobility. Third, both countries were unable to deal with the shock by nominal devaluation. Spain was an EMU member, without any control of the exchange rate of the euro. Latvia pegged the lat to the euro because of its commitment to become an EMU member. This common restriction places even more weight on wage adjustment; given that nominal devaluation was not possible, nominal wage rigidity was more costly.

Relying on detailed social security panels of both countries we compare pre and post-

recession wages and workers' transitions. In particular, we first analyze the distribution of annual wage changes among workers staying in the same job (henceforth referred to as "stayers") to provide evidence of the incidence of wage rigidity. Additionally, we study the evolution of wages among different workers based on their transitions, including those who change jobs. Particularly interesting is the evolution of wages among new hires, because job creation depends on the labor cost of these contracts. Finally, we report workers' transition rates by computing finding and separation rates, and analyze the volatility of these during the cycle.

We find that in Spain wages tend to be very rigid, increasing in nominal terms by about 3 percent annually even with unemployment reaching 20 percent; the reduction in wages of new hires is small. Meanwhile, in Latvia wages are adjusted more robustly, with wage cuts affecting 60 percent of stayers and nominal wages being reduced by about 6 percent. Thus, wage dynamics can be characterized as very rigid in Spain, and flexible in Latvia. This observation applies to the aggregate mean wages, as well as to the wages for both stayers and new hires.

Besides wage dynamics, we also focus on workers' flows into and out of unemployment. The finding rate decreased and separation rate increased in both countries. Moreover, the change in these transition rates was much more persistent in Spain than in Latvia. In fact, after the adjustment in wages, transition rates were back to the pre-crisis level and employment growth was restored in Latvia by 2010, whereas Spain suffered a longer period of net job destruction. Additionally, measured by GDP, productivity and changes in interest rate, the shocks in Spain were of much lower intensity than in Latvia, implying that the elasticity of transition rates and

unemployment vis-à-vis shocks was much higher in Spain.

Finally, we show that during the crisis, the changes in separation rates account for about half of the changes in unemployment in both economies. This observation contrasts with the evidence from "normal" times during which changes in separation rates explain only about one-third of the changes in unemployment (Shimer 2012a). Importantly, the changes in separation rates also seem to be different when wages are rigid, with productivity shocks impacting these changes to a greater extent.

To explore the connection between wage rigidity and workers' flows in a more structured way we use a matching model with endogenous separation (Mortensen and Pissarides 1994). We use job creation and job destruction conditions to analyze the predictions of the model. When considering the observed changes in productivity and interest rates — along with the endogenous change in wages — we find that the observed changes in finding and separation rates are of the same order of magnitude as the predictions of the model.

On the whole, we find that in a rigid-wage economy, the volatility of unemployment is much higher — a conclusion in line with the theoretical literature (Shimer 2005; Hall 2005). The observation that the effects of shocks tend to be more persistent under rigid wages is also in line with Shimer (2011). In this sense, our study can be considered as an empirical counterpart of the search models that analyze the unemployment volatility under rigid and flexible wages.

This paper relates to the extensive empirical literature that analyzes the incidence of wage rigidities. The main observation is that, while the distribution of productivity changes at firms' level can be satisfactorily reproduced

with any continuous distribution — such as normal or log normal — wage changes within jobs cannot. Using longitudinal data of workers in the same jobs, the literature has found that wage change distribution usually has a discrete jump at zero (wage freezes are disproportionately frequent), and there is a discontinuous reduction in the mass at negative changes, among other characteristics. This evidence of resistance to wage cuts leads us to the conclusion that wage rigidity is prevalent both in nominal and real terms, and both in developed and developing countries.<sup>1</sup> Based on this literature, we conclude that Latvia seems to be an exception to this rule: here, wages suffered a generalized reduction during the recession.

Our paper also draws from the theoretical literature that focuses on the importance of wage rigidity to explain unemployment volatility. The search and matching model of the labor market is the typical framework to analyze this link. It has been found that the cyclical volatility of unemployment is about 20 times higher in the data than in the canonical matching model under the standard assumption of flexible wages. Contrary to this, under rigid wages, the predicted unemployment volatility can be close to that which is observed (Shimer 2005; Hall 2005). In this model, finding rate is what drives unemployment changes: wage rigidity reduces (or increases) the incentives to open vacancies during recessions (or expansions).

The theoretical mechanism has restricted its attention to the job creation process. For that reason, the relevant evidence with regard to

1. Much of the empirical literature concentrates in European countries (including Barwell and Schweitzer (2007) and Smith (2000) for Britain; Devicienti, Maida, and Sestito (2007) for Italy; Holden (1998) for Nordic countries, among others). There is less evidence of this with regard to developing countries. Examples include Castellanos, Garcia-Verdu, and Kaplan (2004) for Mexico; Messina and Sanz-de Galdeano (2011) for Uruguay and Brazil.

the wage dynamics is the one of new jobs, rather than incumbents, as Pissarides (2009) emphasizes. This observation prompted new empirical research on the cyclicity of wages of new hires (e.g. Haefke, Sonntag, and van Rens (2013) and Roca (2014)).

The effect of wage rigidity on separations is much less analyzed. Some papers have introduced wage rigidity in models with endogenous separations, but its effect is indirect in these papers. The more direct effect of wage rigidity — the fact that wages could be set too high during recessions so that some jobs are destroyed — is not to be found in this literature, the reason being that rational employers and employees could agree to renegotiate wages so that the job is not lost under the circumstances.

We use the same matching model as in this literature. Nevertheless, we depart from the literature by allowing for the potential impact of wage rigidity on separations. In particular, we feel that if wages do not fall during recessions, some jobs could be rendered unprofitable from the point of view of the firm. The joint rationality argument in the literature has discarded this model of inefficient job destruction. We, however, believe that labor market institutions can prevent individual attempts to reduce wages. For example, laws can forbid one to freely reduce wages, or unions could be in a position to restrain any wage adjustment. Informational issues too could restrict the bargaining of wage cuts, as in MacLeod and Malcomson (1995).

The rest of this paper is organized as follows: Section 2 provides a theoretical framework on wage rigidity and unemployment volatility. Section 3 describes the economic context in both countries. Section 4 presents the data and methodology. Section 5 discusses our results, and Section 6 concludes the study.

# Framework

This section analyzes the link between unemployment volatility and wage rigidity using a matching model. Here, we will derive simple and intuitive formulas from a formal and complete model. In that sense, the analysis does not rest on any particular structure or calibration of the model. On the contrary, the aim of this section is to draw attention to the economic mechanism that links workers' flows and wage dynamics, rather than to solve and simulate a completely calibrated model. This type of analysis is closely related to that of Pissarides (2009).

Departing from the typical use of the canonical matching model in several ways, we first consider that jobs begin in a type of contract that is then changed at a constant probability. We do this to separate any possible differences in wages between newly created and incumbent jobs. Second, we consider the fact that wages can be set exogenously and that they can be enforced. Third, we let the firms decide about layoffs, unilaterally, so that separations are not always mutually agreed upon between the firm and the worker. In other words, some jobs could be destroyed because wages do not fall, only because workers and firms cannot agree to change them. Fourth, we consider productivity and interest rate shocks.

Introducing endogenous separation seems important for several reasons. First, while the separation rate is typically less volatile, we suspect that it may matter more during the time of crisis. Thus, separation is crucial to understanding unemployment volatility. Second, the cyclical change in separation suggests that job destruction is endogenously determined. In fact, separations are not a random draw, as is

the case with an exogenous common rate. On the contrary, in a recession the jobs that are typically destroyed are those with lower productivity, generally concentrated in some firms and industries.

Endogenous separation has been typically thought of as idiosyncratic shocks that make a job less productive. A job with productivity lower than the reservation productivity level will be destroyed. Whenever the reservation productivity is an outside option, endogenous separations in that case are efficient; separation occurs only in those matches where the value of maintaining the job is lower than the value of breaking the match. In such a case, both firm and worker agree that it would be better to terminate the job. Nevertheless, in surveys as well as in aggregate statistics it is standard practice to make a difference between resignations (separations decided by the worker) and layoffs (separations decided by the firm). Additionally, workers typically find layoffs to be losses of welfare (they would be better off keeping their jobs), suggesting that the value of a match could be higher than the outside option for the worker.

For these reasons, we consider the possibility of inefficient endogenous separations. In particular, we feel that wages can be set too high outside the firm and we will assume that they cannot be renegotiated by the firm and the worker.

## Unemployment and transition rates

Before describing the model we show how a steady state unemployment rate depends on the finding and separation rates. In the process, we will provide a simple decomposition for the relevance of these rates to changes in unemployment.

Let  $u_t$  be the unemployment rate in a period. The evolution of unemployment is determined by two relevant flows: the flow into unemployment,  $\delta_t$ , which is the average probability that an employed worker loses the job and ends up in unemployment; and the flow out of unemployment,  $f_t$ , which is the average probability of an unemployed worker finding a job. The change in unemployment rate depends on these two rates in the following way:  $u_{t+1} - u_t = (1 - u_t) \delta_t - u_t f_t$ . Using this formula, it is quite easy to show that constant transition rates imply

$$u = \frac{\delta}{\delta + f}, \quad (1)$$

which is the steady state unemployment rate formula. Even if these rates change in time but remain relatively stable, the same formula can be used to approximate the unemployment rate (Pissarides 2009; Shimer 2012a).

Then, to understand changes in the unemployment rate it is crucial to consider the changes in these two rates. To be more explicit, proportional changes in unemployment depend on proportional changes in these two rates:

$$d \ln u = (1 - u) (d \ln \delta - d \ln f) \quad (2)$$

This equation provides a simple decomposition formula to explain a change in unemployment rate. It shows that to understand unemployment volatility, it is important to study how finding and separation rates react to the shocks. We do this by deriving formulas for creation and destruction conditions using a model.

## Model

In the model, workers can be in two states: employed or unemployed. If unemployed, they receive an income flow  $z$ , as household production, and they search for a job. If employed, workers receive a wage

$w_t$ , to be determined depending on the characteristics of the job.

Firms create a vacancy, at a cost. A worker will meet this vacancy at a given probability. When filled, this job begins with a productivity level which is sufficiently high, so that all matches agree to create a job. Additionally, workers at these jobs are paid a wage  $w_n$  that is potentially different from wages paid to incumbent workers. There is a probability  $\gamma$  each period that a new job receives an idiosyncratic shock. After this shock the match receives a new idiosyncratic productivity,  $x$ , from a distribution with cdf  $G(x)$ . Additionally, after this shock the match changes its status to incumbent and wages are updated accordingly.

Importantly, the idiosyncratic productivity shock could be lower than a reservation productivity,  $R$ , in which case the value of the job is negative. In that case, the match is destroyed and the worker becomes unemployed. The value of the job for a firm is zero after the destruction of the match (i.e., there are no firing costs for the firm).

Incumbent jobs also face idiosyncratic shocks to productivity, by which, with probability  $\lambda$ , a new productivity is drawn from the distribution  $G(x)$ . Again, if productivity is lower than  $R$ , the match is destroyed. The reservation productivity is no different from the previous one.

Finally, there is an aggregate interest rate at which both workers and firms discount the future,  $r$ , and an aggregate productivity level,  $p$ , so that productivity in a job with idiosyncratic productivity  $x$  is  $px$ . As in Pissarides (2009) we will analyze steady states by changing  $p$ . Our recession would, thus, be a permanent drop of  $p$ . This procedure allows for simplified formulas, and is also justified by the fact that the

shock tends to be very persistent. We will also consider the effects of changes in interest rate,  $r$ .

In what follows, we first describe the technology that allows workers and vacancies to meet, and that incorporates the friction in this labor market. We then highlight the problems of firms and workers in this economy, and their decisions. Thereafter, we discuss two different wage settings: first, we consider Nash bargaining, as is usual in the literature of matching models, and second, an exogenous wage.

## Matching function

Vacancies,  $v$ , and unemployed workers,  $u$ , are met according to constant returns of scale matching function,  $m = m_0 u^\eta v^{1-\eta}$ , with  $m_0 > 0$  and  $\eta \in (0, 1)$ . We can also define labor market tightness as  $\theta = v/u$ . This means that the probability of filling a vacancy is  $q(\theta) = \theta^{-\eta}$ . Additionally, the probability of finding a job for an unemployed worker is  $f(\theta) = \theta^{1-\eta}$ .

## Value functions

The lifetime utility value of an unemployed worker,  $U$ , satisfies

$$rU = z + f(\theta) [W_N(p, x_N, w_N) - U]$$

where  $W_N$  is the value of being employed at a new job with aggregate productivity  $p$ , idiosyncratic productivity  $x_N$  and wages  $w_N$ . That value satisfies

$$rW_N(p, x_N, w_N) = w_N + \gamma [1 - G(R)] \mathbb{E} [W(p, x', w') - W_N(p, x, w) | x' \geq R] + \gamma G(R) [U - W_N(p, x, w)]$$

where  $R$  is an idiosyncratic productivity below which the match would be dissolved, and where the continuation value for an incumbent job with aggregate productivity  $x$ , idiosyncratic productivity  $x$ , and wage  $w$ ,  $W(p, x, w)$ , satisfies

$$rW(p, x, w) = w + \lambda [1 - G(R)] \mathbb{E} [W(p, x', w') - W(p, x, w) | x' \geq R] + \lambda G(R) [U - W(p, x, w)]$$

Wages  $w$  will be a function of  $p$  and  $x$  if there is Nash bargaining, or, alternatively, they are set exogenously. For that reason we still consider the three as state variables. From the point of view of a firm, the value of an existing job is defined by:

$$rJ(p, x, w) = px - w + \lambda [1 - G(R)] \mathbb{E} [J(p, x', w') - J(p, x, w) | x' \geq R] - \lambda G(R) J(p, x, w)$$

The value of a vacancy is:

$$rV = -c + q(\theta) [J_N(p, x_N, w_N) - V]$$

where  $c$  is the cost of an open vacancy and  $J_N$  is the value of a new job which is defined by:

$$rJ_N(p, x_N, w_N) = px_N - w_N + \gamma [1 - G(R)] \mathbb{E} [J(p, x', w') - J_N(p, x_N, w_N) | x' \geq R] - \gamma G(R) J(p, x_N, w_N)$$

where  $x_N$  and  $w_N$  are the initial idiosyncratic productivity and initial wage of a job.

$$\bar{J} = \mathbb{E} [J(p, x, w) | x \geq R] = \frac{p\bar{x} - \bar{w}}{r + \lambda G(R)}$$

In this model we can define  $\delta(R) = \lambda G(R)$  as the average probability of job destruction. In other words,  $\delta$  is the separation rate.

It is useful to define the expected value of a continuing job as:

where  $\bar{x}$  and  $\bar{w}$  are the mean values of idiosyncratic productivity and wages among continuing jobs.

## Wage determination

The kind of frictions that characterize this labor market generate a value for the match that has to be split between the firm and the worker. In other words, given the gap between home production,  $z$ , and the productivity of the match,  $px$ , the wage is undetermined. The canonical matching model (Mortensen and Pissarides 1994) uses a Nash bargaining rule to solve for wages and for the value of a job. In such a case, wages are:

$$w = (1 - \beta) z + \beta (px + c\theta)$$

where  $\beta$  is the bargaining power of workers. In this case,  $x$  and  $p$  are the only state variables.

Others have found a better description for rigid wages. Wages can be considered fixed in a given value. Typically it is assumed that this wage is consistent with efficient separations, that is, the wage level is never a reason for separation. The argument is that if the match has value, both firm and worker would find it convenient to renegotiate a new wage so that both can gain. In this way, wages can be thought of as "fixed and low".

In this paper we assume that wages are determined exogenously by an agent, such as unions or the government. We also assume that wages can be enforced and are not subject to negotiation. This means that labor cost could be too high: a firm will not be willing to hold on to the job and workers would be affected by the layoff, meaning that after separation they would be worse off than they were while in the job. In such a case, there would be job separations that are inefficient.

## Creation and destruction conditions

In this context, both finding and separation rates depend on wages. We show this relationship formally.

In equilibrium, firms would create vacancies until the value of an additional vacancy is exhausted, so that  $V = 0$  and

This is the job creation condition, which is also a condition for the finding rate, given that  $d \ln f = (1-\eta) d \ln \theta$ . When we consider

$$\frac{c}{q(\theta)} = c\theta^\eta = J(p, x_N, w_N) = \frac{1}{r + \gamma} [px_N - w_N + \gamma [1 - G(R)] \bar{J}] \quad (3)$$

exogenous changes in  $p$  and  $r$  and we differentiate equation (3), we get:

$$d \ln f = \frac{1 - \eta}{\eta} \left[ \Gamma_N \frac{d \ln p - \varrho_N d \ln w_N}{1 - \varrho_N} + (1 - \Gamma_N) d \ln \bar{J} - d \ln r \frac{r}{r + \gamma} \right] \quad (4)$$

where  $q_N \Xi \frac{w_N}{x_N}$  is a measure of the labor share, and  $(1 - \Gamma_N)$  is the share of the value of the short term effect and  $(1 - \Gamma_N)$  the proportion of the value of a new job explained by the continuation value. To derive the last equation we follow Pissarides (2009) in assuming that the continuation value is not affected by changes in  $R$ . The reason is that variable changes to make the value of the job are equal to zero.

Finally, the changes in continuation value are:

$$d \ln \bar{J} = \frac{d \ln p - \bar{\varrho} d \ln \bar{w}}{1 - \bar{\varrho}} - d \ln r \frac{r}{r + \delta} \quad (5)$$

where  $q_N \Xi \frac{w_N}{p x_N}$  is a measure of the expected labor share of the continuing jobs.

On the other hand, there is a reservation idiosyncratic productivity below which the match will be destroyed. To characterize the separations we first define that value as  $J(p_R, w_R) = 0$ , where  $w_R$  is the wage when  $x = R$ . Now use the value of a job to get the separation condition for incumbents:

$$\delta = \lambda G(R) = \lambda G \left( \frac{w_R}{p} - \lambda [1 - G(R)] \bar{J} \right) \quad (6)$$

We can also consider the proportional change in separation rate as depending on changes in short-run effects and on the continuation value effects. In particular:

$$d \ln \delta = H(R) [\Gamma_R (d \ln w_R - d \ln p) + (1 - \Gamma_R) d \ln \bar{J}] \quad (7)$$

where  $H(R) = R \frac{G'(R)}{G(R)}$ ,  $\Gamma_R = \frac{\frac{w_R}{p}}{\frac{w_R}{p} - \lambda [1 - G(R)] \bar{J}}$ , and  $(1 - \Gamma_R) = \frac{\lambda [1 - G(R)] \bar{J}}{\frac{w_R}{p} - \lambda [1 - G(R)] \bar{J}}$ .

Our analysis misses the separations that arise on impact. The change in productivity from  $p$  to  $p'$ , with  $p' < p$ , renders a proportion of jobs unprofitable. This proportion is the measure  $G(R) - G(R')$ . The above analysis does not include these separations.

Importantly, both finding and separation rates are determined by productivity, wages and continuation values. They depend on changes in wages in different ways. The finding rate depends on the wage of newly created jobs, while the separation rate is determined by the wages paid at the reservation productivity. Finally, both rates depend on changes in incumbent wages.

## The economic mechanisms

The aim of this section is to simplify the framework to show the crucial mechanisms at work that can relate unemployment volatility to wage rigidity. The literature has emphasized the importance of wage cyclicality of new hirings to determine job creation volatility. This is what equation (3) shows, along with the importance of the changes in continuation values. Departing from the literature, we also emphasize the effect of the incumbent wages on separation rate. Equation (6) specifies that if wages around the reservation productivity do not fall with aggregate productivity, then separations would be affected by wage rigidity. This analysis justifies our focus on analyzing the cyclicality and wage rigidity of both new hirings and incumbent jobs.

# Recent boom and bust in Spain and Latvia

In this section we provide some context for the countries analyzed. Our focus is on the years 2004 to 2011, with emphasis on certain similarities that the two countries experienced in their recent boom and bust. First, they were both constrained by the euro adoption. Spain was part of the EMU since its beginning. Latvia was a member of the EU since 2004 and expected to adopt the euro after January 2014, pegging the lat to the euro since January 2005. Both countries benefited from the higher relative development of their neighbors. Moreover, they received substantial capital inflows that lowered the interest rates. After a period of healthy growth, both countries evidenced strong current account deficits as well as over development of the construction sector fuelled by low interest rates on mortgages.

The global financial crisis found these two countries open to shocks, with high private debt and a high share of employment in the construction sector. The crisis had a huge impact, bringing the GDP down in a few quarters.

In both countries, the possibilities to devalue were nil and there were strong pressures calling for an increase in competitiveness through other channels. In the remaining part of this section we will describe the particularities of the surge of the crisis in both Spain and Latvia.

## Spain

Since the early 1990s and until 2007 Spain experienced a lengthy period of growth. GDP grew at a mean rate of almost 4

percent for the 12 years between 1995 and 2007. There was also a massive increase in employment. In spite of immigration, unemployment went down from 25 percent in the early 1990s to about 8 percent in 2007.

From mid-1990s to 2007 the extraordinary housing boom brought about a three-fold increase in housing prices. The low interest rates on mortgages, substantial lengthening of maturities (up to 28 years), as well as demographic factors and foreign investment explain this boom. The real estate sector made its mark in the economy, growing from 17 percent to 23 percent of GDP between 1995 and 2007. There was also an increase in employment in the construction, financial and real estate sectors: while in 1995 these sectors represented 11 percent of employment, they expanded to represent about 15 percent in the same period.

Two main issues — productivity gains and current account deficits — arose even before the global crisis. In spite of the country's high growth rates, productivity in Spain had stagnated. This development is related to the increasing importance of the real estate sector and also to a lower competitiveness in manufacturing. Additionally, there was a persistent and important deficit in trade balance that reached about 6 percent of GDP in 2007, with a current account deficit of 10 percent of GDP. Spain exports mainly to European countries, with a total ratio of exports of over 26 percent of GDP in 2008.

In this context, the global financial crisis directly affected the Spanish economy to a greater degree compared to other economies.

Unemployment grew from 8 percent to 20.3 percent between 2007 and 2010. While

total employment decreased by 8 percent (almost 2 million workers), employment in the construction, real estate and financial sectors went down by 34 percent, with more than 1 million displaced workers.

The effects of recession on the labor market depend on the institutions governing the functioning of the market. The Spanish labor market was frequently characterized as suffering from strong segmentation, based on its widespread use of temporary contracts and high employment protection for permanent jobs (benefited by a high severance pay, of 45 days' wages per year of seniority). Additionally, a very generous and long unemployment insurance increased the outside option for workers.

Spanish collective bargaining did not provide instruments for flexibility in any respect. It had an intermediate level of centralization (at the sectoral and regional levels) with few chances to modify the main conditions by particular firms. Furthermore, collective agreements were very persistent given that previous agreements could be extended for two years if no new agreement was reached. Importantly for wage flexibility, all wage payments also had to comply with the "inflation safeguard clause", which required that all wages should at least adjust as much as inflation (if collective bargaining ended in lower wage growth). Consequently, the collective bargaining resulted in wages that were mildly positive and always higher than 1.5 percent between 2009 and 2011. Furthermore, in cases where bargained wages increased less than inflation, wages were updated by applying the "safeguard clause". These cases represented about half of the total and implied an overall collective bargaining increase in wages of about 2.2 percent during the period.

The Spanish government first focused on alleviating the effects of the crisis on workers, introducing the relevant reforms in the labor market institutions only in a second stage. In April 2008 the early reforms included increasing the unemployment insurance (extending benefit entitlements) and other forms of transfers. Additionally, there were some efforts to promote self-employment by providing loans and reductions in social security contributions. New hirings of some targeted unemployed workers were promoted by transitory cuts in social security contributions.<sup>2</sup>

After 2010, reforms in institutions proved to be more substantial. In particular, in September 2010 a law reduced the severance pay. Later, new rules facilitated internal flexibility (working hours, changes in duties and job descriptions, working compensation). They also changed wage bargaining by extending the application of opt-out clauses for wages. Concretely, if an agreement between employees and a firm was reached it could change the centralized bargained wage. Also, the extension of collective bargaining was limited in order to reduce inertia in wage settings. More steps in the same direction were introduced in 2012, while in 2013 the scope for part-time jobs was further widened.

## Latvia

Latvia experienced an extended period of extraordinary growth in per capita GDP, fostered by its accession to the EU in 2004. The relatively low development of the country led to a catch-up period of capital inflows, with foreign (particularly Swedish) banks financing high investment.

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2. It is important to emphasize that these social security rebates were far from being generalized. The conditions imposed restricted their relevance.

Average annual growth was almost 9 percent between 2000 and 2007, with the unemployment rate decreasing from 14 percent to 6 percent.

Latvia is a small open economy. In 2012 exports represented 60 percent of its GDP, with about 30 percent of these being re-exports. The country's currency lat was pegged to the euro from January 2005, the objective being to join the EMU in January 2014. Financial openness is also high in Latvia. In 2012 the ratio of gross foreign liabilities to GDP stood at 135 percent, of which about half were bank liabilities, and there were no capital controls. The ratio of private sector credit to GDP increased from 20 percent to 90 percent.

Never the less, concerns grew during the year 2007, with strong signals of over heating. In spite of the peg, inflation remained very high. The consumer price index went up by about 60 percent, the GDP deflator about 80 percent while unit labor costs increased by 111 percent. Inflation was 10 percent in 2007 and 15.3 percent in 2008. The current account balance deteriorated, with deficit increasing from 5 percent to 25 percent in 2007. Appreciation and large current account deficits, with lower credit quality, as well as balance sheet risks associated with external borrowing generated a context for the anticipation of some form of adjustment.

More over, investment reflected, in part, a housing boom; housing investment increased from 2 percent to 5 percent of GDP, with 40 percent of the increase in employment during the period taking place in the construction and real estate sectors.

From the end of 2007 till the end of 2009 a big bust took place. GDP dropped by

25 percent over eight quarters. Domestic demand declined by 43 percent, mainly because of a credit crunch and a currency crisis. At the end of 2008 private sector deposits fell by 10 percent (from August to December). This led to the nationalization of Parex Banka, the largest domestically owned bank. Besides, the Bank of Latvia lowered reserve requirements and the policy rate; it defended the peg by selling foreign currency which caused official reserves to fall by about 20 percent. This outflow was compensated by a strong credit line from Swedish and Danish central banks, EU/IMF and the Nordic countries program, and private Nordic banks recapitalizing their subsidiaries. This helped reduce the impact, but the financial tightening, credit rationing and the increase in interest rates (from 6.3 percent in September 2008 to 21 percent in June 2009) could not be avoided.

Unemployment was at about 20 percent at the end of 2009, with the construction sector incurring 40 percent of total job losses.

The effect of the crisis promised to be different in Latvia when compared to Spain. Labor market institutions are in fact very different between the two countries. The Latvian labor market is characterized by low minimum wage, weak unions, decentralized collective bargaining (firm level), limited unemployment insurance and low employment protection, particularly for long-tenured workers (see Table 1). These institutions provide a context in which wage moderation or wage cuts could be more generalized.

Furthermore, tripartite dialogue (between government, employer and trade union) — in place since the 1990s — had helped to introduce some painful measures, including

wage cuts in the public sector and publicly-controlled firms.

Importantly, fiscal tightness did not have a central role during the first year of the recession. Additionally, as in Spain, there was no “fiscal devaluation” that could result in the reduction of labor costs, besides the adjustment of wages. On the contrary, the workers’ tax burden increased.

Fiscal consolidation was announced by a new government in June 2009 and was partially imposed as a condition of aid disbursements. New measures included a 20 percent cut in wage bills, reduction in health and education budgets and increases in personal income taxes. Fiscal consolidation in 2009 was estimated at about 8 percent of the GDP (Blanchard, Griffiths, and Gruss 2013). From July 2009 public sector salaries (ministries and subsidiary institutions) were reduced by 15 percent and 20 percent for higher wages. Much of the austerity measures affected the education and health sectors. Though the wage cuts were imposed on the public sector, the private sector too was affected.

## Comparison between the two countries

Figure 1 shows the comparative evolution of crucial variables between the two countries. In panel (a) we plot the unemployment rate. Importantly, during the surge in the crisis, both countries experienced a rise in unemployment — from less than 10 percent at the end of 2007 to 20 percent after two years. Nevertheless, this comparable rise in unemployment was not related to the similar change in GDP. During the same period, real GDP went down by about 7 percent in Latvia, while in Spain the GDP was reduced by less than 4 percent (see panel (b)).

In panel (d) of Figure 1 we plot the Total Factor Productivity (TFP) of both countries. From the peak, Spain experienced a reduction of about 6 percent in TFP, while

Table 1: Labor Market Institutions

	Spain	Latvia	Source
Sev. Pay generosity	2.9	2.5	RSP
Sev. Pay at 5 years	14.3	8.7	RSP
Sev. Pay at 10 years	52.0	17.3	RSP
UI generosity index	69	6	RSP
UI benef/Pop (2011)	6.2%	1.7%	EUS
Minimum wage / mean wage 07	42.1	31.5	EUM
Minimum wage (in euros, 2009)	728	254	EUM
Trade union density (08/09)	14.5	13	RSP

Notes: The table summarizes the characteristics of severance pay (Sev. Pay), unemployment insurance (UI), labor market policies (LMP) and other institutions in Spain and Latvia according to several sources. Pensions schemes are Pay-as-you-go in Spain and a mixed system in the case of Latvia.

Sources: RSP: Holzmann and Vodopivec (2012). EUM: Minimum wages, Eurostat, 2009. EUS: Eurostat database, 2013.

Latvia was affected by a 10 percent drop in TFP. Real interest rates in Latvia increased sharply, while in Spain they were almost unaffected (see panel (d)).

Thus, while the rise in unemployment in both countries is similar, Latvia was hit by a much harder shock than Spain. This implies that elasticity of unemployment with respect to shocks is much higher in Spain.

Why is unemployment more volatile in Spain compared to Latvia? We argue that this could partly be explained by the evolution of real wages. In panel (f) of Figure 1 we plot the evolution of real wages. From the end of 2007 to 2010, mean real wages in Spain increased by 6 percent while in Latvia they decreased by more than 10 percent. The evolution of wages suggests a strong wage rigidity in Spain, and much more flexible wages in Latvia.

## Data and Methods

In this section we describe the data and methods used. We refer to the Appendix for particular issues on each source and for details of the variables used.

### Social security data

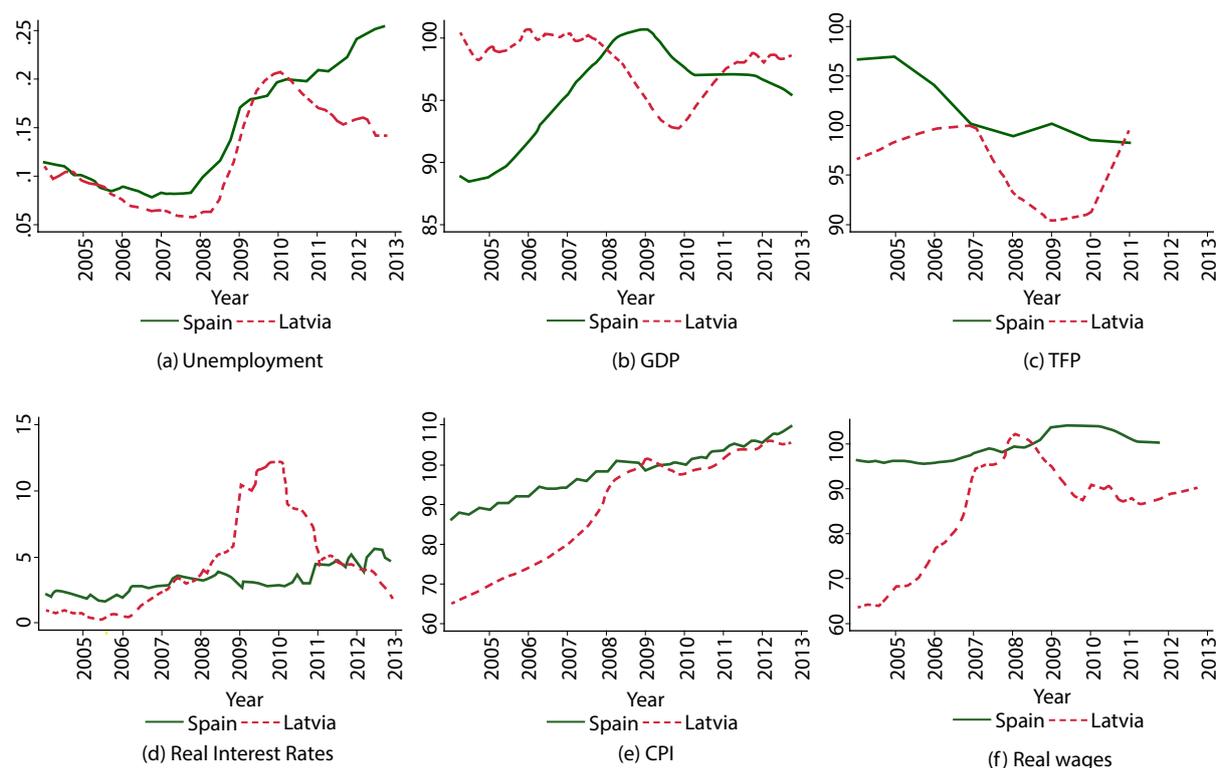
#### Spain

Our paper uses the Spanish *Muestra Continua de Vidas Laborales* (MCVL). This is a panel of workers from across their labor market history, constructed from the social security data. The MCVL is a representative sample of all individuals who paid to or received a transfer from the social security in a given year. It means that the individual concerned could be sampled if employed, if receiving unemployment benefits, or if retired and receiving a pension. Each year, the sample comprises about 4 percent of all individuals in social security registers, which works out to about 1.1 million individuals. All the historical information is compiled for each of the individuals sampled, covering the entire period for which their social security records are available.

The MCVL collects information on several variables related to the person (date of birth, sex, nationality, region); to the job (hiring and separation dates, type of contract and income, etc.); and to the firm (industry, size, location, etc.).

The wage reported to the social security (that we use in this paper) includes all the concepts that determine the social security contributions. For example, it includes overtime payment but excludes in-kind payments. Additionally, wages are top- and bottom-coded, and are constructed such that they represent monthly payments.

Figure 1: Spain and Latvia during the Great Recession



Notes: Unemployment rates, GDP, and real wages are a smoothed, seasonally adjusted series. Real interest rates are long-term interest rates (government bonds maturing in 10 years), net of annual change in CPI in the same period (CPI series are forecasted using OECD estimates for 2015-2017 and assuming inflation converging to 2.2% for remaining years).

Sources: Panels (a), (b) and (e): Spain: *Instituto Nacional de Estadísticas*, INE. Latvia: Central Statistical Bureau of Latvia. Panel (c): FRED, Federal Reserve Bank of St. Louis. Panel (d): OECD. Panel (f): authors' sample from administrative data.

To be explicit, the MCVL follows the worker over different periods, specifying their employment status, wage income and the employer each period. With this information it is possible to construct a worker's transitions and changes in wages.

For the purposes of this paper, most of the MCVL information is not relevant; a subsample suffices to characterize the transition rates. In our paper, we construct a random subsample of about 40,000 males between the ages of 20 to 60 years, employed under a general regime (no self-employment or rural labor).

## Latvia

The data from Latvia is also generated through contributions from social security. A standardized tax return form is filled in by firms every month and submitted to the Internal Revenue Service. The main purpose of the salary tax return form is the calculation of social security taxes and income taxes.

The Latvian database has information about the individual (year of birth and sex), the job (type of contract/insurance and monthly gross wages and salaries), and the firm (activity and type of institution). As in the previous case, this data provides information on the same worker for different periods, specifying their employment status, the wage and the employer for each period.

The wage is gross monthly salaries. There is some top-coding in this database but it is rarely binding.<sup>3</sup>

Throughout the paper we will work with a subsample of about 60,000 males between the ages of 20 to 60 years, sampled at random from those employed during the period 2004 to 2012 under general insurance contract, excluding employees of micro enterprises and rural labor such as individual merchants, firms of individuals, fishermen, and peasants.

## Consistency, filtering, corrections and samples

In both databases, we have the monthly wage for workers, including overtime pay and excluding in-kind payments. In this sense, the definitions from both sources are consistent.

In spite of this, we have developed several corrections to and selections from the original data that do not change the overall results but are worth noting.

First, declared wages are bottom- and top-coded. In the Spanish data, about 1 percent and 13 percent of wages are affected by bottom- and top-coding respectively. For our purposes these cases would not provide any information of wage flexibility since changes

cannot be observed. For that reason, we change any truncated wage to missing, and mark the observation as being affected by the bottom- or top- coding. In the case of Latvia, the top coding applies to the annual income but it is highly uncommon, so no case is affected by top coding in our sample.

Second, we have found several monthly declarations with zero income within a job (we observe positive wages for the worker in that firm before and after the zero is observed). This is more frequent in the Latvian data. Some cases exhibited a pattern, as in a seasonal job. Others could be explained as an unpaid leave or zero hours in the month for hourly-paid jobs. Importantly, in Latvia the proportion of zeros more than doubles during the period 2009-10, suggesting that they are related to the cycle.

Third, we observe that wages tend to be different from one period to the next in a small proportion of workers. This is probably due to some component of compensation (differences in hours or days worked between months, overtime pay, commissions, bonuses, etc.). Some of these changes could provide somewhat different monthly payments at the same wage rate. Given that our objective is to identify wage rate rigidity, we corrected for any small difference between months by filtering the data. For doing so, we took a centered moving median covering a span of 13 months.

An important qualification is that we will work mostly with log wages. Thus, both in mean wages and in the wage changes analysis, all adjustment will be eliminated through zero wages. In other words, we will be underestimating the wage adjustment through this channel.

Table 2: Administrative data

	Spain	Source
Number of individuals	43066	64061
Mean number of obs per id.	66.18	56.40
Number of monthly observations (in th.)	2850.11	3612.68
Numb. of ltered monthly wages (in th.)	1973.93	2188.01

Notes: Statistics from the sample used in this paper. The sample is restricted to males between 20 to 60 years of age. Source: Spain: MCVL; Latvia: CSB.

3. The ceiling for contributions of annual labor income was LVL 23800 in 2007, LVL 29600 in 2008, etc., but less than 1 percent of the sample is affected by this type of ceiling.

Our sample is restricted to males between 20 and 60 years of age. Our data allows us to identify jobs as public and private. This difference is important because of the wage cuts imposed by the government, as explained in Section 3. Additionally, we identify jobs that pay wages below the legal minimum. These could be considered part-time jobs.

On the whole, results presented in this paper are for the overall sample, and we concentrate on “filtered” wages, unless otherwise specified. Filtered wages are the moving median of wage over jobs in which we never observe a zero wage or a truncated wage (if we observe a zero or if wages are affected by bottom- or top-coding, we drop the entire job). Notice that these corrections are important for the analysis of wage dynamics, but not for workers’ dynamics. We also ensure that the main results of the paper are robust to other definitions of wages (raw wages, for example) and to other samples (private and for jobs above the minimum wage). For brevity’s sake we avoid presenting all this diversity of statistics, but we point out any important difference that we may find with the presented statistic.

## Employment transitions

Our data allows us to identify different employment transitions of workers. Taking two periods (months)  $t_0$  and  $t_1$ , we identify the worker as:

**Stayer (S)** if the worker is employed in the same job (firm and contract) in  $t_0$  and  $t_1$ ,

**Job-to-job (EE)** if always employed between  $t_0$  and  $t_1$ , but not in the same job (firm and contract)

**Re-employed (EUE)** if employed in  $t_0$  and  $t_1$ , but with some period spent without a job in unemployment in between

**Entry (XE)** if employed in  $t_1$ , but not in  $t_0$

**Exit (EX)** if employed in  $t_0$  but not in  $t_1$ ,

**New Hire** for short-tenured workers, and includes those hired between  $t_0$  and  $t_1$  (EE, EUE, XE).

This classification of workers based on their transitions in each period allows us to provide a detailed analysis of employment and wage dynamics.

## Transition rates

Following the literature, we compute the finding rate as the proportion of non-employed workers who find a job, and the separation rate as the proportion of employed workers who become unemployed. These two transition rates indicate outflow from and inflow into unemployment, and are computed as monthly rates. Given the strong seasonality, we plot the annual averages or the seasonally adjusted series.

## Wage dynamics

In this paper, as in the literature, we analyze wage dynamics from different perspectives. The literature typically analyzes wage rigidity by presenting the histograms of wage changes among stayers.<sup>4</sup> We follow this idea to discuss the differences in wage dynamics in both countries.

First, based on the literature on wage rigidity, we analyze the distribution of annual wage changes for workers who do not change jobs. To be explicit, we plot detailed histograms of changes of

4. Altonji and Devereux (1999) developed a much more sophisticated method to identify wage rigidity. It takes into account measurement error and consists of an estimation of notional wage changes, which are the wage changes that could be predicted if these were drawn from a normal distribution. The incidence of wage rigidity is the proportion of jobs that should have had a wage cut according to the notional wage change model but where observed wages did not fall. Goette, Sunde, and Bauer (2007) extended this method to estimate wage rigidity on real wages.

the log of nominal wages for workers who continue with the same job, i.e. stayers, between the same month of two consecutive years. We analyze, in particular, these distributions before and after the recession to understand the extent to which the worsening of economic conditions and the rise in unemployment alters the wage dynamics. From this information, we can also compute different moments of this distribution, such as the mean by period, the median, the proportion of workers with no wage change (wage freezes) and the proportion of workers with negative wage changes (wage cuts). We present the time series of these statistics to compare them with the evolution of unemployment and productivity.

As emphasized by the theoretical literature, wage rigidity of stayers is not the only or even the most relevant guide to understanding labor market behavior. Wages of new hires are also relevant. For that reason we extend the same analysis to workers with other types of transitions, including job-to-job transitions and workers who suffer some period of unemployment in between two jobs. The distribution of wage changes among these workers are typically more dispersed and show an important proportion suffering income loss due to unemployment (see Davis and von Wachter (2011) and Couch and Placzek (2010) for recent evidence on loss in earnings upon displacement and the incidence of recessions).

## Wage changes decompositions

We now turn to analyzing wage changes among different workers.

Let us define the mean log of wages as

$$w_t = \frac{\sum_{i=1}^{N_t} \ln W_{it}}{N_t}$$

where  $W_{it}$  is the nominal wage of worker  $i$  in period  $t$  and where  $N_t$  is the total number of workers in period  $t$ . Then, the wage difference is

$$\Delta w_t = w_t - w_{t-1}$$

Another way of computing this same outcome is by defining some groups and computing averages of log of wages for each of them and then computing the mean as the weighted average. In particular, we consider different groups:  $S$  for stayers,  $N$  for new jobs (grouping both  $EE$  and  $EUE$  transitions),  $E$  for entries, and  $X$  for exits. Then, we have

$$\Delta w_t = \theta_{St} w_{St} - \theta_{St-1} w_{St-1} + \theta_{Nt} w_{Nt} - \theta_{Nt-1} w_{Nt-1} + \theta_{Et} w_{Et} - \theta_{Xt-1} w_{Xt-1}$$

where  $\theta_{jt} = \frac{n_{jt}}{N_t}$ , being  $n_{jt}$  the number of workers in group  $j$  in period  $t$ , and where

$w_{jt} = \frac{\sum_{i=1}^{n_{jt}} \ln W_{it}}{n_{jt}}$  is the mean of wages for that group. Using this computation we construct the following decomposition:

$$\Delta w_t = \theta_{St} \Delta w_{St} + \theta_{Nt} \Delta w_{Nt} + \Delta \theta_{St} (w_{St-1} - \bar{w}) + \Delta \theta_{Nt} (w_{Nt-1} - \bar{w}) + \theta_{Et} (w_{Et} - \bar{w}_t) - \theta_{Xt-1} (w_{Xt-1} - \bar{w}_t), \quad (8)$$

where  $\bar{w}$  is an indicator of an aggregate wage, such as  $\bar{w}_t = \frac{w_t + w_{t-1}}{2}$ . The first two terms measure the within contribution of stayers and new jobs to aggregate wage changes, weighted by the proportion of workers in each group. The third and fourth terms add the composition effects (between component) of changes in the proportions of stayers and new jobs in total employment in each period. Finally, the last two terms account for entries and exits effects.

# Results

## Employment and wages

We begin by comparing our sample with the aggregate information from national statistics.

Let us first consider the evolution of employment. Figure 2 shows the total number of employed workers in a given quarter in our sample. For example, in Spain we have about 4,300 observations of employed workers in 2007, while in Latvia the number reaches 11,000. The evolution of the number of employed is common to both countries: there is strong employment growth before 2007 and a deep drop from then on until the beginning of 2010. The reduction in employment reaches 20 percent in both countries. Additionally, we plot the number of employees according to the national statistics to show that the evolution is similar to the number of observations employed in our sample.

An important difference between both countries is that in Latvia, after 2010, there is a partial recovery of employment while in Spain we find no signs of recovery until 2012.

Figure 3 displays raw mean wages (without any filtering or correction) in nominal terms, in euros, for both Spain and Latvia. In Spain, the mean wage in our sample goes from 1,500 in 2005 to 1,600 euros in 2007. Importantly, mean wage goes up further to 1,800 euros in 2010 to finally stabilize at that level. In Latvia, there is a huge increase from 500 to 700 euros between 2007 and 2008, but then wages go down to around 625 euros. Importantly, these figures are very similar to the ones from the national statistics.

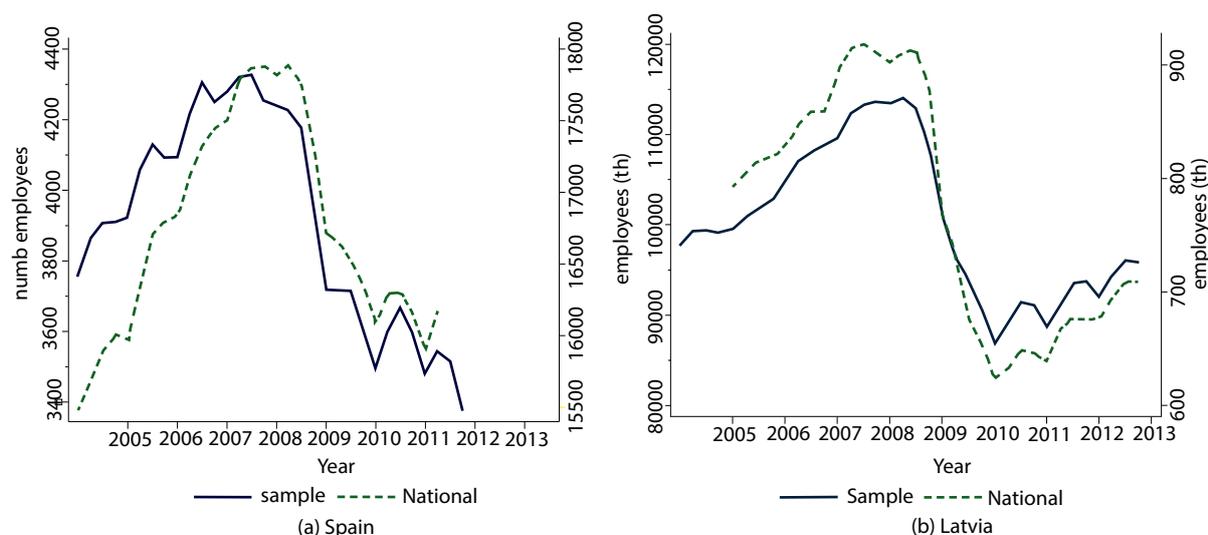
## Wage changes among stayers

In this section, we concentrate on the annual nominal wage changes of stayers. The distribution of the log wage change of stayers and its evolution over time will be the evidence we will provide on wage rigidity. This distribution is crucial for the literature that measures the incidence of wage rigidity.

Figure 4 displays the histogram of the distribution of annual difference in the log of nominal wages for stayers (workers who were continuously employed in the same job between month  $t$  and 12 months thereafter). Every bar represents one percent point. In panels (a) and (b) we show annual wage changes before the recession by piling up all available months between 2005 up to the end of 2007. Several observations are in order. First, in the case of Spain we see very compressed wage rises with a mode of 3 percent, which is about one point higher than the inflation rate each year. This is consistent with the wage setting mechanisms that adjust wages according to past inflation, as described in Section 3. Second, it is possible to observe a spike in the distribution at wage freezes. Third, the proportion of wage cuts is very small. Wage changes of -1 percent are far less frequent than wage changes of +1 percent.

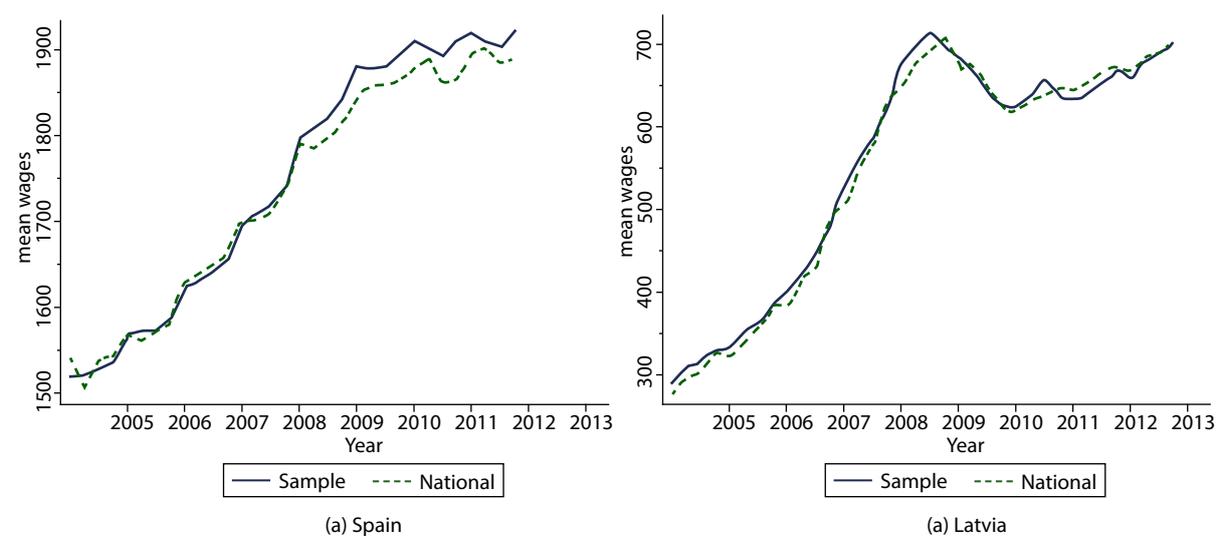
The analogous figures for Latvia are very different from the Spanish ones. Wage changes are much more dispersed and it is not uncommon to observe increments of 25 percent in these changes. Additionally, without taking into account wage freezes, the mode is around 13 percent. In several months the modal wage change is close to the rise in minimum wages, suggesting that

Figure 2: Employees



Notes: The series labeled Sample is the number of observations with a job using the authors' sample from administrative data. The series labeled National shows the number of employees according to national statistics. Spain: *Instituto Nacional de Estadísticas*, INE, number of persons, employees, non-adjusted data. Latvia: Central Statistical Bureau of Latvia, average number of employees in full time work, units by quarter.

Figure 3: Mean nominal wages



Notes: The series labeled Sample is the quarterly average of nominal wages (in euros in both countries) using the authors' sample from administrative data. The series labeled National shows the average wage according to national statistics. Spain: *Instituto Nacional de Estadísticas*, INE, labor cost per worker, seasonally adjusted by the authors. Latvia: Central Statistical Bureau of Latvia, average monthly wages and salaries of employees.

this institution is relevant in the wage setting in Latvia. Finally, there is also a spike at wage freezes but wage cuts are rather frequent, showing no appreciable discontinuity.

Panels (c) and (d) of figure 4 show the same analysis but for high unemployment periods, piling up all available months from

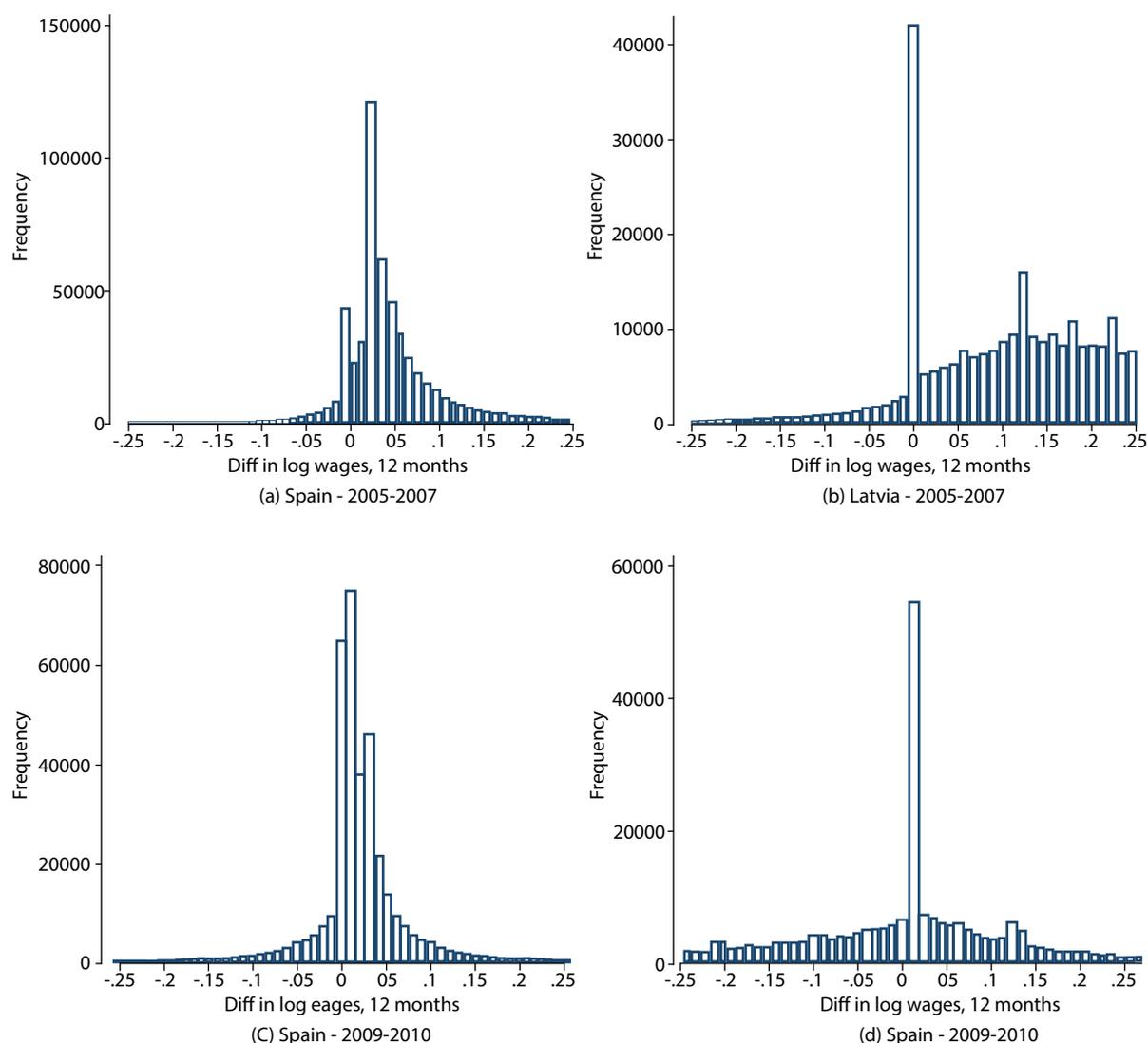
2009 to 2010. In Spain the distribution is even more compressed. The multimodal distribution could arise simply because we are considering many different periods. The most prominent mode is at 1 percent rise, which, again, is close to the inflation rate of the periods. In any case, there are now

many more observations with wage freezes and the discontinuity in wage cuts is even more noticeable. In Latvia wage changes are again more widely dispersed and are almost symmetrically distributed at both sides of zero, partly because we are considering periods in which there is fluctuation in mean wages, mostly suggesting some form of wage flexibility. There are again some spikes around 13 percent, probably led by minimum wage rises.

These distributions are similar when we restrict the sample to private jobs, with wages above the minimum wage. We find no qualitative difference when analyzing these distributions of wage changes.

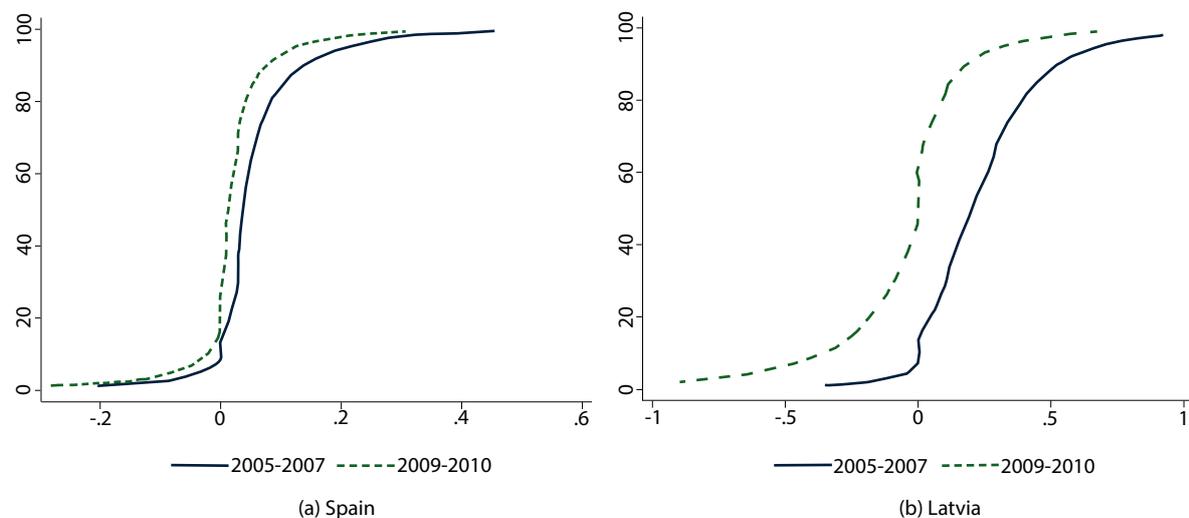
Figure 5 displays the empirical cumulative distribution function of wage changes of stayers for Spain in panel (a) and for Latvia in panel (b). This plot allows for a direct comparison between the periods 2005-07

Figure 4: Distribution of wage changes – Stayers



Notes: Wage changes are the annual difference of monthly nominal log wages. Wages are filtered by a moving median process and jobs with zero wages are not considered.  
Source: authors' sample of administrative data.

Figure 5: Cumulative distribution of wage changes – Stayers



Notes: Empirical cumulative distribution function of the annual difference of monthly nominal log wages.  
Source: authors' sample of administrative data.

and 2009-10. We find that the distribution of log wage changes in low unemployment periods is higher than that in high unemployment periods. This observation is common to both countries. There are important differences, though. The horizontal difference between both lines accounts for the degree of wage adjustment. While in Spain the difference is small and about 0.05 log points at the median, in Latvia it is around 0.2 log points, and is noticeable through the entire distribution.

The evidence presented so far clearly indicates that wages are affected by the recession and the rise in unemployment, though differently in both countries. In Spain it appears that the distribution was compressed at zero but with few wage cuts. This asymmetry in the distribution is more obvious for the periods of high unemployment. What is striking, though, is that even when unemployment was steadily increasing to reach 20 percent, the mode of wage change was positive. In Latvia the recession generated a strong shift, affecting many jobs that experienced a reduction in

nominal wages. In clear contrast to Spain, wage changes in Latvia seem much more symmetric. The evidence strongly suggests that Spanish wages are much less flexible than the Latvian wages. This difference in wage setting is clearer in periods during which unemployment is high and rising. This observation connects to Messina and Sanz-de Galdeano (2011) which shows that wage rigidity gains prominence after deflation in developing countries.

Figure 6 shows the proportion of wage freezes and wage cuts as a monthly time series for both Spain and Latvia. Importantly, we still restrict the wage changes to the stayers.

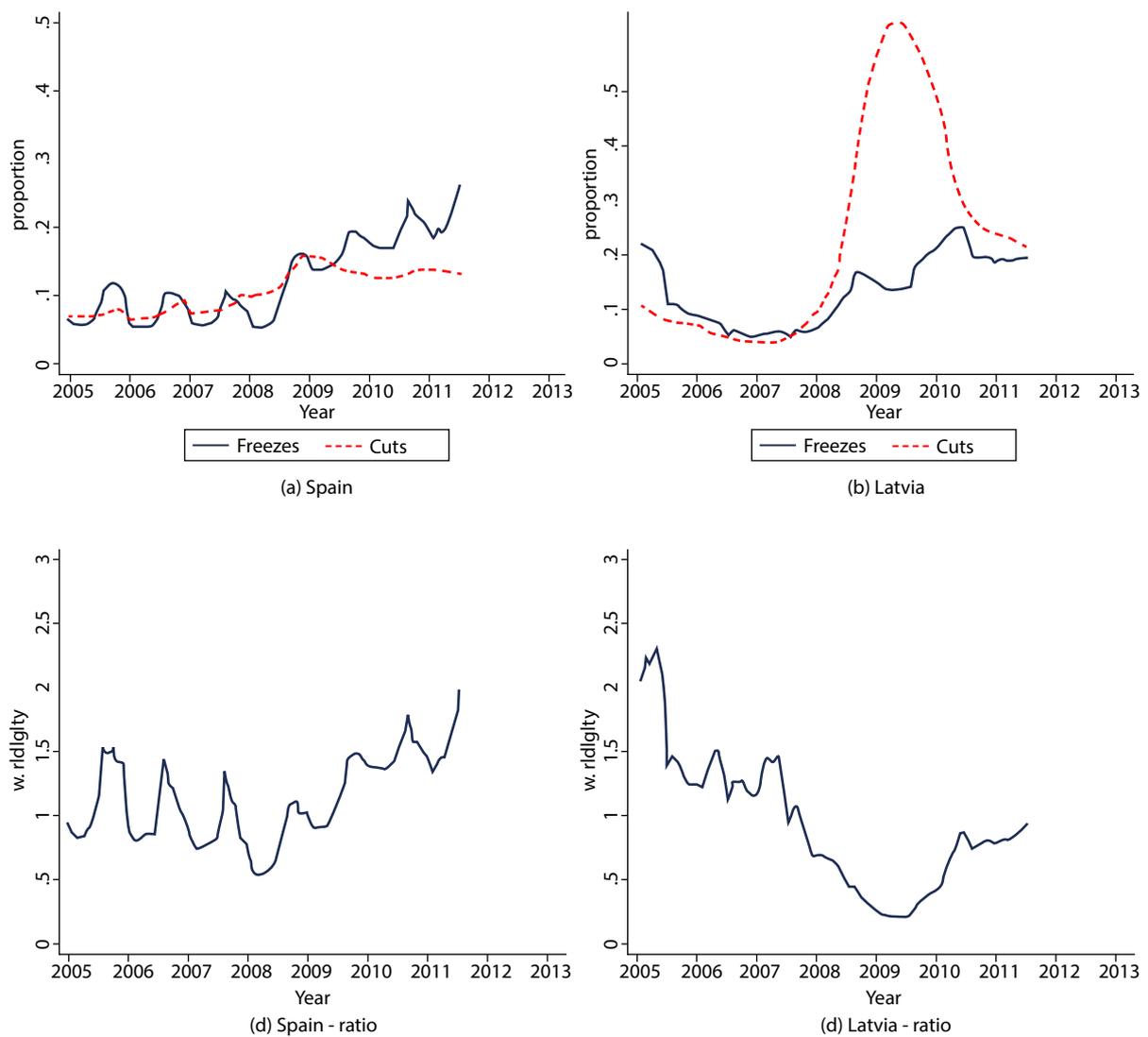
The proportion of wage freezes and wage cuts rises sharply at the beginning of the recession. In the wage freezes the jump is of about five percentage points while wage cuts jump by about 10 percentage points. Notably, in both countries this rise can be identified in a very narrow period, around January 2009, implying that wage setting was strongly and sharply affected by the recession.

Besides the common factors there is also a strong difference between the two countries. In Spain the proportion of wage cuts had a peak at 15 percent before starting to fall. From mid-2009 on, less than one-tenth of jobs suffered wage cuts. The proportion of wage freezes continuously increased to represent 25 percent at the end of the series. Such is not the case in Latvia, where the proportion of wage cuts increased to

represent more than 60 percent of the stayers. In other words, in 2009 and even in 2011 wage cuts were a generalized practice in Latvia.

Had the distribution of wage changes been continuous, the proportion of wage freezes over wage cuts would be very low. Then, one simple way to identify wage rigidity (or resistance to wage cuts) would be by computing the rate of wage freezes to wage

Figure 6: Proportion of wage freezes and wage cuts



Notes: Panels (a) and (b): The proportion of wage freezes is the proportion of stayers for whom wages did not change from month  $t$  compared to  $t-12$ . The proportion of wage cuts is the proportion of stayers for whom the wage is lower in  $t$  compared to  $t-12$ . Panels (c) and (d) show the ratio of wage freezes over wage cuts.

Source: authors' sample of administrative data.

cuts; the higher this rate the stronger the wage rigidity.

Figure 6 displays this indicator of wage rigidity in the lower panels, from which it is apparent that wage rigidity tended to increase in the recession and that it was much higher in Spain than in Latvia.

So far we have focused on the wage change among stayers. A concern is whether this group is relevant to the aggregate economy. To analyze this we plot two time series in Figure 7. The solid line is the overall mean of wage changes, considering only the stayers in the same job. The dashed line is the change of nominal log mean wages, including all types of workers. It is quite evident that the wage changes of stayers have a high correlation to the change in the aggregate wage.

Then, different moments of distribution of nominal wage changes show important and substantial differences between the two countries, consistently suggesting that

Spanish wages are far less flexible than Latvian wages. We can, therefore, think of Spain as a rigid-wage economy.

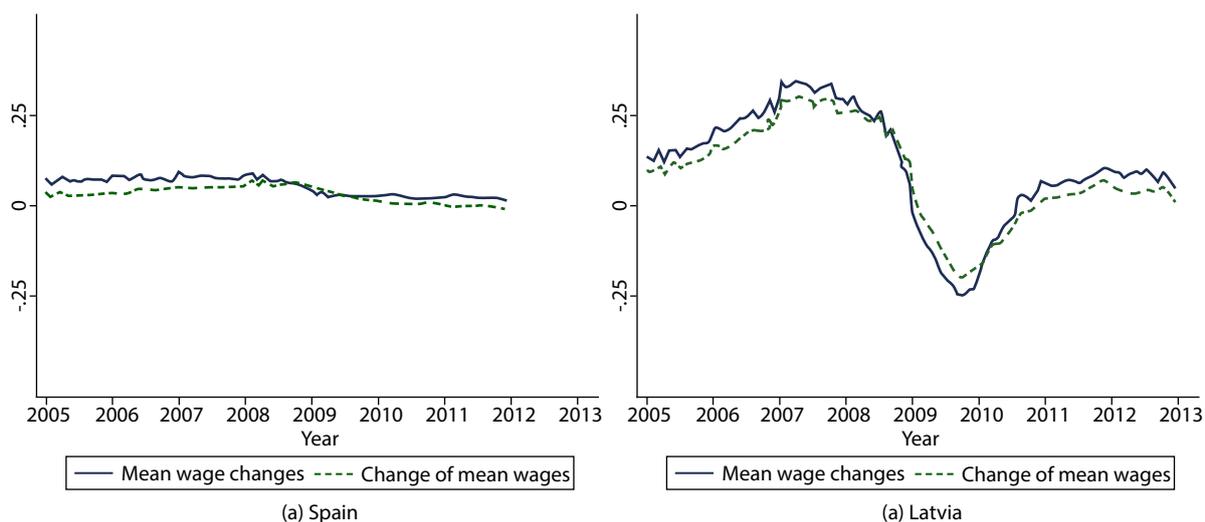
## Wage changes in new jobs

We now analyze whether our findings in the case of same jobs (focusing on stayers) have similarities with our study of workers changing jobs. In particular, we follow workers with wages in  $t$  and in  $t-12$  but who change jobs in between. These are *EE* and *EUE* transitions. We are focusing, then, on newly hired wages. We compare the new hirings with the previous job and compute the log wage difference.

The newly hired wages are important because this labor cost is closely related to the incentives to open vacancies (as  $w_v$  in the model in Section 2). Computing wage changes for the same worker controls for the productivity and idiosyncratic characteristics of the workers.

Figure 8 displays the cumulative distribution

Figure 7: Mean wage annual change



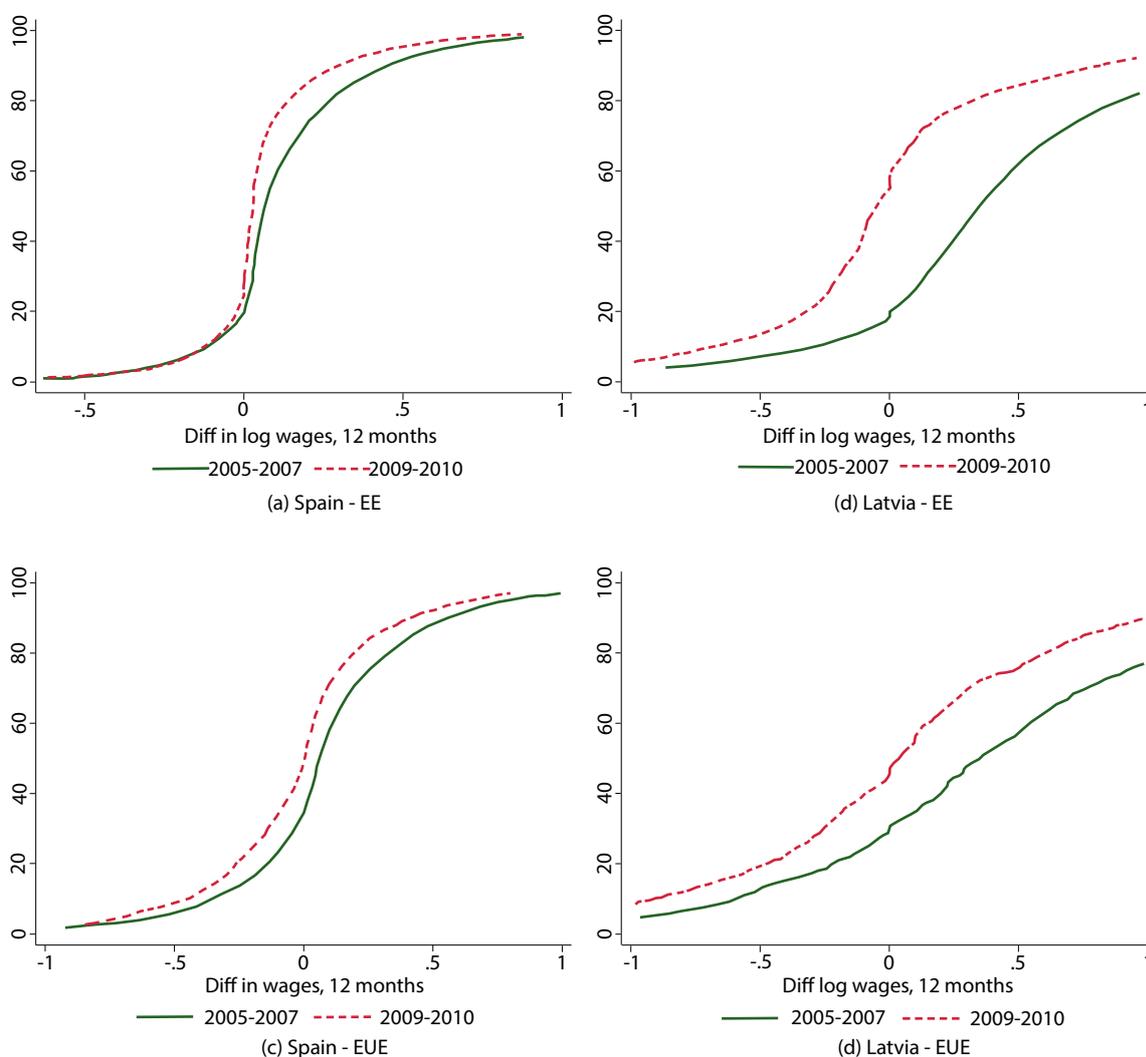
Notes: Mean wage change is the average of annual difference of monthly nominal log wages of stayers. *Change of mean wages* is the annual change of the mean of monthly nominal log wages, including all workers.  
Source: authors' sample of administrative data.

of log wage changes of *EE* (panels (a) and (b)) and *EUE* (panels (c) and (d)) transitions in low and high unemployment periods. These distributions offer the same qualitative results as in Figure 5, which is the analogous plot for stayers. First, the distributions in low unemployment periods dominate those in high unemployment periods. Second, the distributions in Spain are more compressed than they are in Latvia. Third, the horizontal difference of the distribution is mild in Spain while in Latvia it is strong.

Particularly striking is the distribution in panel (a) which shows that most workers who changed jobs in Spain improved in their wages. In particular, the proportion of workers with *EE* transitions, who suffered wage cuts, is no different in low and high unemployment periods. Thus, in Spain the distribution of *EE* wage changes is also compressed around zero, as in the case of stayers.

This is additional evidence of some form of wage rigidity affecting not only stayers but

Figure 8: Cumulative distribution of wage changes - Job changers



Notes: Empirical cumulative distribution function of the annual difference of monthly nominal log wages for job changers, including job-to-job transitions (EE) and those who experienced some periods without a job (EUE). Source: authors' sample of administrative data.

also new hires. The issue is very important. We will come back to it by comparing mean wages of *EE* and *EUE* workers and by analyzing the time series of the mean wage change of these transitions.

## Workers' flows

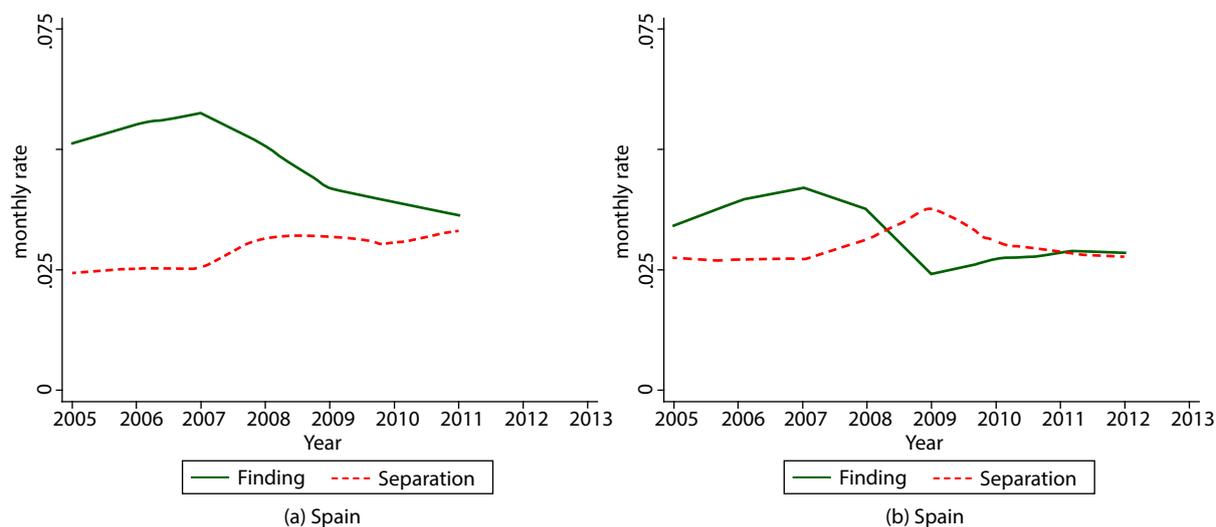
We now present our computed rates of transition of workers from employment to non-employment.

Figure 9 displays the finding and separation rates. These are annual averages of monthly transition rates. In both countries the recession impacted these rates significantly: it led to a decrease in the finding rate and increase in separation rates. Both changes are important. In Spain the finding rate dropped drastically, by around 25 percent from 2007 to 2009. The analogous drop in Latvia is strong (close to 15 percent from 2007 to 2009), but recovery is quick. Importantly, this rise in the number of new jobs occurred after wages were adjusted.

The separations too changed dramatically, with their number first rising in Spain. In Latvia separations rose substantially, by about 50 percent, from 2007 to 2009. Finally, these went down in 2010 to the pre-crisis levels and stayed down until 2012. Again, the improvement in separations occurred after the wages had been adjusted.

The evidence with regard to workers' flows is important from several points of view. First, the change in separations can help to determine the employment level. Second, the wage level and adjustment of wages among stayers seem important to understanding the difference in mobility between the two countries. Latvia recovered from the recession through an increase in hirings and fewer separations after wages were adjusted. In Spain, on the other hand, the effects on finding and separation rates were persistent so there was no recovery in employment growth during the period.

Figure 9: Employment to unemployment and Unemployment-to-employment transition rates



Notes: annual mean of monthly finding and separation rates. Finding rate is the average transition probability from unemployment to employment. Separation rate is the average transition probability from employment to unemployment. Source: authors' sample of administrative data.

To further emphasize the role of separation we take advantage of the implied decomposition of equation (2) to compute the relative importance of finding and separation flows to the change in unemployment. In particular, we want to focus on the periods of the rise in unemployment, mainly concentrated between the years 2008 and 2009. We therefore compare the average finding, separation and unemployment rates in 2007 with the same averages over the period 2008 to 2009. The reason for taking averages is to understand the relevance of the rates through the entire period. A spike in a rate could have a persistent effect on unemployment that we would miss if we were to consider only a month-to-month comparison. Besides, we need to include a rather extended period of changes, because our formula rests on the steady state approximation of unemployment rate, and this steady state rate is relevant to only several periods of constant transition rates. In other words, our decomposition effort would be accurate if rates were to change and stay constant at the new levels.

Table 3 shows the result of this decomposition exercise. The separation rate effect represents about half of the overall decomposition of the rise in unemployment. In particular, it represents 51 percent of the change of the overall effects in Spain; the analogous value for Latvia is 45 percent.

Table 3: Unemployment change decomposition

	Spain		Latvia	
	Effect	%	Effect	%
Finding: $-(1-u) * d \ln f$	0.202	49	0.288	55
Separation: $(1-u) * d \ln \delta$	0.207	51	0.237	45
Decomposition: $(1-u) * (d \ln \delta - d \ln f)$	0.409	100	0.526	100
Observed $d \ln u$	0.570		0.731	

Notes: The table implements equation (2) considering the rate of the average of 2007 and of 2008-09.

Source: authors' sample of administrative data.

The evidence then shows that both finding and separation rates are equally important

to understand the rise in unemployment in both countries. We have shown that the changes in these rates are substantial. Moreover, in Latvia the rates recover their pre-recession level while in Spain the changes seem to be very persistent. Importantly, the persistence of a transitory shock on transition rates is what the model would predict if wages were to be rigid (Shimer 2012b).

## Wage changes and workers' flows

In this section we consider the evolution of wages based on the type of transition, showing, in addition, a decomposition of the aggregate wage change. In this sense, we measure how the wages of different workers were affected by the recession and the rise in unemployment. We also provide more evidence on the importance of the wage of stayers.

Figure 10 shows the mean wage by type of worker, according to the transition. For example, the solid green line represents the mean wages of stayers. The evolution of this wage is close to the aggregate wage.

We also consider the mean wage of those workers who were always employed between  $t-12$  and  $t$  but who changed jobs in between (*EE* transitions). We find that this wage is always increasing in Spain, even more than the wage of stayers, whereas in Latvia, the mean wage is always decreasing. Moreover, while the mean of wages of stayers and of those who changed jobs were similar in January 2008, in January 2012 the gap between these two wages was about 30 percent. In other words, these transitions finally reinforced the difference in wage adjustment in both countries: during the crisis, in Spain, they tended to grow more whereas in Latvia they were inclined to reduce further.

Figure 10 also shows the average of wage in  $t$  of those employed at  $t$  and who were employed at  $t-12$  but were not employed at some period in between (*EUE* transitions). We consider these workers as suffering some separation and unemployment spell shorter than one year. The mean of wages of the workers who experienced these transitions is much lower compared to the previous groups. In Spain the mean of these wages stopped growing at the beginning of the recession, in mid 2008. In Latvia, the mean wage of workers who recently suffered some non-employment spell went down fast, and after 2010 it stabilized at a level at least 20 percent lower than the level in 2008.

We also consider the case of those workers who were employed in  $t$  but not in  $t-12$  (*XE* transitions). In both countries, this wage is very similar to the wage of *EUE* workers, though after the crisis, it tends to be lower. In Spain, in particular, it went down by about 10 percent from 2008 to 2010.

Importantly, these last three groups (*EE*, *EUE* and *XE*) can be considered as new jobs. Between both countries, the mean of wages of these workers as a group shows a striking dissimilarity. While in Latvia this group suffered a substantial reduction in wages — even more than the adjustment of stayers — in Spain the wage shows almost no adjustment. This is relevant as an incentive for job creation. If firms face no reduction in wages of new hires the incentives to generate new jobs are diminished, as in the case of Spain. On the other hand, if wages of new jobs go down, opening up vacancies is less costly and job creation is less responsive to recession.

Finally, Figure 10 displays the mean of log wages in month  $t-12$  of workers who are employed in  $t-12$  but not in  $t$  (*EX*). The value of this wage shows that workers who lose their jobs belong to a particular group, with

wages lower than the average. In Spain, these wages are not inclined to fall; on the contrary they register a growth until 2009. In Latvia, on the other hand, they decreased during the period 2008 to 2010, by about 0.2 log points. Importantly, the evolution of this wage is similar to that of the *EUE* group.

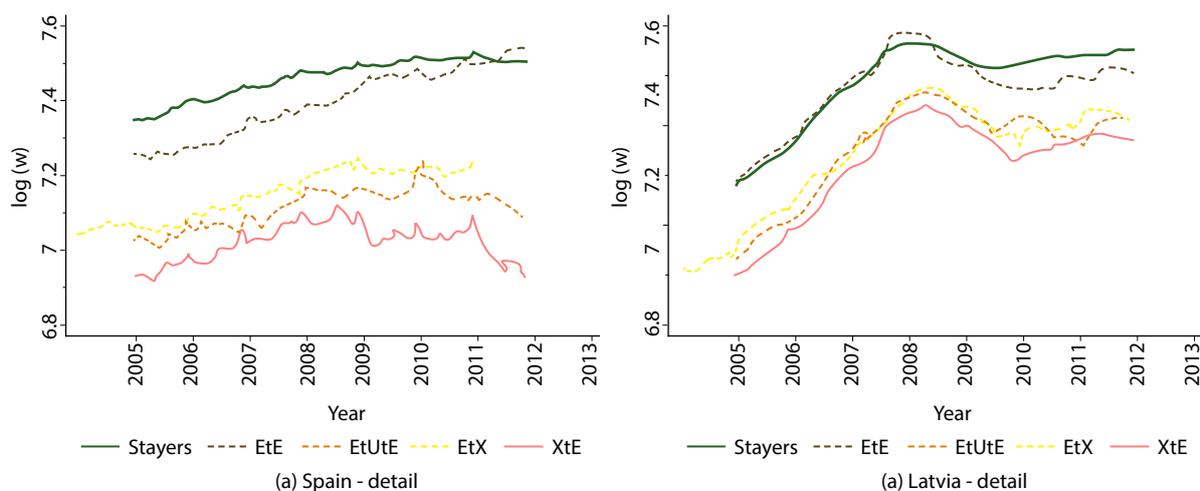
The analysis above does not take into account any composition effect. For example, wages of *XE* group could be decreasing because the composition of workers in that group is changing in time. To reduce this composition effect we follow the same workers and compute the annual change in log wages and plot the mean of that variable.

Figure 11 displays the time series graph for the mean of log wage changes for stayers (reproducing the series of Figure 7), for *EE* and *EUE* workers. There is a strong correlation between the three variables in both countries, and in two cases the group of *EUE* suffered stronger wage cuts. In Spain the changes for stayers and *EE* are always positive, while only *EUE* suffered mild wage cuts, though only during 2009; for other periods, post-displacement wage is, on average, no different from pre-unemployment wage. In Latvia the three groups suffered wage cuts. For example, in 2009 workers who switched jobs (as *EE*) suffered a mean wage drop of about 15 percent while stayers suffered a wage cut of about 25 percent; in 2012 mean wage growth among stayers was lower than 10 percent while for those who switched jobs it was about 15 percent.

The evolution of the series in Figure 11 also shows some time series correlation between the wage change of stayers and of workers who changed jobs. It suggests that new hires also tend to be affected by the same wage dynamics as those in incumbent jobs.

Importantly, the comparison between the two countries gives the same overall qualitative

Figure 10: Mean nominal log wages by type of transition



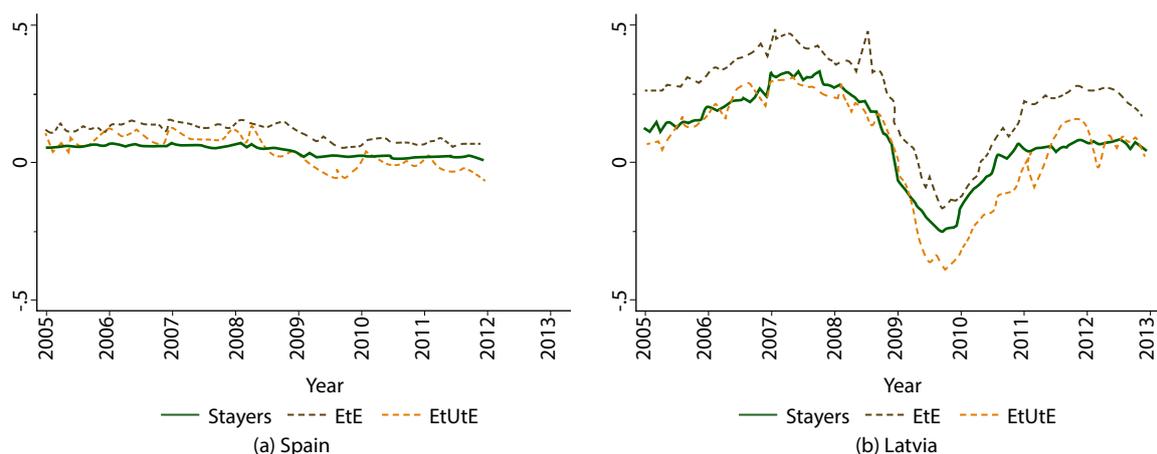
Notes: Each line is the average of nominal log wages by type of transition between month  $t-12$  and  $t$ , including stayers in the same job, job-to-job transitions (EE), in new job with some period without a job in between (EUE), and entries (XE). Additionally, the line label (EX) corresponds to workers with a job at  $t$  who will not have a job at  $t - 12$  (exits). Source: authors' sample of administrative data.

results if we were to compare raw wages (without any filtering), or if we focused on private jobs with wages above the minimum, or plotted the median of log wage changes.

We finally apply a wage change decomposition method as described in Section 4. We first show some mean wage changes for some groups, and then weigh these changes to build the decomposition. We compare one year and

three years' changes, from July 2008 to July 2009 and from July 2008 to July 2011. These changes are relevant not only because of the differences in wage adjustment, but mostly because the number of transitions increase and stayers reduce their importance in terms of their proportion of the total number of workers. We also compute the same exercise for all workers in the sample and for private jobs.

Figure 11: Mean wage annual change



Notes: average of annual difference of monthly nominal log wages of Stayers, EE and EUE workers. Source: authors' sample of administrative data.

Table 4 presents the wage changes for the period July 2008 to July 2009 by type of transition for the total sample. The difference between the two countries is clear: the mean of wage changes of stayers is +0.026 log points in Spain and -0.211 in Latvia. Even stronger is the difference for *EUE* workers: -0.05 log points in Spain and -0.394 in Latvia. We also show wage changes of private jobs from July 2009 to July 2011 (this means that stayers are those who are in the same job through the entire period). The main conclusions are maintained. In Spain we find an increase in log wages of both private stayers and *EE* workers — 0.06 and 0.10 log points respectively — up to July 2011. No wage adjustment occurred for these groups that represent about two-thirds of workers in Spain. For workers who were separated from private jobs and then re-employed in a private job there is a drop of almost 0.10 log points. This group represents 14 percent of the workers. In Latvia, in contrast, the wage drop is of about 0.19 log points for private job stayers and 0.08 for *EE* where these groups represent about half the number of workers in private jobs. The *EUE* group (about 20 percent of workers) suffered a wage reduction of almost 0.40 log points. On the whole, the adjustment in private wages was substantial.

Table 5 shows the decomposition using such wage changes. We use equation (8) to measure the effect of each transition and the total effect

as its sum. The table also shows the proportion of the total explained by each effect. For example, in Spain the within effect in stayers is almost 0.02 log points, nearly 80 percent of the total change in wages. Latvia shows similar numbers. The within effects are more important than the between effects, and while entry and exit effects are big, they tend to compensate each other. We also present the decomposition for private jobs for the three-year span from July 2008 to July 2011. The log wage change in private jobs in Spain is +0.036 log points during this span of time, most of it (87 percent) explained by the within effect in stayers. Between effects are unimportant while Entry and Exit effects have a net effect as important as *EUE* (representing almost 40 percent of the total change). On the other hand, in Latvia, the total private wage change of -0.22 log points is mostly due to within effects of stayers. Additionally, *EUE* and Entry-Exit effects are equally important. Between effects are, again, irrelevant.

To sum up, we have shown that our observations about wage rigidity analyzing stayers are maintained when including other types of transitions and even when we extend the time span. We also find that the composition effects are not big. This is remarkable given the strong jump in unemployment.

Table 4: Wage changes by type of transition from July 2008

	Spain				Latvia			
	Total 1 year		Private 3 years		Total 1 year		Private 3 years	
	$\Delta w$	% wkrs.	$\Delta w$	% wkrs.	$\Delta w$	% wkrs.	$\Delta w$	% wkrs.
Stayers	0.026	0.731	0.059	0.528	-0.211	0.673	-0.187	0.429
EE	0.067	0.071	0.100	0.104	-0.049	0.101	-0.083	0.103
EUE	-0.050	0.060	-0.096	0.143	-0.394	0.047	-0.398	0.185
Total	0.024		0.036		-0.202		-0.225	

Notes: columns labeled " $\Delta w$ " report the average of annual difference of monthly nominal log wages of Stayers, EE and EUE. Columns labeled "% wkrs." report the proportion of workers in each group.

Source: authors' sample of administrative data.

Table 5: Wage change decomposition. Changes from July 2008

		Spain				Latvia			
		Total	1 year	Private	3 years	Total	1 year	Private	3 years
		Effect	%	Effect	%	Effect	%	Effect	%
Within	Stayers	0.019	0.790	0.031	0.867	-0.142	0.702	-0.080	0.358
	EE	0.005	0.197	0.010	0.289	-0.005	0.025	-0.009	0.038
	EUE	-0.003	-0.124	-0.014	-0.381	-0.018	0.091	-0.073	0.326
Between	Stayers	0.007	0.275	0.012	0.337	0.015	-0.073	0.017	-0.075
	EE	0.000	0.004	0.003	0.085	-0.001	0.005	0.001	-0.003
	EUE	-0.002	-0.090	-0.005	-0.150	-0.003	0.015	-0.005	0.024
Entry		-0.044	-1.836	-0.068	-1.881	-0.065	0.321	-0.106	0.473
Exit		0.047	1.942	0.053	1.461	0.052	-0.257	0.039	-0.175
Total		0.024		0.036		-0.202		-0.225	

Notes: within and between effects from wage change decomposition as presented in Section 4.4. The columns labeled “%” report the proportion of the effect over total change in wages.

Source: authors’ sample of administrative data.

## Unemployment volatility and wage rigidity

In this section we explore the importance of wage rigidity on unemployment volatility. To do this, we connect our results with the theoretical literature that has analyzed the ability of the matching model to generate as much unemployment volatility as observed in the data. We first present some evidence with regard to the volatility of unemployment in both countries and then use the derivations of Section 2 to evaluate the extent to which the changes during the recession can be explained using the matching model.

The first two columns of Table 6 present statistics for productivity, unemployment, workers’ transitions and wages for Spain and Latvia during the period 2007 to 2011. Productivity,  $p$ , is the total factor productivity by the Federal Reserve Bank of St. Louis. The annual data is smoothed with a moving average to interpolate for quarterly time series. Unemployment,  $u$ , is the unemployment rate by the Spanish INE and the Central Statistical Bureau of Latvia. Finding rate,  $f$ , and separation rate,  $s$ , are constructed from our sample of the administrative data as the quarterly average

of monthly transition rates. Wage is the average real wage, deflated using the CPI. Time series of all these variables are plotted in Figures 1 and 9. For this exercise we used seasonally adjusted time series of logged variables.

To analyze the volatility of the time series we detrended the data with a Hodrick-Prescott (HP) filter with smoothing parameter  $10^5$  as in Shimer (2004). The standard deviation of detrended unemployment is about 20 times higher than the standard deviation of detrended productivity in Spain, while it is about 10 times higher in Latvia. This higher volatility of unemployment is related to similar differences between the two countries in both finding and separation rates. In particular, the standard deviation of the detrended finding rate is almost 12 times higher than that of productivity in Spain, while it is 5.6 times higher in Latvia. The analogous statistic for the separation rate is 8.3 and 3.6 for Spain and Latvia, respectively. In other words, the rigid-wage country has a volatility which is double the volatility of the flexible-wage economy.

To emphasize this connection, Table 6 also reproduces some statistics from Shimer

5. The results do not change if we use a linear trend instead.

(2004) for the US (third column of the table). We find that the US lies in between the two countries, with relative unemployment volatility higher than in Latvia and lower than Spain.

Another important factor is that the relative volatility of the finding rate is more than double that of the separation rate in the US. This is related to the relevance of the finding rate in explaining unemployment changes in the US. However, this is not so much the case in our samples in Spain and Latvia, where the relative volatility of the finding rate is about 50 percent higher than that of the separation rate, highlighting the importance of separations during the last recession in these countries.

The wage cyclicality in the US falls between the cyclicality in Spain and Latvia. The correlation between unemployment and real wages (both seasonally adjusted series) is -0.8 in Latvia, -0.17 in the US and 0.75 in Spain, and this is related to the degree of flexibility of wages. Latvia is close to the flexible wage setting. In contrast, the positive correlation in Spain is unmistakable; it is partly driven by the “inflation safeguard clause” as discussed earlier.

The last two columns of the table show the results of the simulations using a matching model calibrated for the US (Shimer 2004). It compares the results for a Nash bargaining setting — in which wages are flexible — and a rigid wage setting. In the flexible wage case, the correlation between unemployment and wages is -0.96, close to that observed in the case of Latvia. In the rigid-wage case this correlation is zero, closer to that of the US. In the model, rigid wages generate higher unemployment volatility because of the robust change in the finding rate (separation rate is a fixed parameter in this model). This result is qualitatively similar to the observed relationship in these countries because, as in

the model, the data shows that the economy with lower wage flexibility has higher finding rate and unemployment rate volatility. Nevertheless, while the comparison between the data and the model shows qualitatively similar outcomes, they are quantitatively very different for two main reasons. First, the volatility of the flexible wage case in Spain is much lower than the volatility observed in Latvia. Second, the unemployment volatility in Spain is even higher than that seen in relation to rigid wages. This second difference can be justified by the fact that the correlation between wages and unemployment in Spain is not zero as in the model but positive. Moreover, the finding rate volatility is higher in the model than in Spain; what the model misses is the separation rate cyclical changes.

Then, while Latvia can be characterized as the flexible wage economy, its volatility is much higher compared to that observed in the flexible-wage model, one of the reasons being that Latvia suffered both a very deep drop in productivity and a real interest rate rise. This last shock is not accounted for in these time-series analyses. To get a closer look at this aspect we take advantage of our derivations in Section 2. The finding and separation rate conditions derived therein allow us to discuss the effects of shocks in both productivity and interest rates, as well as to introduce different types of wage adjustments.

Table 7 provides statistics of changes between the last quarter of 2007 and the same period of 2010 for main variables. Panel (A) presents the log differences of the variables. Real mean wages of stayers,  $w_s$ , increased 0.03 log points during this period in Spain and fell 0.07 log points in Latvia. Wages of new hires fell in both countries, but only 0.02 log points in Spain and a much larger drop of 0.27 in Latvia. We also show the changes in real mean wages in quarter  $t$  for

those who will be displaced in quarter  $t+4$ ,  $w_{EX}$ . This wage was stable in Spain while it fell 0.22 log points in Latvia.

The differences in wage changes are also related to a big difference in shocks. The observed total factor productivity was 0.02 log points lower in Spain while in Latvia it was down by almost 0.1 log points. This drop, however, is related to both an aggregate shock and to composition effects. Composition changes take place in recessions because when productivity  $p$  is reduced, the reservation productivity  $R$  increases; some low productivity jobs are destroyed and the mean idiosyncratic productivity,  $x$  rises. The adjustment in employment and output by industry at the beginning of the recession is clear indication of this composition effect. Hence, we take it that the observed TFP measures  $px$  rather than  $p$ . We use an alternative measure of  $d$  in  $p$  as the average change in TFP of continuing firms. We approximate this by using the results from Hospido and Moreno-Galbis, that compute this rate at about -0.06 log points. In the absence of a similar estimate for Latvia, we use a calibrated version of the

model to account for this composition effect and multiply the change in measured TFP by 1.6 to get a change in  $p$  of -0.15 log points in Latvia.

While the shocks in productivity rates are stronger in Latvia than in Spain, the changes in finding and separation rates (and, then, in unemployment) are similar in both countries. In Spain, the finding rate dropped 0.38 log points, while in Latvia it fell by 0.41 log points. Separation rate increased by 0.18 and 0.17 log points in Spain and Latvia, respectively.

This implies that the response of workers' flows to shocks was stronger in Spain. Panel (B) of Table 7 displays the elasticities of workers' flows to changes in productivity  $p$ . We concentrate on the productivity shock which is the typical analysis. The finding rate elasticity is about 6 in Spain and 1.7 in Latvia. Additionally, elasticity of the separation rate is -3 in Spain and -0.71 in Latvia. Finally, the elasticity of unemployment is about four times higher in Spain than in Latvia.

But productivity is not the only shock. During the recession Latvia suffered substantial increases in interest rates. Like changes in

Table 6: Cyclicalities of wages and flows

	Spain	Latvia	US <sup>†</sup>	Matching model, Shimer (2004)	
				Flexible wages <sup>†</sup>	Rigid wages <sup>†</sup>
$\sigma_u/\sigma_p$	19.25	10.27	12.06	0.56	11.56
$\sigma_f/\sigma_p$	11.71	5.60	10.25	0.63	23.81
$\sigma_s/\sigma_p$	8.30	3.65	4.17	0.00	0.00
$cov(p, u)/\sigma_p$	-0.16	-0.20	-0.05	-0.01	-0.17
$cov(p, f)/\sigma_p$	0.10	0.13	0.03	0.01	0.38
$cov(p, s)/\sigma_p$	-0.05	-0.10	-0.03	0.00	0.00
$corr(u, f)$	-0.94	-0.88	-0.95	-0.96	-0.92
$corr(u, s)$	0.65	0.41	0.58	0.00	0.00
$corr(u, w)$	0.75	-0.80	-0.17	-0.96	0.00

Notes: Definitions:  $u$  is unemployment rate,  $f$  is finding rate,  $s$  is separation rate,  $p$  is TFP and  $w$  is real wage. Finding and separation rates are computed using the administrative sample, as for figure 9. Remaining variables are described in figure 1. For each variable the standard deviation ( $\sigma$ ) covariances and correlations are reported. All variables are logged, seasonally adjusted quarterly series. Measures of  $\_$  are deviations from an HP trend with smoothing parameter 100000.

<sup>†</sup>US data and matching model are from Shimer (2004).

real interest rates affect the value of a job and thus reducing the incentives to open a vacancy. by the same effect, a higher interest rate also implies higher separations. Higher discount rates reduce the incentives to wait for an improvement in idiosyncratic productivity, and more jobs are destroyed.

Real interest rates increased 0.09 log points in Spain and 0.8 log points in Latvia. This is a strong shock for Latvia, above the effect of productivity.

Again, this evidence relates to the analysis in Table 6: flexible wages imply lower elasticity of workers' flows. The difference in elasticities is strong.

We now proceed to link the wage dynamics and workers' flows through the model in order to analyze whether the different wage adjustments can explain the strong differences in elasticities in workers' flows. To emphasize this issue and to introduce the shock to interest rates we use the equations 4 and 7 of Section 2. These equations link changes in wages, productivity and interest rates to changes in workers' flows. We use  $w_S$  to measure the changes in incumbent wages,  $w_N$  to represent the newly hired wages, and  $w_{EX}$  is used as a proxy for changes in  $w_R$ , which denotes the wages at reservation idiosyncratic productivity. We set  $\eta = 0.33$ ,  $\gamma = \lambda = 0.1$ ,  $H(R) = 4$ ,  $IN = 0.7$  and  $IR = 1.126$ . These parameters arise from a calibration of the model and are fully explained in the Appendix.

Panel (C) of Table 7 shows the predicted changes in finding and separation rates using the formulas. For Spain, the calibrated equations predict changes of -.19 and +.27 log points for finding and separation rates, respectively. The predicted changes in Latvia are -.49 and +.20. All these changes are in the order of magnitude of the observed changes. But some differences

are important. Adjustment of finding rate in Spain, for example, is twice that much its predicted change. The converse is true for the separation rate.

On the whole, we learn that the experience during the recession could be explained by a model and different wage adjustments. The separation rates are also important and could be related to wage settings.

Table 7: The effect of the recession on the labor markets: changes between 2007 and 2010 and the model

	Spain	Latvia
(A) Log differences between 2007 and 2010		
$w_S$	0.03	-0.07
$w_N$	-0.02	-0.27
$w_{EX}$	-0.01	-0.22
$p\bar{x}$	-0.02	-0.09
$p$	-0.06	-0.24
$r$	0.09	0.80
$f$	-0.38	-0.41
$s$	0.18	0.17
$u$	0.32	0.30
(B) Elasticities		
$\eta_{f,p}$	6.29	1.73
$\eta_{s,p}$	-3.02	-0.71
$\eta_{u,p}$	-5.29	-1.26
$\eta_{w_S,p}$	-0.43	0.29
$\eta_{w_H,p}$	0.35	1.12
(C) Formulas		
$f$	-0.19	-0.49
$s$	0.27	0.20
$u$	0.29	0.40

Notes: Panel (A) shows the log differences in the variables from the end of 2007 to the end of 2010. Wages  $w_S$ ,  $w_N$  and  $w_R$  are real wages of stayers, new hires and *EX* groups, respectively. Unemployment is the steady state rate computed using equation (1). Panel (B) reports elasticities of variables with respect to  $p$ . Panel (C) shows the result from plugging in changes in productivity and wages of panel (B) in equations (4), (5) and (7). Other parameters used for the calibration of these formulas are  $\eta = 0.33$ ,  $\gamma = \lambda = 0.1$ ,  $H(R) = 4$ ,  $IN = 0.7$  and  $IR = 1.126$  and are the result of a calibration of the matching model as explained in the Appendix.

# Conclusions

In theory, during a recession, the employed workers in a rigid-wage economy should be open to greater wage adjustment compared to workers in a completely flexible economy. When workers' flows are analyzed through a model with frictions in the labor market, the conclusion is similar: rigid wages imply higher finding rate and unemployment volatility.

An ideal research design to test this theoretical result would be to compare two sets of identical economies affected by the same shocks, allowing one group to flexibly adjust their wages, and imposing wage rigidity on the other group. This experiment, however, is not available to us, an obvious reason being that wage dynamics cannot be imposed by the researcher. Besides, wages have been found to be typically rigid in many countries, and a flexible-wage economy is hard to come by.

This paper compares the wage dynamics and workers' mobility during the period 2004-11 in Spain and Latvia. These two economies are similar in their boom, fuelled by the real estate sector, and the global shock of the recession. They are, however, different in many other respects. Wage bargaining and other labor market institutions such as the "inflation safeguard clause" impose a strong wage rigidity in Spain, to the extent that real mean wages were still peaking even after unemployment exceeded the 20 percent mark. In contrast, the Latvian real mean wage decreased by about 10 percent in the same period.

The choice of these two countries rests on three main facts: first, both countries have social security data to build measures of wage rigidity and workers' mobility during the recession. Second, the rise in unemployment was high in both countries which allows for a more significant effect on

wages and mobility. Third, both countries had fixed exchange rates, making wage adjustment even more important. Because of these factors, the Spanish and Latvian comparison provides clear and important insights.

The first finding of our paper is that the wage dynamics are very different in both countries, with Latvian wages being much more flexible than Spanish wages. This finding is supported not only by the time series of real wages in both countries, but also by very diverse measures of wage rigidity. These measures include the distribution of log wages of stayers, as well as the mean wage change of workers who changed jobs.

The second central finding is that workers' flows, both into and out of unemployment, are far more responsive with respect to productivity shocks in the rigid-wage economy. In fact, the elasticity of unemployment to productivity is four times higher in Spain than in Latvia. Additionally, the changes in workers' flows are much more persistent in Spain than in Latvia. We also show that the order of magnitude of changes in the finding and separation rates can be predicted by conditions derived from a matching model. In this model, we introduce the observed changes in real wages, productivity and interest rates, as well as some other parameters. These findings are in line with the theoretical results.

The third finding is that the separation rate plays a more important role than was previously documented in explaining the rise in unemployment during a recession. The theoretical literature has focused on the analysis of the finding rate which tends to be more cyclical than the separation rate. Also, previous empirical results show that the finding rate is more important in explaining the change in unemployment, probably due to the fact that the shocks have been milder

than the ones observed in our sample. Our results suggest that the analysis of changes in the separation rate is important. We also observe that the elasticity of separation rate is four times higher in the rigid-wage economy. This suggests that job destruction decisions are related to wage dynamics, and that wage rigidity tends to amplify the effect of shocks not only in finding rate, but also in separation rate.

Overall, our paper presents empirical evidence that supports the theoretical conclusions: that rigid wages generate higher volatility in workers' flows, and in unemployment.

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# Appendix

## Details about data

We had identification numbers for men with general insurance and generated quite a large sample (10 percent of total observations) stratified by age group and number of observations group.

The type of firm can be identified directly from the data.

We eliminated all workers with more than one job.

For Latvia we considered the following types as public sector administration (percentage of employment in 2008 in parenthesis): Budget authority (19 percent), Commanding (0.1 percent), Municipal enterprise (0.1 percent), Public company (0.1 percent), Company or religious organization (1.3 percent). In 2008 these represented about 22 percent of employment.

We considered the following as related to self-employed (employees of self-employed) and/or agricultural employment: Individual merchant (1 percent), Individual company (0.4 percent), Cooperative society (0.5 percent), Peasant farming (1.1 percent), Fisherman holding (0.1 percent). In 2008 these represented about 3 percent of employment. (These jobs are not self-employed but employees of an individual. In any case, we decided to drop these observations throughout the analysis.)

We then kept limited liability companies (65 percent of total employment in 2008), corporations (9.6 percent), and "another form of business" (0.5 percent).

We dropped any insurance that was not general insurance. In 2008 other types of insurance represented about 8 percent of employment in Latvia. New types of

insurance/contracts were implemented after 2010 for micro-enterprise employment. Nevertheless, given that we do not have these firms in the first place (these are the employees of individual self-employed/employers) there is no bias in not including these new types of insurance.<sup>1</sup>

We kept observations for male workers between 20 to 60 years of age.

Some comments about the particularities of the data and implications for the methods used:

**Zero wages:** The data has many observations with zero in wages in Latvia, but less in Spain. These could be: seasonal employment, workers in unpaid leave, zero hours worked in a part-time job. We found that the proportion of observations with zero wages goes up during the recession (from 6 percent to 16 percent in limited liability companies), suggesting that many of these are related to the cycle as a way to reduce overall labor costs. In our analysis of wage changes, we log all wages, eliminating the difference between zero wage and missing observation. Thus, our analysis of wage cuts misses this type of adjustment, such as suspensions.

**Very low wages:** In Latvian database there are many observations with very low wages, below minimum wage. They could mostly be part time jobs. We deal with this by excluding all jobs with wages less than minimum wage from the analysis of wage changes.

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1. For these new types of insurance, related to the micro-enterprise employee income policy, there is a different way to pay contributions; it is related to turnover and to total payroll rather than to individual wages. For this reason, it is possible that declarations of wages of individual workers could be misreported even when total taxes paid are correctly declared.

## Full calibration of the model

For the calibration of the model of Section 2 we consider a period to be a month. Interest rate is set to  $r=0.004$  equivalent to a 5 percent real interest rate. Idiosyncratic shocks are set to  $x_N=1$  for new hirings and for incumbents there are draws from uniform distribution with support 0.55 to 1. The probability of a shock to idiosyncratic productivity is set to  $\gamma=\lambda=0.1$ . For the matching function an  $\eta=0.33$  and  $m_\theta=0.3$  are chosen. Finally, the cost of opening a vacancy is set to  $c=0.8$ . As usual we imposed the normalization of productivity  $p=1$ . If wages are set to  $w_I=0.8$  and  $w_N=0.75$  then this calibration gives a separation rate of 3.6 percent and finding rate of 45 percent, with a steady state unemployment rate of 7 percent. These rates are similar to those of Pissarides (2007), like most of the parameters of the calibration.

Importantly, when the aggregate productivity level is reduced,  $x$  increases so that the change in  $px$ , related to the observed productivity level, reduces less than the initial shock in  $p$ . If wages are flexible then changes in  $px$  are small. With rigid wages the difference between the two measures is substantial. To account for this fact, we imposed an elasticity of wages with respect to productivity shocks of 0.5 and computed that the change in  $p$  should be 0.025 to generate a  $px$  change of 0.01. Thus, we use this number to estimate the change in  $p$  in Latvia.

Overall, this calibration gives a  $\Gamma_N=0.73$ ,  $\Gamma_R=1.126$  and  $H(R)=4$ . These values are then used in the numerical exercise with the formulas.

## Descriptive statistics

**Table C.1: Descriptive statistics – Spain**

	(1)	(2)	(3)
Variables	Total	From 04 to 08	From 09 to 11
Num.of obs (in th.)	2850.11	1820.55	1029.57
Numb. of valid corrected wages (in th.)	1973.93	1301.93	671.99
Prop. of bottom capped SS wgs.	0.01	0.01	0.00
Prop. of top capped SS wgs.	0.13	0.12	0.13
Mean numb. of obs per id.	66.18	45.41	28.75
Number of individuals	43066.00	40089.00	35811.00

**Table C.2: Descriptive statistics**

	(1)	(2)	(3)
Variables	Total	From 04 to 08	From 09 to 11
Num.of obs (in th.)	3612.68	2126.67	1486.01
Numb. of valid corrected wages (in th.)	2188.01	1284.41	903.60
Mean numb. of obs per id.	56.40	37.29	29.55
Number of individuals	64051.00	57026.00	50284.00
Number of monthly observations (in th.)	3612.68	2126.67	1486.01

# Notes

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The Global Development Network (GDN) is a public international organization that supports high quality, policy-oriented, social science research in developing and transition countries to promote better lives. It supports researchers with financial resources, global networking, and access to information, training, peer review and mentoring. GDN acts on the premise that better research leads to more informed policies and better, more inclusive development. Through its global platform, GDN connects social science researchers with policymakers and development stakeholders across the world. Founded in 1999, GDN is currently headquartered in New Delhi.

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