Labour markets during recessions – evidence on the role of wage rigidity and hysteresis

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Abstract: The financial crisis has led to the strongest global downturn since the Great Depression in the 1930s. Although economies are stabilising and recovering, the recession is still feeding through the labour market. In this paper, we analyse the labour market reactions to past financial crisis by extracting stylised facts about the role of wage rigidities and hysteresis at industrialized OECD countries from 1970s to the present. We find substantial evidence that the labour market repercussions of financial crisis tend to be stronger than those of other downturns. The shadow of recessions in terms of higher unemployment and long-term unemployment is not only a function of the severity of the recession, but also the flexibility at the micro-level and the ability to restructure as captured by worker flows. In addition, wages do not tend to work symmetrically during upswings and downturns, and some downward nominal and real wage rigidity has added to the stronger employment and output losses following financial crises. When looking at individual episodes, this pattern is confirmed for the ERM II crisis in the early 1990s, but is less evident in the the current crisis.

The opinions expressed herein are those of the authors, and do not necessarily reflect the views of the ECB, the Bank of Finland, or the Eurosystem. We thank participants of the Wage Dynamics Network for very helpful comments. All errors are our responsibility.

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1. INTRODUCTION

The financial crisis has led to the strongest global downturn since the Great Depression in the 1930s. Although economies are stabilising and recovering, the Great Recession – as it is now termed – is still feeding through the labour market. The labour market impact of the recession has been rather heterogeneous among industrialized countries – in some cases like the U.S., but also Ireland and Spain, drastic unemployment increases have gone far beyond earlier experiences, while in many other countries like Germany, France or Finland employment reactions have been rather muted given the magnitude of the downturn. A number of special factors contributed to these disparities – such as the policy measures taken during the recession or the sectoral composition of shocks. However, while special factors undoubtedly played a role, it leaves open a more general question of the right yardstick for the labour market reaction compared to normal business cycle fluctuations: the issue is whether labour market reactions to financial crises are indeed systematically different from normal downturns, and if so what drives this difference? Forming a view to which extent standard mechanisms underlying hysteresis effects play a role is also crucial to clarify views on the outlook for the recovery. In this paper, we look at this question by applying standard approaches proposed in the literature to extract stylized facts – first at the level of descriptive statistics and chart analysis, and then using formal econometric approaches.

The protracted impact of economic downturns on labour markets has been captured under the concept of hysteresis, which essentially imply that demand shocks to employment have a tendency to perpetuate and increases in actual unemployment induce rising structural unemployment (see e.g. Ball 2009). Different reasons have been put forward to rationalize this phenomenon linking it to wages and labour market micro-dynamics. One driving mechanism is the "insider/outsider" effect on wage setting. Insiders may have an incentive to set the entrant wages above the reservation wage restricting the access of those who have lost their jobs in downturns to re-enter employment and hence slowing down the employment creation. A second mechanism, emerging at the micro level, is the loss of skills associated with unemployment. Temporary employment shocks may persist because, on the one hand, workers loose their skills during unemployment and become detached from the labour market and reduce the intensity with which they search for jobs. On the other hand, employers reduce the supply of jobs as the overall duration of unemployment increases and the average quality of available labour falls (Machin and Manning 1999, Pissarides 1992).

When looking at crisis experiences in industrialized countries in the second section, aggregate statistics suggest three key patterns on the labour market reaction to crises. First, employment takes substantially longer to recover than output. This holds for 'normal' circumstances and for a larger extent to financial crises. Second, participation rates (labour supply) decline persistently only after severe crisis, and recovers more rapidly for other downturns. Third, real consumer wages tend to deteriorate substantially more during severe financial crises than otherwise, while unit labor cost growth remains in negative territory for an extended period of time also after normal downturns.

To understand the factors driving the persistence of unemployment, the third section, uses a standard autoregressive distributed lag model (ARDL) approach which has been employed recently to also capture the pattern of output losses and changes in the NAIRU following recessions (see Cerra and Saxena 2008; Furceri and Mourougane 2009a, b). To link the crisis response to the factors mentioned in the labour market matching theories, we disentangle the pattern of unemployment and long-term unemployment and capture to which extent developments in long-term unemployment relate to the severity of the crisis and the micro-flexibility of labour markets in terms of worker flows in and out of unemployment. Cross-country evidence suggests that the impact of severe recessions on unemployment and long-term unemployment is indeed stronger, though not unambiguously longer lasting than during smaller downturns. At the same time, the results suggest that less micro-flexibility is linked to higher long-term unemployment rates following recessions. On this account, flexibility and the ability to restructure the economy seems to be an important precondition in coping with the crisis impact. The structural reforms introduced in European countries which led to more mobile labour markets (see Boeri and Garibaldi 2009; Apraia and Curci 2010) should therefore pay off now in facilitating the restructuring.

The stylized facts derived from chart analysis leave open to which extent wages fully accommodate the downturn and the rise in unemployment, or whether there are signs of wage rigidity, which then by themselves could lead to employment and output losses. As a first step to assess this issue, section 4 presents results from a regression approach allowing for an asymmetry in wage adjustment during upswings and downturns. The evidence on nominal and real downward wage rigidities existing in industrialized countries suggests that the wage reaction may indeed be asymmetric, as suggested by a magnitude of evidence, (see International Wage Flexibility Project (IWFP) and Wage Dynamics Network (WDN) 2009 results). Wage indexation schemes may have a uni-directional element, adjusting for upward price movements, but not for disinflation. Nominal wage rigidity puts a floor on base wages, which would be more binding during downturns. In line with this reasoning, our empirical evidence indicates that wages do not react systematically to downturns as they do for booms. This can be taken as a first indication of wage rigidity.

The next sections then looks at the employment and output effects of wage ridigity, first for a cross section of countries over time and second, by analysing more specifically at the ERM II crisis in the early 1990s and the current “Great Recession”. First, the empirical evidence on the existence of downward wage ridigity is corroborated. This has clear implications for the deviating pattern of employment and unemployment impulse responses emerging for financial crises compared to normal downturns. The employment reaction is substantially more pronounced and unemployment ‘takes off’ after financial crises. The IMF (2010) has recently conducted a similar analysis relying on a single equation approach and found that financial market indicators have a separate impact on employment (and respectively unemployment) developments, in addition to the normal business cycle dynamics. These crisis effects may emerge among others from balance sheet adjustments by firms and uncertainty. On this account, wage rigidities would contribute to the more severe impact found for financial crises, but they are clearly one among other possible factors.

Finally, we compare recent events with the ERM II crisis, using the approach applied by Bernanke and Carey (1996) to the Great Depression. This refines our earlier analysis by focusing on particular crises and specifying the type of wage rigidity – nominal inertia or limited reaction of wage to unemployment in the the downturn. We find a clear downward sloping aggregate supply schedule during the ERM II crisis, suggesting that the wage rigidity was an important determinant of aggregate supply during the ERM II crisis. The negative association between industrial output and real wage reflects primarily a sluggish adjustment of nominal wages during the period. However, in the immediate crisis phase of the current recession up to 2009Q3, there is no statistically significant relationship between industrial output and real wages. Consistently with this, we find considerable difference in the degree of nominal wage inertia during these two episodes. In the current crisis, the degree of nominal inertia has been substantially lower for the cross section of countries when compared to the ERM II crisis. Thus, the fact that wage rigidities seem to have played a less pronounced role during the initial phase of the current recession may also help to explain the more muted employment reaction in some countries. This could reflect the success of the structural labour market reforms implemented during the last decade in some countries.

2. HISTORICAL PATTERNS AND SOME EVIDENCE

We start by looking at the dynamics of wages and employment during previous financial crises. The aim is to enhance our understanding of how labour markets respond to the current financial turmoil, by assessing how labour markets responded to similar shocks in the past and comparing this with other recessions. More specifically, we examine the evolution of nominal and real wage growth, employment, unemployment, participation, output and inflation, during and after crises in a sample of countries that have undergone substantial shocks to the financial sector.

Our focus is on recessionary periods in advanced economies, including most euro area and G7 countries using quarterly data from the 1970s onwards.[1] Following the literature (see IMF 2009), economic cycles in each country in our data set are defined based on movements in real GDP using the so-called BBQ algorithm for dating crises. The approach was developed by Bry and Boschan (1971) and extended by Harding and Pagan (2002).[2] For a particular series, the algorithm defines cycles by identifying troughs and peaks – any quarter lower or higher than the preceding and succeeding two quarters – and using various censoring rules about the minimum duration of the overall cycle as well as the phases of expansion and contraction.[3] Overall, we find around one

[1] The full sample of countries includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. While coverage is reasonably good, there are some gaps in particular for some compensation data.
[2] The MATLAB coding can be found at: http://www.ncer.edu.au/data/.
[3] The algorithm matches closely to other methods of defining cycles such as the recession dates identified for the US by the NBER.

hundred recessions across the twenty-one countries.[4] Table A in the appendix provides details on the dates of the cycles in each country of the sample. Table 1 below provides some summary statistics on the number and average severity of the recessions in each country in our sample. The duration of a recession (expansion) counts the number of quarters between a peak and trough (between a trough and peak). The amplitude of a recession (expansion) measures the percentage change in GDP between a peak and trough (between trough and peak).

Table 1. Cyclical features by country

	Recessions			Expansions		
	Number	Duration	Amplitude	Number	Duration	Amplitude
Australia	5	3.6	-1.9	4	15.3	17.5
Belgium	6	3.2	-1.1	5	18.0	13.6
Canada	3	4.0	-2.8	3	33.0	34.7
Denmark	6	4.3	-1.6	6	19.0	14.4
Finland	5	4.8	-3.9	5	19.8	25.2
France	2	2.5	-1.6	2	64.5	45.5
Germany	6	3.2	-1.5	6	19.5	14.3
Greece	7	3.6	-7.0	6	10.2	14.6
Ireland	2	3.0	-1.1	2	46.0	141.0
Italy	8	3.1	-1.3	8	13.6	10.3
Japan	3	4.7	-2.4	3	15.3	9.2
Luxembourg	4	3.5	-3.4	3	33.7	65.6
Netherlands	5	4.0	-2.2	5	24.4	26.3
New Zealand	9	3.3	-6.2	10	11.8	16.8
Norway	3	2.3	-2.3	2	22.5	20.7
Portugal	4	4.5	-3.4	4	29.8	29.8
Spain	4	3.0	-1.1	4	30.5	29.2
Sweden	3	7.3	-3.9	3	35.0	31.5
Switzerland	8	3.8	-2.3	8	13.4	8.9
United Kingdom	4	4.8	-3.6	4	30.3	27.5
United States	4	2.8	-2.4	5	27.8	29.6

Note: Table shows the average durations and amplitudes for each country. The duration of a recession (expansion) counts the number of quarters between a peak and trough (between a trough and peak). The amplitude of a recession (expansion) measures the percentage change in GDP between a peak and trough (between trough and peak). The sample period is 1970Q1 to 2009Q1.

The second step is to identify those cycles that were associated with episodes of financial crisis or turmoil. A number of papers have already made comparisons of periods of financial crisis and we follow them closely in identifying the crisis episodes. Our approach is nearest to the IMF (2008 and 2009), which identified fifteen recessions that were associated with (i.e. followed) financial crises. In doing they relied on the narrative analysis of Reinhart and Rogoff in a series of recent papers describing banking crises over the past four decades.[5] Those papers identified five major or 'systemic' crises – Spain in the late 1970s, Norway in the late 1980s and Sweden, Finland and Japan in the early 1990s – and thirteen crises that were not as severe. Some of those crises, however, were not followed by recession episodes. For example, the US Savings and Loans crisis in the early 1980s took place during a period of expansion; likewise, the collapse of Barings Bank in 1995 was not

[4] Note that we omit the latest recessions – in 2008 and 2009 – from our analysis.

[5] That analysis built on work identifying banking crisis episodes from the World Bank: Caprio, G, Klingebiel, D, Laeven, L and Noguera, G at: http://www1.worldbank.org/finance/html/database_sfd.html

followed by a recession in the UK. We have followed the IMF's approach of omitting crises not immediately associated with a recession. Overall, we identify sixteen recessionary episodes which are associated with financial crisis – five 'systemic', eleven 'non-systemic' – which are listed in Table 1. The definition of 'systemic' is subjective. Broadly, it means any crisis in which the volume of non-performing loans was high and most or all bank capital was exhausted – see Laeven and Valencia (2008).

Table 2. Periods of financial crisis

	Business cycle dates		
	Previous peak	**Trough**	**Subsequent peak**
Systemic crises			
Spain	1978Q2	1979Q1	1980Q4
Finland	1989Q4	1993Q2	2001Q1
Sweden	1990Q1	1993Q1	2008Q1
Norway	1988Q1	1988Q4	1992Q3
Japan	1993Q1	1993Q4	1997Q1
Non-systemic crises			
Australia	1990Q1	1991Q2	
Denmark	1986Q4	1988Q2	1992Q3
France	1992Q3	1993Q2	2008Q1
Germany	1980Q1	1980Q4	1982Q1
Greece	1992Q1	1993Q1	1994Q3
Italy	1992Q1	1993Q3	1996Q1
Japan	1997Q1	1999Q1	2001Q1
New Zealand	1986Q3	1987Q4	1990Q4
United Kingdom	1973Q2	1974Q1	1974Q3
United Kingdom	1990Q2	1991Q3	2008Q2
Canada	1981Q2	1982Q4	1990Q1

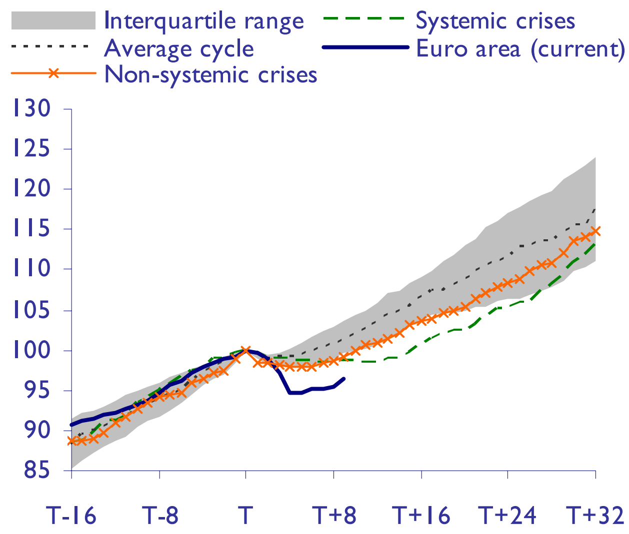
Using the definitions of cycles and crises established above, we provide a short overview of various macro series during recessions and crises. The following charts show developments preceding and following the recessions identified in our sample.[6] In each chart, quarter *T* represents the peak in the output level before a recession. The dotted line shows the average or 'normal' cyclical path, found by averaging across countries and cycles in our sample. The grey shaded area around that shows the range of experience across countries and cycles – summarised by the inter-quartile range. The crossed and dashed lines identify the average path of activity following systemic and non-systemic crises. Of course, this average profile masks some heterogeneity amongst the countries that experienced banking crises.[7] Finally, the thick bold line in the charts shows the recent euro area experience.[8]

[6] See also Tables A2 and A3 in Annex 1 for more details on changes in labour market variables during recessionary periods.
[7] Table A2 in the Annex 1 provides details on each of the financial crisis episodes.
[8] For a more detailed discussion of the recent euro area recession, see the article "The latest euro area recession in a historical context" in the November 2009 edition of the ECB's Monthly Bulletin. "

Charts 1 and 2 illustrate developments in activity. As documented elsewhere, there are some stark differences in the depth and duration of activity declines between 'normal' cycles and those associated with financial crisis. So-called 'normal cycles' tend to involve a decline and then a sharp recovery – a pronounced '*V*' shape. Banking crises – particularly the systemic variety – have involved much more protracted '*U*'-shaped recessions (Chart 2). In addition, although growth eventually recovers, there would appear to be a permanent loss in output – the level does not return to the previous trend (Chart 1).

Chart 1. Activity levels – real GDP

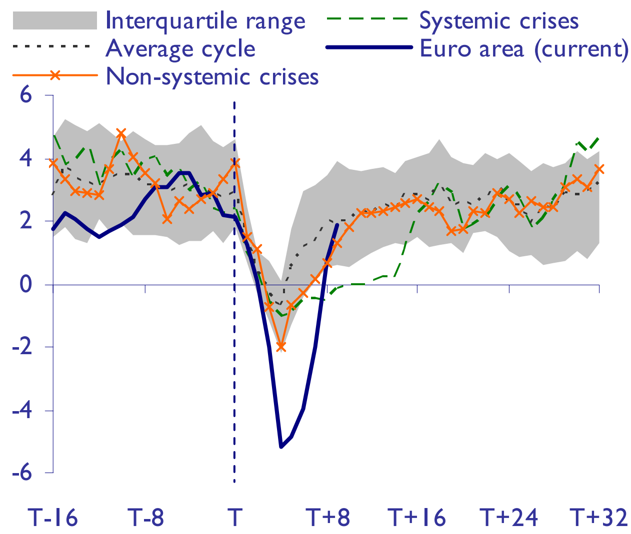
(real GDP, T (peak)= 100)



Sources: OECD and authors' calculations

Chart 2. GDP growth

(year-on-year growth, T = peak)



Sources: OECD and authors' calculations

Table 3 provides some figures. The average recession in our sample lasts nearly four quarters, whereas recessions following systemic financial crises lasted on average seven quarters; those following non-systemic financial crises lasted nearly five quarters. Recessions following systemic crises are also deeper, with GDP falling on average 4.6% from peak to trough, compared to around 3% for average crises. Finally, the duration of a recovery – the number of quarters after a trough before activity has recovered to the level of the previous peak – is also much longer for recessions associated with financial crises.

Charts 3 to 6 show developments in employment, unemployment and participation. Mirroring the activity declines, employment has fallen much more rapidly during periods of financial turmoil than other recessions. The employment response also appears to have been much more protracted: during the systemic crises, employment fell and then stagnated for a substantial period of time, with a sustained recovery coming only after about seven to eight years after the peak. Although the rapid decline in labour demand was offset to some extent by lower participation (Chart 6), sharp increases in unemployment were observed, which continued to rise and remain above pre-crisis levels well after the trough in activity had been passed. (Chart 5).

Table 3. Business cycles – some summary statistics

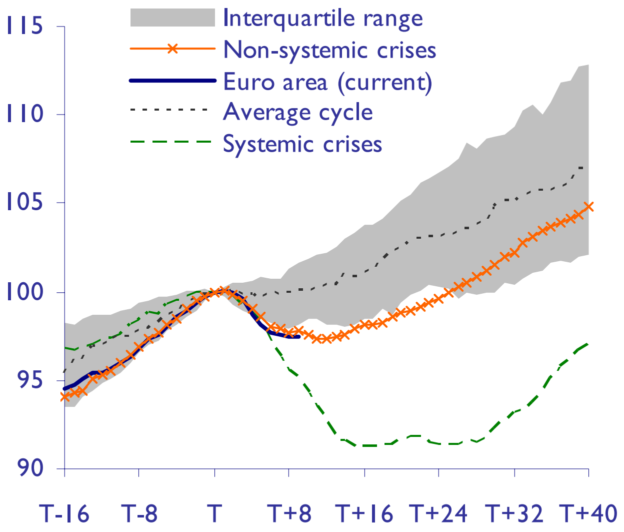
	Duration (quarters)			Amplitude (% GDP)	
	Recession	Recovery	Expansion	Recession	Expansion
Systemic crises					
Mean	7.0	6.2	25.2	-4.6	24.4
Standard deviation	5.5	4.7	21.4	4.7	23.9
Coefficient of variation	0.8	0.8	0.8	-1.0	1.0
Observations	5	5	5	5	5
Non-systemic crises					
Mean	4.9	6.9	21.5	-2.8	16.3
Standard deviation	1.6	5.7	23.2	1.6	19.7
Coefficient of variation	0.3	0.8	1.1	-0.6	1.2
Observations	11	11	10	11	10
'Normal' cycles					
Mean	3.7	4.6	21.6	-2.9	23.6
Standard deviation	2.2	5.3	20.5	2.9	35.1
Coefficient of variation	0.6	1.2	0.9	-1.0	1.5
Observations	101	101	98	101	98

Notes: The duration of a recession (expansion) counts the number of quarters between a peak and trough (between a trough and peak). The duration of a recovery measures the number of quarters after a trough before is back to the previous peak level. The amplitude of a recession (expansion) measures the percentage change in GDP between a peak and trough (between trough and peak).

Turning to compensation variables, Charts 7 and 8 show changes in compensation and unit labour costs (both deflated using CPI). With some significant differences in inflation regimes across our sample, we have focused here on real variables. On average, real compensation growth tends to moderate during a recession, declining after the peak and picking up again after about eight quarters. The decline in real compensation was much larger in recessions following a severe banking crisis, with real compensation showing pronounced falls and compensation growth only recovering after four years. During an ‘average’ cycle, real unit labour cost growth has tended to rise slightly following the peak in activity. This reflects the slight lag in adjustments in compensation combined with a faster fall in productivity. Thereafter, real unit labour costs have fallen, with real unit labour cost growth remaining subdued for considerable time. This pattern was more pronounced in economies hit by a severe downturn in demand following a financial crisis, but overall real unit labour cost growth rates remain in negative territory for a long time for all downturns.

Chart 3. Employment levels

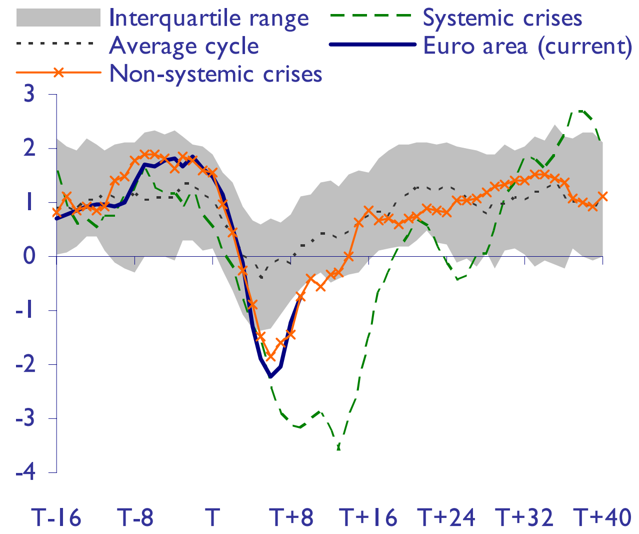
(T (peak)= 100)



Sources: OECD and authors' calculations

Chart 4. Employment growth

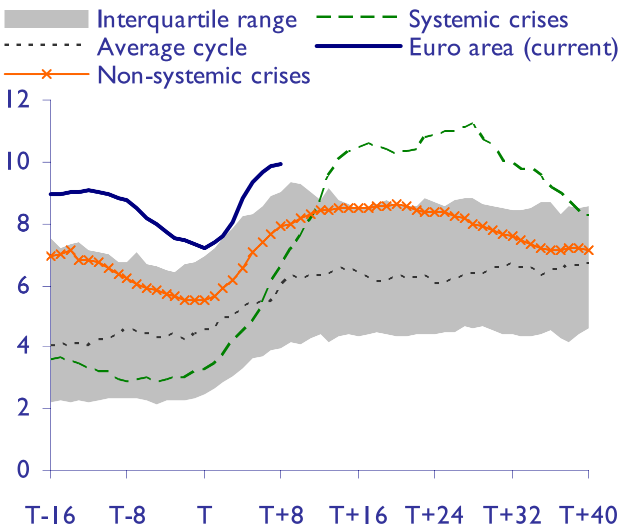
(year-on-year growth, T = peak)



Sources: OECD and authors' calculations

Chart 5. Unemployment levels

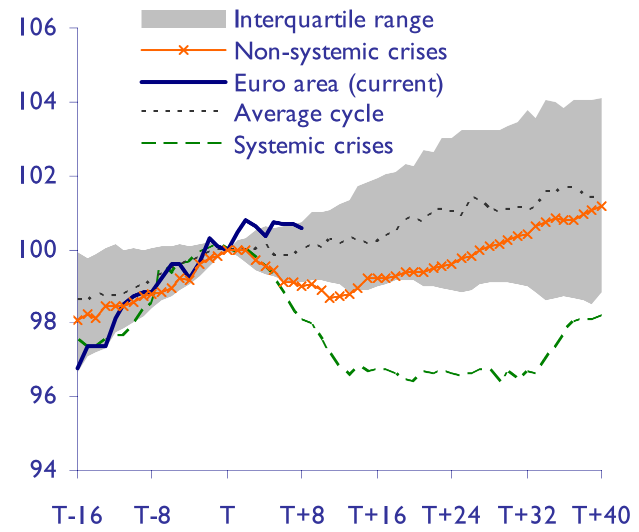
(percent of labour force, T = peak)



Sources: OECD and authors' calculations

Chart 6. Participation levels

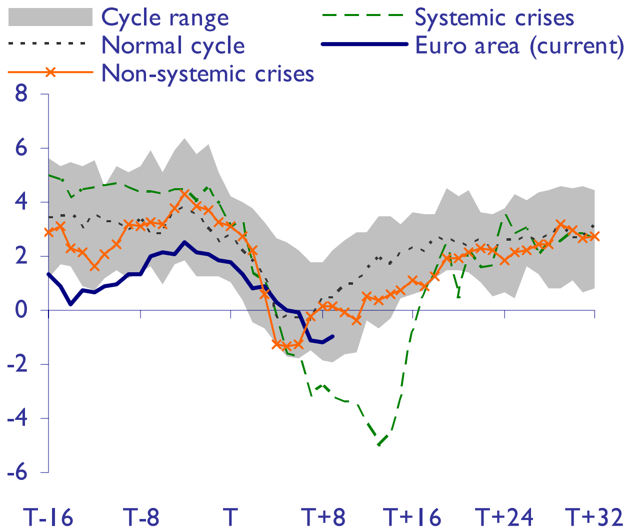
(T (peak)= 100)



Sources: OECD and authors' calculations

Chart 7. Real compensation (deflated using CPI)

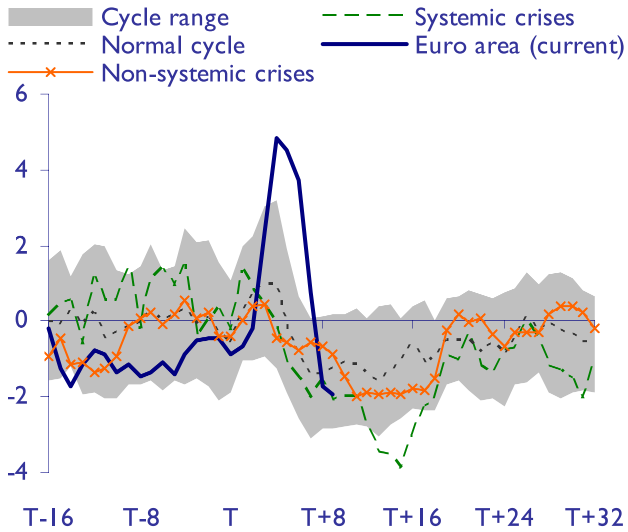
(year-on-year growth, T = peak)



Sources: OECD and authors' calculations

Chart 8. Real unit labour costs (deflated using CPI)

(year-on-year growth, T = peak)



Sources: OECD and authors' calculations

BOX: SOME CONCEPTUAL CONSIDERATIONS

The objective of this paper is to identify some empirical patterns of past crisis developments. Nevertheless, it seems useful to briefly refer to a framework used in the literature to explain labour market fluctuations during recessions and the link with wage rigidities in order to propose a conceptual line of reasoning for the issues at hand.

Changes in unemployment can be explained by worker flows

$$\frac{du}{dt} = s_t(1-u_t) - f_t u_t$$

where s is the separation rate, f is the job finding rate, u is the unemployment rate and subscript t denotes time. There is some controversy for the US, what role the separation rate plays compared to the job finding rate to explain overall unemployment fluctuations. However, for European countries, both seem to affect the development of unemployment in the context of recessions and the subsequent recovery, with the separation rate being countercyclical and the job finding rate being procyclical.

There are different mechanisms why one might observe the asymmetric pattern desribed above where unemployment rates tend to increase substantially during the recession, but then take long to decline afterwards. First, the relationship itself can contain an asymmetry if the job finding rate is exogenous *with respect to unemployment. Gross worker flows depend on both the job finding and unemployment rate. The search pool becomes smaller during booms as the unemployment rate declines, and gross flows vanish for a given job finding rate.*[9] *The opposite holds for the separation rate so that the ratcheting up of unemployment after a recession depends on the relative volatility of job finding and separation rates. Second, job finding rates may be duration dependent. If the job finding rate is negatively related to the duration of unemployment, the emergence of long-term unemployment may hamper a decline of the unemployment rate. Under standard assumptions, as formulated by Shimer (2008), the hazard rate of ending an unemployment spell h is a function of the duration* τ*,* $h=1/2\tau$*. The probability of a worker who has been unemployed for the time* τ *to be employed at* $\tau+1$ *is then* $F(\tau)=\left(1-\sqrt{\tau/(1+\tau)}\right)/2$ *, i.e. it declines the longer a worker stays out of the job. In standard models this is seen as one underlying mechanism of hysteresis effects where current unemployment depends on past demand shocks.*

Finally, wage stickiness may contribute to asymmetric unemployment dynamics and output losses. Standard matching models are not able to explain the empirically observable fluctuations in unemployment. Hall (2005) among many others has argued that wage stickiness is one plausible mechanism leading to higher volatility and some delay in the reduction of unemployment. In standard matching models, wages are the outcome of a Nash bargaining solution. Hall (ibid) discusses different wage rules, which may emerge as an equilibrium result of collective bargaining practices where wages respond only partially to productivity developments. For example, if wages w are related to long term productivity trend z_t^p*,* $w_t = wz_t^p$*, a wage rule partially smoothing out productivity shocks could be*

$$w_t^p = \alpha w + (1-\alpha)w_t^N$$

where w_t^N *is the state contingent Nash bargaining wage reflecting productivity shocks, and* $0 \le \alpha \le 1$ *indicates the degree of smoothing. An alternative wage rule could adopt an adaptive wage setting mechanism, reflecting the fact that past labour market conditions exhibit persistent effects on current wages such that*

$$w_t^A = (1-\alpha)w_{t-1}^A + \alpha w_t^N$$

In both cases, the wage adjustment would lead to an asymmetric unemployment response to a productivity shock, where the initial rise in unemployment only dissipates slowly over time. This result may however not be directly driven by a decline in the change in the job finding rates or duration of search, but also derive from the slack of the economy and low productivity growth.

[9] See Hairault, Langot and Osotimehin (2008) for a model analysing fluctuation in job finding and separation rates along these lines.

3. UNEMPLOYMENT DYNAMICS AND LABOUR MARKET FLOWS

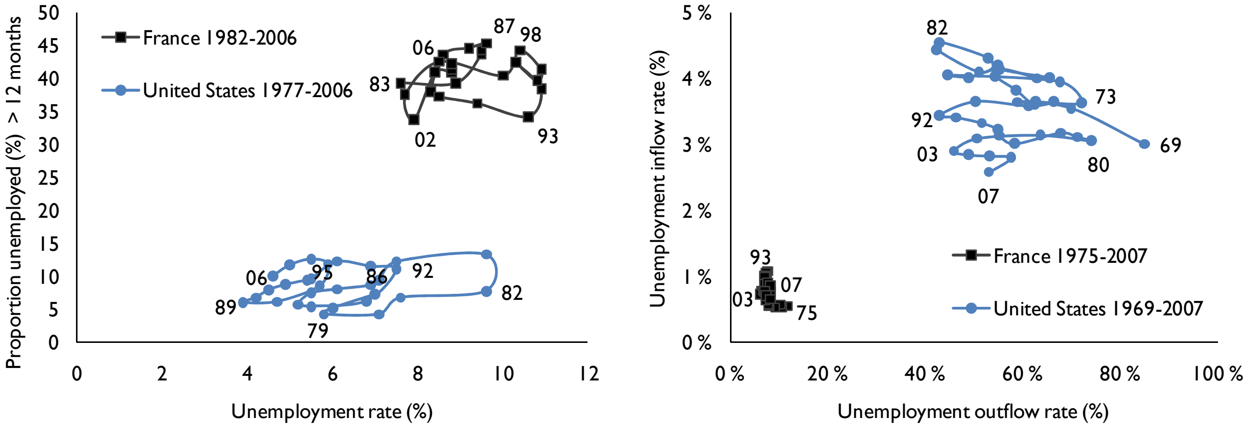
As shown in the previous section, severe recessions have tended to throw a long shadow on labour markets even after output has recovered. Unemployment rates have remained high for prolonged periods following a crisis, but long-term unemployment has proved to be even more persistent. In this section, we look more closely at the impact of recessions and crises on unemployment rates and long-term unemployment. We examine the impact of severe recessions on unemployment and long-term unemployment, and we are particularily interested in whether the unemployment responses differ depending on the degree of reallocation in the economy. We use average worker flows into and out of unemployment as a proxy for of reallocation. An autoregressive distributed lag model (ARDL) is used for the empirical analysis to account for the effects of recessions and crises on our variables of interest. Results show that not only the strength, but also the timing of the reaction of unemployment and long-term unemployment differ for recessions of different severity. At the same time, worker flows are important for the impact of crises on unemployment and especially long-term unemployment as both variables tend to rise more and show more persistence in recessions when reallocation rates are low.

3.1. Unemployment dynamics and labour market flows: the data and stylized facts

Given the focus of this section, the data basis differs from that of other sections. The analysis is based on measures of unemployment and the unemployment stock by duration for 21 industrialized countries taken from OECD (2010). Data are available at an annual frequency and the starting years in our sample varies between 1970 and 1994. The OECD data is based on Labour Force Surveys in different countries, and the data has been standardized to adhere to the same structure. The same data source is used for the total labour force as percent of the working population 15-64. We also use estimates by Elsby et al. (2008) on inflows to and outflows from unemployment for 14 OECD countries. In the definitions of recessions and crises we follow the other sections, albeit adopting the definitions to annual data. This will be discussed in more detail below.

The evolution of unemployment and long-term unemployment (LTU) display common patterns. Two general qualitative features emerge across countries and business cycles as previously documented by Machin and Manning (1999). First, there is a generally positive relationship between the unemployment rate and the incidence of long-term unemployment. Second, long-term unemployment lags the unemployment rate and displays anti-clockwise loops over the business cycle. Starting from the peak of the business cycle, when unemployment starts to rise, the share of long-term unemployment initially falls as a larger number of newly separated workers enter the unemployment pool. After the initial peak in the inflow to unemployment moderates, and the share of long-term unemployment starts to rise. When the trough is finally reached, and unemployment begins to fall, the proportion of long-term unemployment shows a protracted increase before starting to fall.

Chart 9. Unemployment and long-term unemployment (panel A) and unemployment flow rates (panel B)



Sources: OECD (2009) and Elsby et al. (2009).

Large quantitative cross-country variation in the behaviour of unemployment rates and the proportion of long-term unemployed can be observed despite the common qualitative patterns. In Anglo-Saxon countries unemployment and LTU have been low in recent decades.[10] The rise of unemployment and the proportion of LTU in downturns have remained relatively modest, and both variables have typically returned relatively rapidly close to the pre-crisis level. Continental European countries have displayed markedly higher unemployment rates and in particular a higher proportion of LTU.

A prime explanation for the cross-country variation in unemployment rates and LTU are the shocks experienced by the countries over the last decades and how reallocation in the economy takes place following shocks. Reallocation and thus unemployment and LTU are driven by the inflow into unemployment and the outflow out of unemployment capturing jointly the overall flexibility of labour markets.[11] It is interesting to note that the countries, where unemployment and LTU tends to remain relatively low over business cycles and an increase in unemployment and the proportion of LTU tends to be reversed rapidly, are roughly the same countries (Anglo-Saxon) as those with high reallocation rates. In countries with low reallocation rates (Continental Europe) unemployment and LTU tend to increase more in downturns and the recovery is more sluggish. In these cases, the gap between inflow and outflow rates emerging in the crisis is not closed afterwards.

[10] In the Great Recession labour markets in the United States have departed from this pattern, as both unemployment and long term unemployment have risen to European levels.

[11] These are affected by e.g. institutional factors, see Furceri and Mourougane (2009b) for an analysis on the impact of institutional factors on the structural unemployment following recessions.

Table 4. Labour markets in selected countries, summary statistics

	Unemployment rate	Proportion LTU (>12m)	Total labour force, % of population 15-64	Unemployment exit rate	Unemployment inflow rate	Gross unemployment exit	Gross unemployment inflow
Finland	7.1	22.9	75.1	-	-	-	-
	(0.172)	(0.338)	(0.006)				
France	7.5	37.8	67.8	0.078	0.008	0.081	0.083
	(0.054)	(0.053)	(0.002)	(0.051)	(0.049)	(0.047)	(0.048)
Italy	9.0	60.9	60.9	0.042	0.004	0.049	0.048
	(0.040)	(0.040)	(0.008)	(0.092)	(0.076)	(0.093)	(0.076)
Japan	2.9	21.1	74.6	0.193	0.006	0.069	0.070
	(0.060)	(0.073)	(0.004)	(0.104)	(0.101)	(0.095)	(0.101)
Norway	3.2	12.5	76.5	0.383	0.016	0.181	0.181
	(0.141)	(0.151)	(0.009)	(0.087)	(0.100)	(0.088)	(0.098)
Spain	13.2	45.4	62.3	0.062	0.010	0.101	0.102
	(0.073)	(0.034)	(0.006)	(0.109)	(0.070)	(0.083)	(0.065)
Sweden	4.6	15.9	79.1	0.289	0.012	0.136	0.138
	(0.148)	(0.146)	(0.006)	(0.093)	(0.098)	(0.094)	(0.092)
United Kingdom	6.6	34.9	74.5	0.133	0.01	0.113	0.111
	(0.119)	(0.070)	(0.004)	(0.078)	(0.069)	(0.076)	(0.066)
United States	6.1	7.8	74.0	0.570	0.036	0.409	0.409
	(0.102)	(0.207)	(0.003)	(0.096)	(0.022)	(0.019)	(0.020)

Sources: Own computations based on OECD data and data from Elsby et al. (2008).
Notes: The mean has been calculated from raw annual data and the std. deviations have been calculated from annual log data that is hp(6,25) filtered. All variables were calculated from year 1970 or later period depending on data availability. Country notes: Finland: missing values for LTU in 1981, 1988, 1990, 1992 and 1994. Sweden LTU: Data 1976-2003. Italy: Missing values for f,s, F,S 1993.

Elsby et al. (2008) find that Anglo-Saxon and Nordic countries exhibit high exit rates from unemployment as well as high unemployment inflow hazards. For the exit rates the monthly hazard rates exceed 20 percent of unemployment and the unemployment inflow exceeds 1.5 percent of employment at a monthly frequency. Continental European countries have much lower flow rates. The exit rates from unemployment are typically less than 10 percent and the unemployment inflow hazards around 0.5 to 1 percent at a monthly frequency. When considering the number of workers flowing in and out of unemployment (as opposed to the inflow and outflow rates) Elsby et al. (2008) find that Anglo-Saxon and Nordic countries exhibit annual worker flows in and out of unemployment that exceed 15 percent of the labour force. In the continental European countries the worker flows remain less than 9 percent of the labour force.

3.2. Methodology

To extract the pattern how recessions affect unemployment and long-term unemployment, we employ an approach similar to the one adopted in Cerra and Saxena (2008) and Furceri and Mourougane

(2009a, 2009b)[12]. It consists of estimating the following autoregressive distributed lag model (ARDL)

$$\Delta x_{it} = a_i + \gamma_t + \sum_{j=1}^{4} \beta_j \Delta x_{it-j} + \sum_{j=0}^{8} \delta_j CRISIS_{it-j} + \varepsilon_{it} \qquad (1)$$

where x is the labour market variable of interest (unemployment, proportion of long term unemployed), $CRISIS$ is a dummy variable which is equal to one at the start of the recession or crisis, and a_i and γ_i are country and time fixed effects. The coefficients β_i and δ_i are restricted to be the same for all countries. The number of lags for the dependent variable and the crisis dummy is eight, which is also partly motivated by the stylized facts reported above. As we do not want to a *priori* constrain the lag strcture, the number of lags has been chosen to be large to allow for an extensive comparison of the effects of recessions and crises of different degree in a unified framework. The number of lags is equal to the maximum number of lags that is significant for any of our variables of interest. Indeed, in some of the cases below a smaller number of lags may have been appropriate. However, our aim is not to produce a model that produces the best possible fit for individual cases, but rather to allow the comparison of different cases in a unified framework.

To test whether the unemployment and LTU responses to crises differ significantly depending on the degree of reallocation in the economy, we estimate the ARDL model separately for country groups with low and high worker flows. Our definitions of high and low flow countries is based on Elsby et al. (2008). The countries with high worker flows are Australia, Canada, New Zealand, Norway, U.K., U.S. and those with low worker flows are France, Germany, Ireland, Italy, Japan, Portugal, Spain.

The dummies that identify the start of economic downturns are based on the OECD measure of the output gap, and s is a measure of the severity of the downturn,. Accordingly, we consider the peaks in the movements of real GDP that precede recessions identified in the quarterly data and qualify the quarter following the peak as the starting time of the recession. In the year in which the output gap turns negative the dummy takes the value

$$CRISIS_t^s = 1$$

Otherwise

$$CRISIS_t^s = 0.$$

s is an indicator that classifies the severity or type of downturn. We define three thresholds for the cumulative output loss, s=-10%, s=-15% and s=-20%. This yields 21 episodes corresponding to

[12] Cerra and Saxena (2008) apply this methodology to assess the impact of financial and political crises on output. Furceri and Mourougane (2009a, 2009b) use a similar methodology to study the effect of financial crises on potential output and structural unemployment, respectively.

output losses of at least 10%, 8 episodes corresponding to output losses of at least 15%, and 3 episodes corresponding to output losses of at least 20%.

3.3. Results

We start by presenting results for unemployment and long term unemployment for the benchmark model. We present a full set of results with a similar lag structure for all cases to allow for reasonable comparison. We are interested specifically in the distribution of the lag coefficients, and in how the lag structure compares across recessions of different degree.

Table 5: Impact of recession on unemployment rate

	All recessions		Recessions, gap=10		Recessions, gap=15		Recessions, gap=20	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-0,194	-2,345 **	-0,133	-3,065 ***	-0,076	-2,052 **	-0,031	-0,910
Δu(-1)	0,407	5,754 ***	0,361	5,022 ***	0,376	5,748 ***	0,425	6,263 ***
Δu(-2)	-0,060	-0,966	-0,100	-1,523	-0,105	-1,692 *	-0,095	-1,492
Δu(-3)	-0,081	-1,247	-0,101	-1,620	-0,106	-1,709 *	-0,097	-1,534
Δu(-4)	-0,073	-1,363	-0,059	-1,206	-0,083	-1,682 *	-0,067	-1,292
Δu(-5)	-0,008	-0,144	-0,029	-0,513	-0,015	-0,246	-0,017	-0,290
Δu(-6)	-0,057	-0,978	-0,066	-1,147	-0,091	-1,636	-0,084	-1,468
Δu(-7)	-0,018	-0,338	-0,027	-0,485	-0,025	-0,436	-0,015	-0,271
Δu(-8)	0,056	1,027	0,053	1,038	0,054	1,011	0,060	1,066
CRISIS	0,524	3,978 ***	0,879	4,345 ***	1,302	3,487 ***	1,123	1,755 *
CRISIS(-1)	0,549	3,525 ***	0,881	2,930 ***	1,567	2,444 **	0,984	1,051
CRISIS(-2)	0,253	1,808 *	0,840	3,325 ***	1,284	2,940 ***	0,919	1,382
CRISIS(-3)	-0,001	-0,008	0,142	0,623	0,017	0,078	-0,329	-1,291
CRISIS(-4)	0,063	0,489	0,200	1,163	0,345	1,965 **	0,126	0,830
CRISIS(-5)	0,147	1,139	0,324	1,792 *	0,554	2,443 **	0,445	1,301
CRISIS(-6)	-0,030	-0,208	-0,028	-0,147	0,157	0,654	0,002	0,006
CRISIS(-7)	0,032	0,258	-0,102	-0,696	-0,315	-1,511	-0,061	-0,351
CRISIS(-8)	0,040	0,357	-0,015	-0,100	0,173	0,635	-0,139	-0,984
R-squared		0,556		0.578410		0,578		0.541211
S.E. of regression		0,728		0.709424		0,710		0.740061
Durbin-Watson stat		1,998		1.995948		1,980		1.984829
F-test country		0,836		1.392332		1,495 *		0.918536
F-test time		4,414 ***		4.709279 ***		5,218 ***		5.554958 ***
N		494		494		494		494

Note: Specification is given in equation (1). Dependent variable is change in unemployment rate (Δu). Explanatory variables are the lags of the dependent variable and the recession dummy and its lags. *, **, *** denote significant at 10%, 5% and 1% significance levels, respectively. Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K, U.S

Table 5 shows estimation results for equation (1) with the change in unemployment (Δu) as the dependent variable. The first autoregressive coefficient of unemployment is positive followed by a series of negative lags. This reflects typical business cycle behaviour, where unemployment is typically decreasing before a recession starts, and continues to do so initially before starting to increase. Once the increase in unemployment has occurred, it continues for several periods. The overall effect of the autocorrelation coefficients is approximately zero, so the main impact arises through the crisis dummy.

When considering the estimation results including all recessions (Table 5, first column and Chart 10), the coefficients of the crisis dummy point to the largest effect of a recession on unemployment taking place with a lag of 1-2 years and then dying out gradually. As the regression with all recessions is dominated by relatively mild downturns, the effets of a recession are relatively contained and short-lived. In more severe recessions we observe that the coefficients become larger as one would expect, and the effect of the recessions on the increase in unemployment is also more persistent (Table 5, columns 2,3 and 4 and Chart 10).

Table 6: Impact of recession on long-term unemployment

	All recessions		Recessions, gap=10		Recessions, gap=15		Recessions, gap=20	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-1,775	-4,067 ***	-1,088	-3,930 ***	-0,743	-3,616 ***	-0,538	-2,860 ***
ΔLTU(-1)	0,001	0,010	-0,012	-0,152	0,017	0,220	0,028	0,358
ΔLTU(-2)	-0,224	-3,306 ***	-0,236	-3,482 ***	-0,228	-3,390 ***	-0,216	-3,180 ***
ΔLTU(-3)	-0,175	-2,578 **	-0,174	-2,459 **	-0,144	-2,091 **	-0,139	-2,023 **
ΔLTU(-4)	-0,071	-1,114	-0,066	-1,080	-0,058	-0,925	-0,052	-0,836
ΔLTU(-5)	-0,285	-4,793 ***	-0,291	-4,765 ***	-0,292	-4,903 ***	-0,288	-4,875 ***
ΔLTU(-6)	0,008	0,126	-0,026	-0,408	-0,043	-0,651	-0,047	-0,708
ΔLTU(-7)	-0,100	-1,675 *	-0,139	-2,426 **	-0,159	-2,808 ***	-0,159	-2,762 ***
ΔLTU(-8)	0,079	1,442	0,046	0,836	0,059	1,036	0,050	0,875
CRISIS	-1,498	-2,243 **	-1,340	-1,140	-0,223	-0,237	0,239	0,189
CRISIS(-1)	2,144	2,724 ***	3,329	2,771 ***	3,996	2,060 **	3,877	1,300
CRISIS(-2)	2,246	3,011 ***	3,948	3,150 ***	2,873	1,891 **	2,714	1,677 *
CRISIS(-3)	2,769	3,931 ***	3,607	3,507 ***	4,116	2,343 **	2,054	1,131
CRISIS(-4)	2,126	3,114 ***	2,935	2,547 **	2,079	1,421 **	1,507	0,673
CRISIS(-5)	1,468	1,824 *	1,144	1,178	2,437	2,237 **	1,036	0,884
CRISIS(-6)	2,668	2,890 ***	2,214	2,081 **	2,574	2,371 **	0,514	0,615
CRISIS(-7)	1,048	1,379	1,566	1,809 *	2,755	3,026 ***	2,244	2,197 **
CRISIS(-8)	-0,239	-0,308	-0,214	-0,237	1,526	1,630	0,880	0,659
R-squared		0,452		0,433		0,398		0.379383
S.E. of regression		3,114		3,167		3,264		3.313313
Durbin-Watson stat		2,060		2,033		2,050		2.027127
F-test country		2,213 ***		2,259 ***		1,945 ***		1.708835 **
F-test time		1,383		1,583 **		1,762 **		1.934314 ***
N		347		347		347		347

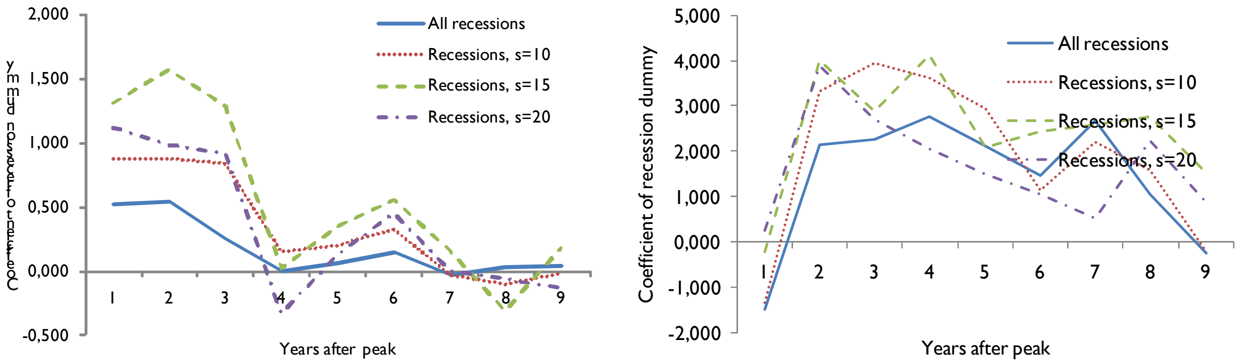
Note: Specification is given in equation (1). Dependent variable is change in proportion of long-term unemployed (ΔLTU). Explanatory variables are the lags of the dependent variable and the recession dummy and its lags. *, **, *** denote significant at 10%, 5% and 1% significance levels, respectively. Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, U.K, U.S

Table (6) presents estimation results for equation (1) with the change in long term unemployment (ΔLTU) as the dependent variable. In the first column of table (1), the coefficients for the crisis dummy tell a similar story as in Machin and Manning (1999). The effect of recessions on long-term unemployment lags the effect on unemployment, so that proportion of long term unemployment initially falls and subsequently starts to rise. The inital negative effect can arises naturally if there is a large inflow of newly dismissed workers into the unemployment pool which reduces the proportion of long term unemployed. Gradually as the new entrants become long term unemployed and the share of LTU starts to increase. Indeed, after the initial negative values, the coefficients of the crisis dummy are positive for subsequent periods.

In more severe recessions, the initial negative effect becomes smaller (columns 2 and 3) and eventually turns positive (column 4). A potential reason for this is that the contribution of the fall in the unemployment outflow rate (as opposed to the contribution of the inflow rate) in raising unemployment becomes relatively more important in severe recessions. When this is the case long term unemployment increases more immediately as those already unemployed at the start of the recession do not find jobs, and thus lead to a more rapid increase in the share of long term unemployed. We will examine the relative role of inflows and outflows in more detail below.

The overall effect of the autocorrelation coefficients of LTU is negative and the estimation results point to a positive and significant impact of recessions on long-term unemployment.

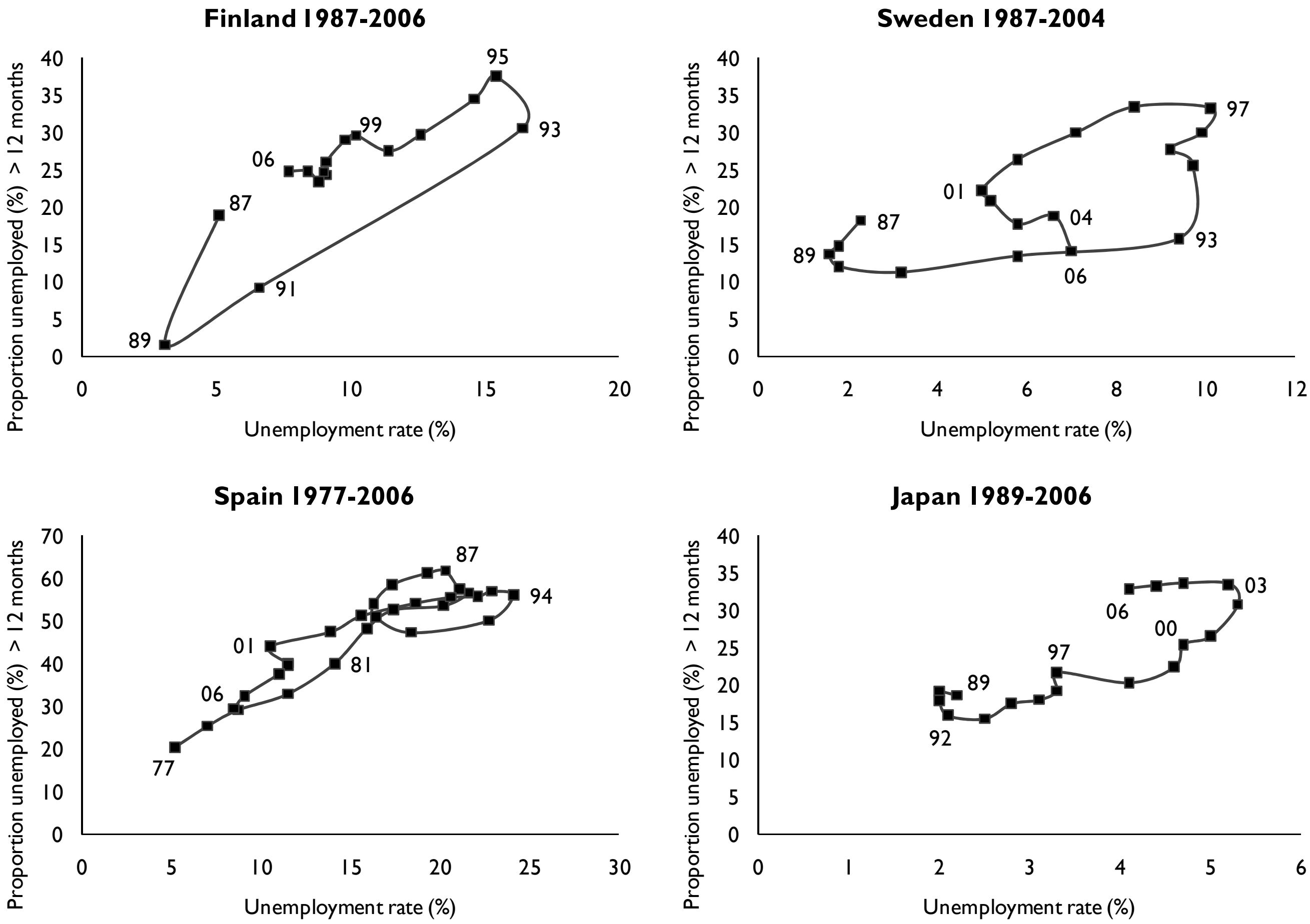
Chart 12. Response of unemployment (panel A) and long term unemployment (panel B) to recessions.



Note: Chart shows the autoregressive coefficients of unemployment rate from Table 5 and Table 6 for different classifications of recessions. The specification of the regression is given in equation (1).

These results reflect the patterns observed in the descriptive analysis above. Indeed, the "big five" systemic crisis episodes (Japan, Spain, Finland, Sweden and Norway) exhibit this type of patterns in the evolution of unemployment rates and LTU. Figure 11 plots long-term unemployment against the unemployment rate for four of the "big five" countries about two years preceding the downturns up to 2006. Especially in the Nordic countries the pattern is very clear. The unemployment rate rises strongly during the downturn, Finland being the most spectacular case where unemployment rose from 3 % to 17 % in just five years (1990-1994). In Sweden the rise in unemployment was fast as well, but it peaked at a lower level at 10 %. The rise in unemployment was accompanied by a lagged rise in the proportion of long-term unemployed. In Sweden and Norway the proportion of LTU remained relatively stable during the first years of the crisis before starting to rise steeply, whereas in Finland the rise in LTU started earlier. A common feature in the sample countries is the high persistence of LTU. Once long-term unemployment has risen, recovery towards pre-crisis levels has taken very long.[13]

Chart 11. Unemployment and long-term unemployment in systemic crisis



Source: OECD (2009).

[13] Before the crisis in the late 1980s especially the share of LTU decreased to an exceptionally low level which was mostly due to the government's policy to use active labour market policy programs (ALMP) to prevent people from falling into long-term unemployment.

To test whether the unemployment and LTU responses to crises differ significantly depending on the degree of reallocation in the economy, we consider the following two groups of countries.a) countries with high worker flows (Australia, Canada, New Zealand, Norway, U.K., U.S.) and b) countries with low worker flows (France, Germany, Ireland, Italy, Japan, Portugal, Spain).

With unemployment as the dependent variable, the effects of recessions are relatively short-lived in countries with high worker flows, whereas the effects are more persistent in countries with low worker flows. This supports the hypothesis that low reallocation rates tend to prolong the unemployment consequences of recessions. Long-term unemployment for the country groups with high and low worker flows reflects the above results for unemployment for these two groups. Slow reallocation of labour in the economy leads to high and persistent long-term unemployment, whereas high reallocation leads to a lower and more short-lived rise in long-term unemployment.

Table 7. Impact of worker flows on the effect of recessions on unemployment rates

	All recessions High worker flows		All recessions Low worker flows		Recessions, gap=10 High worker flows		Recessions, gap=10 Low worker flows	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-0,063	-0,454	-0,311	-2,462 **	-0,093	-0,850	-0,153	-3,196 ***
Δu(-1)	0,385	3,381 ***	0,559	4,868 ***	0,289	2,469 **	0,431	3,803 ***
Δu(-2)	-0,031	-0,297	-0,155	-1,429	-0,032	-0,309	-0,158	-1,558
Δu(-3)	-0,099	-0,791	-0,077	-0,606	-0,064	-0,640	-0,134	-1,231
Δu(-4)	-0,082	-0,730	0,098	0,853	-0,085	-0,867	0,099	0,950
Δu(-5)	-0,043	-0,384	-0,258	-2,686 ***	0,120	1,197	-0,260	-3,185 ***
Δu(-6)	-0,099	-0,986	0,131	1,091	-0,082	-0,982	0,074	0,699
Δu(-7)	0,102	1,184	-0,169	-1,436	0,090	1,149	-0,157	-1,559
Δu(-8)	0,024	0,292	0,140	1,106	0,020	0,245	0,085	0,786
CRISIS	0,171	0,688	0,535	2,508 **	0,659	1,884 *	1,023	3,981 ***
CRISIS(-1)	0,270	1,052	0,592	2,598 **	0,687	2,573 **	1,262	2,655 ***
CRISIS(-2)	-0,115	-0,533	0,359	1,576	0,479	1,441	0,724	1,930 **
CRISIS(-3)	-0,495	-2,012 **	0,181	0,944	-0,493	-0,906	0,496	1,618
CRISIS(-4)	0,108	0,482	0,206	1,038	0,167	0,604	0,302	1,256
CRISIS(-5)	-0,085	-0,379	0,233	1,143	-0,271	-0,880	0,239	0,861
CRISIS(-6)	0,044	0,177	0,304	1,428	-0,610	-1,737 *	0,237	1,166
CRISIS(-7)	-0,122	-0,492	0,153	0,666	-0,827	-2,408 *	0,023	0,104
CRISIS(-8)	-0,147	-0,662	0,174	1,281	-0,162	-0,628	-0,116	-0,523
R-squared		0,777		0,630		0,808		0,680
S.E. of regression		0,618		0,676		0,573		0,629
Durbin-Watson stat		1,977		2,053		2,020		2,097
F-test country		1,456		0,944		0,900		2,151 **
F-test time		4,160 ***		1,704 **		4,148 ***		1,873 ***
N		123		203		123		203

Note: Specification is given in equation (1). Dependent variable is change in unemployment rate (Δu). Explanatory variables are the lags of the dependent variable and the recession dummy and its lags. *, **, *** denote significant at 10%, 5% and 1% significance levels, respectively. Sample countries with high worker flows: Australia, Canada, New Zealand, Norway, U.K, U.S. Sample countries with low worker flows: France, Germany, Ireland, Italy, Japan, Portugal, Spain.

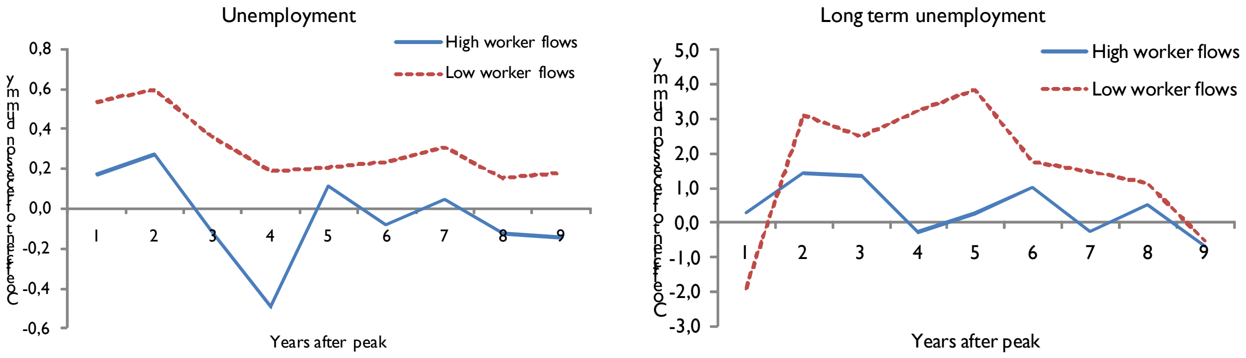
The timing in the reaction of long-term unemployment bears a remarquable difference for the two country-groups (Chart 12, panel b). For the countries with low reallocation rates the proportion of long-term unemployed initially decreases for two years and then starts to increase. For the countries with high reallocation rates the proportion of LTU increases almost immediately. This may reflect a difference in the margins of adjustment in the two groups. In the former, an increase in the unemployment inflow dominates the fall in the unemployment outflow, thereby initially reducing the proportion of long-term unemployed. In the latter, the unemployment outflow dominates the unemployment inflow. A freeze in hiring will then increase the share of LTU immediately as those already unemployed at the beginning of the crisis have a harder time finding jobs, while those entering the unemployment pool are relatively few. This type of a situation would reflect a case where the separation rate plays a relatively mild role, as some authors have claimed to be the case for the United States. The difference in the profiles of the two country groups may also reflect the dynamics of recovery: more vigorous job creation in high-flow (Anglo-Saxon) countries and sluggish hiring in low-flow (Continental European) countries, which feeds into the evolution of long term unemployment.

Table 8. Impact of worker flows on the effect of recessions on long-term unemployment rates

	All recessions High worker flows		All recessions Low worker flows		Recessions, gap=10 High worker flows		Recessions, gap=10 Low worker flows	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	-0,063	-0,454	-0,311	-2,462 **	-0,093	-0,850	-0,153	-3,196 ***
Δu(-1)	0,385	3,381 ***	0,559	4,868 ***	0,289	2,469 **	0,431	3,803 ***
Δu(-2)	-0,031	-0,297	-0,155	-1,429	-0,032	-0,309	-0,158	-1,558
Δu(-3)	-0,099	-0,791	-0,077	-0,606	-0,064	-0,640	-0,134	-1,231
Δu(-4)	-0,082	-0,730	0,098	0,853	-0,085	-0,867	0,099	0,950
Δu(-5)	-0,043	-0,384	-0,258	-2,686 ***	0,120	1,197	-0,260	-3,185 ***
Δu(-6)	-0,099	-0,986	0,131	1,091	-0,082	-0,982	0,074	0,699
Δu(-7)	0,102	1,184	-0,169	-1,436	0,090	1,149	-0,157	-1,559
Δu(-8)	0,024	0,292	0,140	1,106	0,020	0,245	0,085	0,786
CRISIS	0,171	0,688	0,535	2,508 **	0,659	1,884 *	1,023	3,981 ***
CRISIS(-1)	0,270	1,052	0,592	2,598 **	0,687	2,573 **	1,262	2,655 ***
CRISIS(-2)	-0,115	-0,533	0,359	1,576	0,479	1,441	0,724	1,930 **
CRISIS(-3)	-0,495	-2,012 **	0,181	0,944	-0,493	-0,906	0,496	1,618
CRISIS(-4)	0,108	0,482	0,206	1,038	0,167	0,604	0,302	1,256
CRISIS(-5)	-0,085	-0,379	0,233	1,143	-0,271	-0,880	0,239	0,861
CRISIS(-6)	0,044	0,177	0,304	1,428	-0,610	-1,737 *	0,237	1,166
CRISIS(-7)	-0,122	-0,492	0,153	0,666	-0,827	-2,408 *	0,023	0,104
CRISIS(-8)	-0,147	-0,662	0,174	1,281	-0,162	-0,628	-0,116	-0,523
R-squared		0,777		0,630		0,808		0,680
S.E. of regression		0,618		0,676		0,573		0,629
Durbin-Watson stat		1,977		2,053		2,020		2,097
F-test country		1,456		0,944		0,900		2,151 **
F-test time		4,160 ***		1,704 **		4,148 ***		1,873 ***
N		123		203		123		203

Note: Specification is given in equation (1). Dependent variable is change in long term unemployment rate (ΔLTU). Explanatory variables are the lags of the dependent variable and the recession dummy and its lags. *, **, *** denote significant at 10%, 5% and 1% significance levels, respectively. Sample countries with high worker flows: Australia, Canada, New Zealand, Norway, U.K, U.S. Sample countries with low worker flows: France, Germany, Ireland, Italy, Japan, Portugal, Spain.

Chart 12. Impact of worker flows on the effect of recessions on unemployment (panel A) and long-term unemployment (panel B) and unemployment flow rates



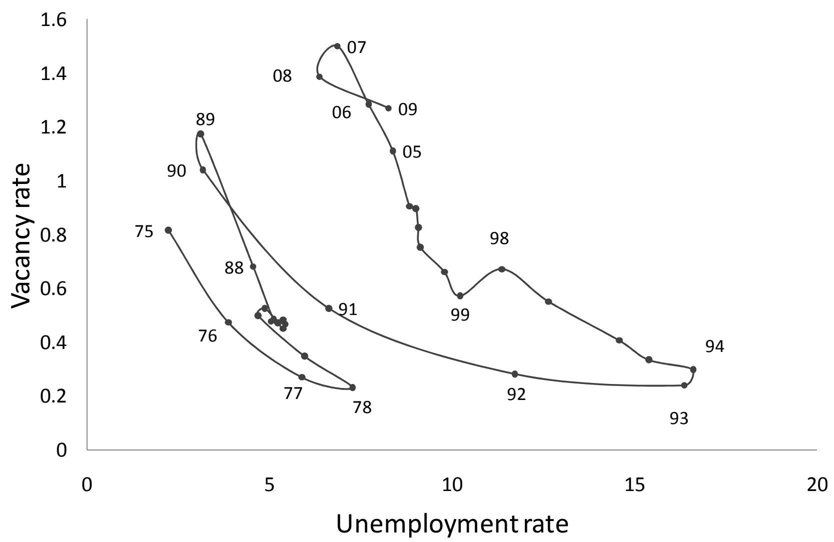
Note: Chart shows the importance of worker flows on the effect of recessions on unemployment and long-term unemployment, as estimated in Table 8. Specification of regression is given in equation (1).

BOX: CRISIS AND LABOUR MARKET RESTRUCTURING IN FINLAND

Reinhart and Rogoff (2009) point to the restructuring that takes place during deep recessions as a factor behind the perhaps strikingly large and persistent employment consequences of deep recessions. The 1990s recession in Finland provides a prime example. When the economy started to recover in 1993 the share of LTU did not decrease, which can be seen as resulting from structural change: the post recession increase in employment occurred in different sectors than the ones from which jobs had been destroyed. This rapid structural change led to an increasing mismatch problem in the Finnish labour market. The mismatch problem is illustrated clearly by the outward shift of the Beveridge curve, whichcoincided with the increase in unemployment and LTU (see chart)

Koskela and Uusitalo (2004) analyze the structural changes of the Finnish economy after the 1990s recession. Although employment increased rapidly during the recovery after 1994, the increase in employment occurred in different sectors than the ones from which jobs had been destroyed. Ilmakunnas and Maliranta (2001) characterize the structural change of the economy as a drastic deindustrialization. The number of jobs in manufacturing decreased from 500 000 in the mid-1980s to 350 000 in the deepest phase of the recession. The construction sector was particularly hard hit, where approximately a half of jobs disappeared between 1990 and 1994. Also the manufacturing, retail trade, hotels and restaurants, and financial services suffered severely, where employment declined approximately by 25%. During recovery employment increased the most in business services and in the manufacturing of equipment, in the electronics industry in particular.

Chart. The Beveridge Curve for Finland 1975-2009



Source: Statistics of Finland and authors own calculations.

4. WAGE ASYMMETRIES IN RECESSIONS AND FINANCIAL CRISES

A key question arising from the cursory description of labour market developments in section 2 is how developments during recessions and financial crises affect the pattern of adjustment in wages. This section analyses aggregate real wage adjustment, asking in particular, whether wage flexibility varies over time or according to the cyclical position of the economy. In particular, it asks whether the wage response is asymmetric: do wages react more or less sharply in periods of recession or financial crisis? Or is the wage response non-linear – i.e. do wages respond differently to a positive or negative output gap?

The usual approach to testing this issue, pioneered by Debelle and Laxton (1997), is to estimate Phillips curve equations, which allow for non-linearities in the response of wages to cyclical conditions. If downward nominal or real wage rigidity were prevalent, one would expect an asymmetric response of aggregate wages to labour market conditions. In tight labour markets, wages would be expected to respond strongly to labour market slack since there are no impediments to increasing wages. In contrast, in weak labour market conditions, the response of wages to unemployment would be muted, reflecting the difficulty in reducing wages. This approach is followed here by estimating a quarterly wage equation for a panel of 17 OECD countries (including most Euro Area countries) with data starting from the 1970s.

4.1 The estimation approach

We estimate a standard wage equation in which workers bargain over real wages and price expectations are backward-looking and takes the following basic form:

$$\Delta w_{it} = \delta_1 + \delta_2(\tilde{u}_{it-4}) + \delta_3 \Delta p_{it-1} + \delta_4 \Delta q_{it} + \varepsilon_{it} \qquad (2)$$

where in quarter *t*, for country *i*, Δw_{it} is change in (log) nominal compensation per employee; Δp_{it} is change in (log) private consumption deflator; and Δq_{it} is change in productivity (measured as output per person). The variable $\tilde{u}_{it-4}$ represents a (lagged) measure of labour market slack and the coefficient δ_2 represents the average responsiveness of compensation to changes in labour market pressure.[14] Negative values would suggest real wage flexibility; positive or insignificant values would tend to indicate an absence of flexibility.[15] We investigate a range of possibilities for $\tilde{u}_{it}$: we estimate the equation using growth in (log) unemployment; we also estimate measures of an unemployment 'gap' – i.e. unemployment relative to some trend or NAIRU ($u_{it} - u^*_{it}$) – by de-trending unemployment (using an HP-filter). Finally, we also consider a broader indicator of economic slack with a measure of the output gap.

[14] Because it can take some time for the impact of changes in labour market or wider economic conditions to be seen in wages, these measures of unemployment gaps and output gaps are included with a lag.

[15] Note that, although the dependent variable is nominal compensation growth, because we have also included price inflation as an explanatory variable, the coefficient on the unemployment term should capture real wage flexibility.

Further extensions to equation (2) are considered. It is common to include supply-shock variables in the equation. We investigate the impact of changes in oil prices and exchange rates. In addition, it can be useful to distinguish between consumer and producer price inflation, which captures part of the difference between the consumption wage received by workers and the product wage paid by firms. Hence, we also include a term for the 'wedge' between the private consumption and gross domestic product deflators.

To determine whether wage flexibility differs over time or according to the cyclical position of the economy, we need to extend equation (2) to search for potential asymmetries in wage behaviour. One possibility is to examine whether wage flexibility depends on whether the economy is in recession or not.[16] Using the cycle dating procedure discussed in section 2, we isolate periods of expansion and contraction across countries and include a dummy variable, which takes the value of one during periods of recession and zero otherwise:

$$\Delta w_{it} = \delta_1 + \delta_2^{'}(\tilde{u}_{it}) + \delta_2^{''}(\tilde{u}_{it}) * dummy_{it} + \delta_3 \Delta p_{it-1} + \delta_4 \Delta q_{it} + \varepsilon_{it} \quad (3)$$

The coefficient $\delta_2^{'}$ now represents the responsiveness of wages to unemployment during periods of expansion; the sum of the coefficients $\delta_2^{'}$ and $\delta_2^{''}$ represent the responsiveness of wages to unemployment during recessions. If $\delta_2^{''}$ is zero or insignificant then there is no significant difference in the flexibility of wages between periods of recession and expansion. An alternative might be to look at differences between periods of financial crisis. We take the same approach as with recessions, including a dummy variable that takes the value one during financial crises and zero otherwise. Another approach is to separate the observations into two or possibly more 'regimes' depending, on whether our measure of labour market pressure is above or below a given threshold. For example, we might identify different responsiveness of wages to an unemployment gap that is above or below zero.

4.2 Results

We start by establishing a preferred specification – Table 9 shows initial estimation results for equation (2). The equations are estimated using the data set described in section 2. The panel equations are estimated with fixed effects and robust standard errors.[17] As expected, nominal compensation growth responds positively to increases in the consumption deflator and improvements in productivity. Wages are also affected by oil prices and changes in US-dollar exchange rates. The second column estimates the equation, separating the past private consumption deflator (PCD) term into the GDP deflator (PGDP) and a term for the wedge between consumer and producer price growth. Wages respond positively to changes in this wedge.

[16] Recessions are defined in section 2.

[17] A Hausmann likelihood ratio test rejects the assumption that the estimated individual effects are uncorrelated with the regressors, so a random effects model is unsuitable. Tests also suggest heteroskedasticity in errors, so robust standard errors are calculated.

Table 9. Initial wage equations

	(1)	(2)	(3)	(4)	(5)
Private consumption deflator (PCD)	0.559 ***				
GDP deflator (PGDP)		0.702 ***	0.711 ***	0.609 ***	0.698 ***
PCD-PGDP wedge		0.374 ***	0.371 ***	0.309 ***	0.372 ***
Productivity	0.198 ***	0.180 ***	0.188 ***	0.183 ***	0.198 ***
Oil price	0.005 ***	0.004 ***	0.004 **	0.004 **	0.004 ***
Effective exchange-rate	0.005	0.004	0.005	0.007	0.004
US dollar exchange-rate	-0.012 **	-0.010 *	-0.010 *	-0.011 **	-0.010 *
Unemployment gap	-0.001 ***	-0.001 ***			
Unemployment growth			-0.007 **		
Unemployment rate				-0.001 ***	
Output gap					0.061 ***
Constant	0.006 ***	0.005 ***	0.005 ***	0.013 ***	0.005 ***
Number of observations	2188	2188	2176	2188	2188
R-Squared	0.410	0.468	0.470	0.447	0.469

Notes: specification as in equation (2). Dependent variable is first difference of log compensation per employee. Explanatory variables are: first differences of log consumer price inflation (CPI), log GDP deflator (PGDP), and the difference between them ("CPI-PGDP wedge"), productivity, oil price, nominal effective exchange-rate and USD exchange-rate. Unemployment gap measured as unemployment rate less estimated NAIRU (using HP filter), first difference of log unemployment growth, unemployment rate and output gap (GDP as percentage of trend GDP measured using HP filter). Stars denote p-values for significance of coefficients: * p<0.1; ** p<0.05; *** p<0.01.

The estimates show that real wages respond to changes in labour market conditions. In the first specification (columns one and two), we measure labour market pressure as the unemployment 'gap': unemployment relative to trend, derived from an HP-filter.[18] A widening of the gap – i.e. a rise in unemployment u_{it} relative to the NAIRU u_{it}^{*} – causes wages growth to slow. The final three columns replace this unemployment gap with other measures. Column three looks at the impact of changes in unemployment and column four the impact of the unemployment level. Column five uses a simple output gap measure (GDP relative to trend, measured also with an HP filter). In each case wage growth responds as expected: negatively to an increase in unemployment and positively to a rise in the output gap.[19]

Does wage flexibility differ according to the state of the economy or the point in the cycle? We start by extending the baseline specification in Table 9 to examine whether wage flexibility depends on whether the economy is in recession or not.[20] In the second column of Table 10, we have separated the series for the unemployment gap between those when the economy is in recession and those when it is not. Column three does the same but separately identifies periods of financial crisis. The results suggest some asymmetry in the estimated wage equations, as the coefficients on the unemployment

[18] Unemployment rate is de-trended using a standard HP filter for quarterly data, with the smoothing parameter lambda set to 1600.

[19] An alternative would have been to use official estimates of the unemployment rate relative to the NAIRU. OECD, for example, provides estimates of the NAIRU but the coverage is fairly limited and would further restrict the estimation sample.

[20] Note that we drop the exchange rate variables for subsequent estimation. Having done that, the sample extends somewhat and the coefficient on oil price changes becomes insignificant.

gap measures are systematically negative in non-recessionary periods, while there does not seem to be a systematic reaction during recessions. Obviously, given the lack of precision of the coefficient attached to recessions, it cannot be rejected that the coefficient are not the same during recession/crisis and outside these periods, i.e. F-tests cannot reject the hypothesis that the coefficient on the unemployment gap measures during a recession is the same as the coefficient on the unemployment gap during periods outside recessions. Moreover, there is no clear difference between recession and financial crises in terms of wage reaction.

One explanation for the result might be that the number of observations of recession or financial crisis is fairly small – particularly for financial crisis periods, we have only 74 quarters to examine. Moreover, because unemployment responds relatively slowly to changes in activity, in about half of the recessionary / crisis episodes the unemployment gap often remains negative – i.e. unemployment u_{it} is below the estimated NAIRU u_{it}^{*} – and conditions in the labour market remain initially relatively tight during recessions.[21] To check these caveats, we analyse separately periods when the unemployment gap is above or below zero. Column four isolates periods in which the unemployment gap is negative from those in which the unemployment gap is positive. Column five does the same but instead isolates periods in which unemployment growth is above / below zero. Finally, the output gap can be used to distinguish downturns from booms.

From these exercises some results emerge, which can be aligned with the evidence presented above, but requires further investigation. First, results using the output gap are very much in line with the above mentioned results, where wage growth appears to respond significantly when the economy is expanding relative to potential, but the coefficient is insignificant for quarters in which the economy is below potential. Second, however, the estimated coefficients suggest a systematic negative response when the unemployment gap is positive and unemployment is rising, but no systematic reaction in the opposite cases. Combining the results with the previous would imply that wages are temporarily decoupled from the labour market situation due to other factors until the crisis feeds fully into unemployment, whereas this is not the case during booms. This could happen during recessions, for example, if wage indexation is backward looking and works asymmetrically to capture high inflation periods. Then ongoing collective agreements in countries where this is a relevant wage setting mechanism would perpetuate wages aligned with price pressures during booms, but not during busts. Although there is evidence on the fact that wage indexation works asymmetrically in some European countries, it would clearly require more research beyond this paper to fully establish this link. In addition, one has to notice, that the result does not hold for the 1990s when in particular several of the serve financial crises occurred. Indeed the estimates would again suggest that wages react to negative employment gaps rather than positive ones, which would fit better into the pattern observed for recessions and the output gap (see Annex1 Table A4).

[21] The unemployment gap is positive in under half of the recessionary periods.

Table 10. Asymmetries in nominal wage behaviour

	(1)	(2)	(3)	(4)	(5)	(6)
GDP deflator (PGDP)	0.700 ***	0.700 ***	0.700 ***	0.701 ***	0.709 ***	0.690 ***
PCD-PGDP wedge	0.362 ***	0.361 ***	0.362 ***	0.361 ***	0.358 ***	0.354 ***
Productivity	0.175 ***	0.175 ***	0.175 ***	0.175 ***	0.184 ***	0.198 ***
Oil	0.004 ***	0.004 ***	0.004 ***	0.004 ***	0.004 ***	0.004 ***
US-dollar exchange rate	-0.008 *	-0.008 *	-0.008 *	-0.008 *	-0.009 **	-0.008 *
Unemployment gap	-0.001 ***					
Unempl. gap - no recession		-0.001 ***				
Unempl. gap - recession		0.000				
Unempl. gap - no crisis			-0.001 ***			
Unempl. gap - crisis			0.000			
Unempl. gap negative				0.000		
Unempl. gap positive				-0.002 ***		
Unemployment falling					0.000	
Unemployment rising					-0.002 **	
Output gap positive						0.121 ***
Output gap negative						-0.008
Constant	0.005 ***	0.005 ***	0.005 ***	0.006 ***	0.005 ***	0.005 ***
Number of observations	2312	2312	2312	2312	2300	2312
F-test: no wage asymmetries		0.330	0.474	0.159	0.320	0.043
Recession / crisis periods		249	74			
No. periods unemp. gap positive				1249		
No. periods of rising unempl.					1025	
No. negative output gap periods						1176
R-Squared	0.411	0.412	0.411	0.412	0.414	0.415

Notes: specification as in equation (3). Stars denote p-values for significance of coefficients: * p<0.1; ** p<0.05; *** p<0.01. Dependent variable is first difference of log compensation per employee. Explanatory variables are: first differences of log GDP deflator (PGDP), and the difference between consumer price inflation and the GDP deflator ("PCD-PGDP wedge"), productivity, oil price and USD exchange-rate. The unemployment gap is measured as the unemployment rate less estimated NAIRU (using an HP filter). The output gap is measured as GDP as a percentage of trend GDP (measured using HP filter). In columns (2) to (4), the observations for the unemployment gap have been separated into those in recession period, crisis periods, or whether they are above or below zero. Column (5) distinguishes between unemployment growth that is above or below zero. Column (6) distinguishes between output gaps that are above or below zero. The F-test shows the p-values for the hypothesis that the coefficients on the unemployment gaps, unemployment growth and output gaps (positive and negative) are the same.

In general, the evidence from this panel estimation provides some evidence for wage asymmetries. The results suggest asymmetry in the estimated wage equations, as the coefficients on the unemployment gap measures are not systematically reacting to recession or crisis episodes, but operating systematically during upswings and booms. Nevertheless, these results are not unambiguous from a statistical perspective, as the impression in the wage reaction does not allow to reject that the coefficients are not the same during recession/crisis and outside these periods. The absence of statistically significant wage reactions during downturns should not be surprising. In a sample period characterised by positive productivity growth and positive (and sometimes high) inflation it is difficult to identify such nonlinearities with aggregate wage data. Moreover, the panel approach adopted here imposes a common set of parameters across countries. Micro results, suggest the pattern of downward nominal and real wage rigidity differs markedly across countries.

5 WAGES, EMPLOYMENT AND OUTPUT

Having looked in the previous sections separately at unemployment dynamics and wages, we now move to a combined analysis of variables and try to identify the impact of wages on real developments. This is done first based on a VAR for a cross section of industrialized countries using the data described in section 2, and then for specific crisis episodes – the ERM II crisis in the early 1990s and the current "Great Recession" as it is now termed. The two analyses are complementary. In particular the evidence gained by looking at specific incidents of crises as case studies allow us to trace more closely developments over time and to capture changes across episodes.

5.1 A panel VAR accounting for crisis experiences

Standard VARs do not generally allow to differentiate boom – bust experiences. The approach applied here is based on a panel VAR developed by Goodhart and Hofmann (2008), which takes the following general form:

$$Y_{i,t} = A_i + A(L)Y_{i,t} + \varepsilon_{i,t} \qquad (4)$$

where $Y_{i,t}$ is a vector of endogenous variables and $\varepsilon_{i,t}$ the error term. A_i is a set of country specific effects and A(L) the polynomial lag operator. The lag structure is determined by the Akaike information criterion and the model can be estimated using simple OLS. The endogenous variables comprise the log difference of real GDP (Δy), the log difference of the CPI (Δp), the log difference in employment (Δy), and log difference in compensation per employee (Δw). The structure of the vector of endogenous variables is

$$Y = [\Delta y, \Delta p, \Delta w, \Delta e,]$$

The orthogonalized shocks of the system are based on a simple Cholesky decomposition given the above ordering.[22] Output is ordered first and prices second in line with standard practices in monetary policy VARs. This ordering is though to capture demand shocks and it has been adopted here since financial crisis are unlikely to enter the labour market directly, but rather as a demand shock to the real economy. In line with the standard wage equations, wages may react to prices and to lagged unemployment, while employment is expected to react to the demand shock with a delay and is therefore ordered last.

The above VAR is re-estimated using the following form in order to establish whether financial crisis exert any different labour market dynamics, which could be caused by wage and unemployment rigidities:

$$Y_{i,t} = A_i + A_{NC}(L)Y_{i,t} \times D_{i,t}^{NC} + A_C(L)Y_{i,t} \times D_{i,t}^{C} + \varepsilon_{i,t} \qquad (5)$$

[22] However, estimates not shown in this note confirm that results are robust to the change in the ordering of wages and employment.

where $D_{i,t}^{C}$ is a dummy variable that is set equal to one when there is a house price boom in period t in country i and equal to zero otherwise. $D_{i,t}^{NC}$ is a dummy variable that is set equal to one when there is no crisis in period t in country *i* and equal to zero otherwise. The specification allows to capture impulse responses in crisis and non-crisis periods.[23]

Given data limitations the estimates are based on observations described in section 2, but only for 15 OECD countries over the period 1980Q4 to 2008Q4.[24] For specifications including the wage rate instead of compensation of employees, the sample had to be further reduced to 12 countries.[25] The identification of crisis episodes and recessions follows the approach described in section 2.

5.1.1 Empirical results

Table 11 reports simple Granger causality tests among the endogenous variables to check the significance of the direct lead-lag relationship. Results would suggest strong multidirectional causality between output and employment. Both employment and output also affect prices, while the reverse does not hold true according to our estimates. In turn, compensation Granger-causes employment, but employment does not clearly lead compensation developments. This can be interpreted as a first confirmation of wage rigidity in the sense that compensation is not be responsive to the employment situation. Overall, these suggest that demand shocks on GDP are directly transmitted into adjustments in compensation and employment, while it is not clear from the analysis that employment would shape compensation patterns.

These Granger causality tests do not take into account the indirect effects running via other variables included in the system nor provide any information about the direction and strength of the effects. Therefore, Chart 12 below depicts the cumulative impulse responses to an orthogonalized one unit shock together with the 5th and 95th percentile error band.

[23] Confidence bands are computed using a wild bootstrap in order to take into account the potential heteroskedasticity of residuals. The wild bootstrap is set up in the following way. For each draw, first an artificial vector of innovations is constructed by multiplying each element of the vector with sample residuals with an *iid* innovation drawn from a standard normal distribution. An artificial dataset is constructed with these innovations based on the estimated VAR. The artificial dataset is then used to re-estimate the VAR and generate shock impulse responses based on the Choleski decomposition. This procedure is replicated 1000 times and a 90% confidence band is obtained by computing the 5th and the 95th percentiale of the bootstrapped shock impulse responses.

[24] Countries are Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Finland, Denmark, Sweden, UK, Australia, Japan, Canada and the US.

[25] The countries are France, Italy, Netherlands, Finland, Sweden, Australia, UK, Japan, Canada, Norway and the US.

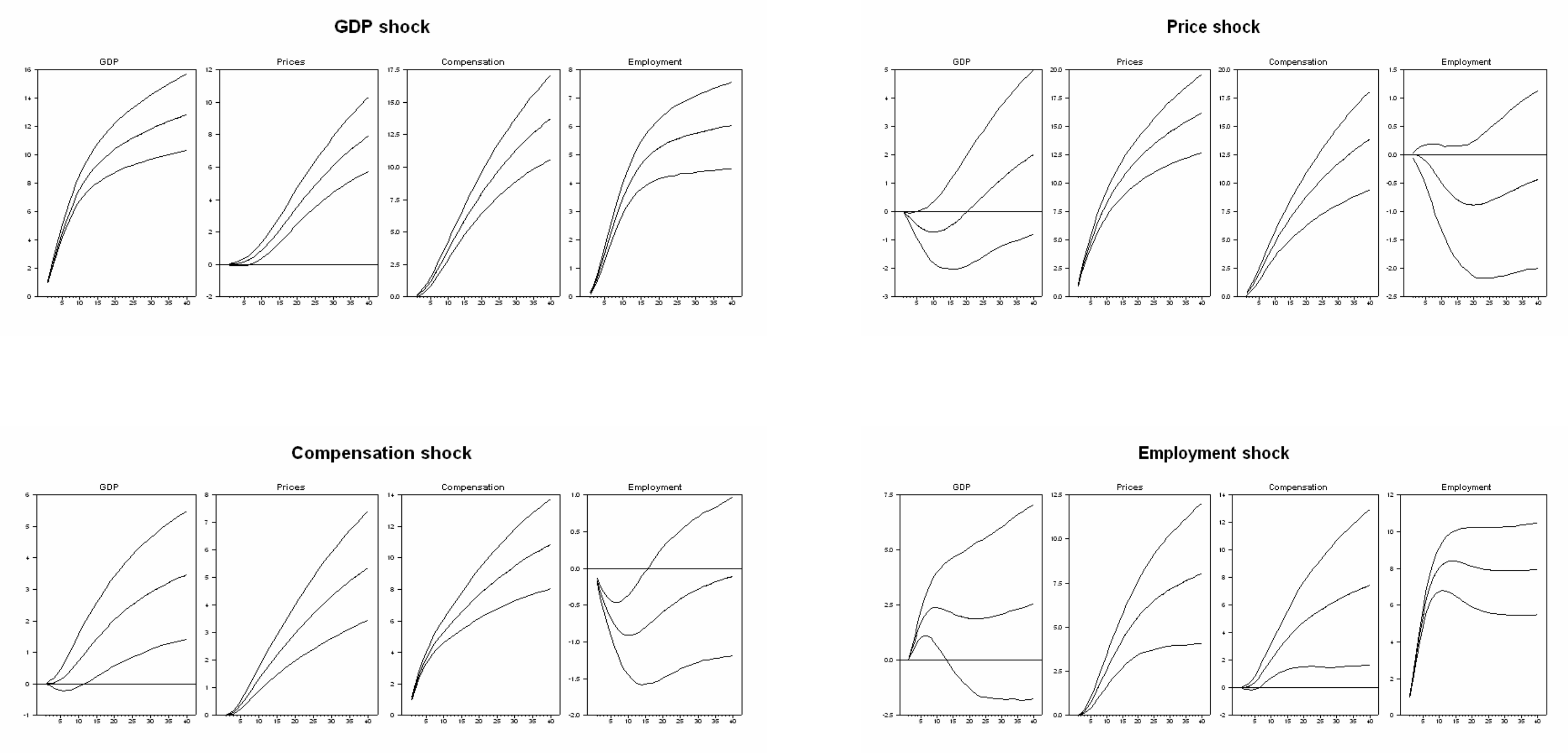
Table 11. Granger causality tests (1980Q1 to 2008Q4)

Δy → Δcpi **4.55** **(0.00)**	Δy → Δemp **25.53** **(0.00)**	Δy → Δcpe **14.66** **(0.00)**
Δcpi→ Δy 2.68 (0.45)	Δcpi → Δemp 0.60 (0.61)	Δcpi → Δcpe **21.55** **(0.00)**
Δemp → Δy **14.9** **(0.00)**	Δemp → Δcpi **6.03** **(0.00)**	Δemp → Δcpe 0.06 (0.98)
Δcpe → Δy **5.33** **(0.00)**	Δcpe → Δcpi **13.10** **(0.00)**	Δcpe → Δemp **2.82** **(0.04)**

Note: Table reports heteroskedasticity robust test statistics (F-test). P-values are in parenthesis. Results which are significant at standard levels below 5% are presented in bold. Δ is the first differenced operator, and y, cpi, emp, cpe denote logarithmic of GDP, consumer price index, employment and producer price index, respectively.

Chart 12 reports the impulse responses of the VAR according to model (4) without any differentiation between crisis and non-crisis periods. The patterns of the variables following a GDP shock indeed are very much in line with a demand shock, driving up prices, compensation and employment at the same time. In contrast, the price shock has some resemblance of a cost push shock diminishing output and employment, but driving up compensation. However, the output effects are not persistent and not statistically significant. Compensation shocks lower employment growth, but regarding output and prices, the demand effect from higher wages seems to prevail and push up both. Employment shocks do not affect wages and compensation rises in line with output and prices. As in other applications of panel VARs, effects are extremely persistent, which can be questioned. It has been suggested that this feature is related to the cross-sectional restriction of the estimates imposing a common coefficient on all countries.

Chart 12. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4



Note: Chart shows the impulse response functions of the VAR according to equation 4 in the main text.

Chart 13 now differentiates between crisis and non crisis periods. The solid lines are the impulse responses and error band for the non-crisis periods, i.e. where the no-crisis dummy is set to one. The dotted lines represent the impulses obtained under the crisis scenario, i.e. where the crisis dummy is set to one. All panels capture the effect of a demand shock to GDP. The upper panel shows the reaction emerging from financial crises. According to these estimates positive GDP shocks propagate much less during crisis situations than otherwise, though they would not be fully reversed. By comparison, prices and compensation per employee for an initial period follow the standard non-crisis pattern, before they show significantly lower growth rates. The impact on nominal growth rates however exceeds the output effect. As a result, employment growth drops remarkably and eventually turns negative. In order to test for the robustness of results, and whether this finding may be driven by 'extreme' events, the exercise is repeated for the broader set of all recessions included in the data set. Indeed it shows that based on this sample, the more modest price and compensation reaction to the weak output push is not apparent and employment growth does not become negative (see Chart 13, middle panel). The number of observations related to systemic crises is very limited in our sample and therefore any estimate related to such episodes has to be seen with great caution. The loweest panel of Figure 13 nevertheless shows the related impulse responses which suggest that the result reported for financial crises are indeed driven by rather extreme events.

An interesting issue, which has also been addressed in the Wage Dynamics Network (WDN) of the ESCB is whether firms react through different compensation margins. In order to test for the role of non-wage vs. wage changes, the system is again estimated using OECD wage rates. Impulse responses for crisis episodes tend to show a slightly more pronounced slowing of output growth and employment (see Chart 14). Conversely, inflation and wage growth remain at a somewhat higher pace compared to compensation of employees. However, these differences do not point to any categorical divergence between the wage reaction and compensation per employee. On this score, the wage drift does not seem to play a crucial role for the adjustment during crisis episodes.

Finally, we want to check more directly for the role of real wage rigidity and whether participation rates may play a role in overcoming the employment effect of financial crises. For that reason, the above system is estimated using the following specification,

$$Y = [\Delta y, \Delta(w-p), dunr,]$$

where *dunr* indicates first difference of the unemployment rate.[26] Chart 15 shows the real compensation and unemployment rate reactions during crises and recessions. The impulse responses confirm some

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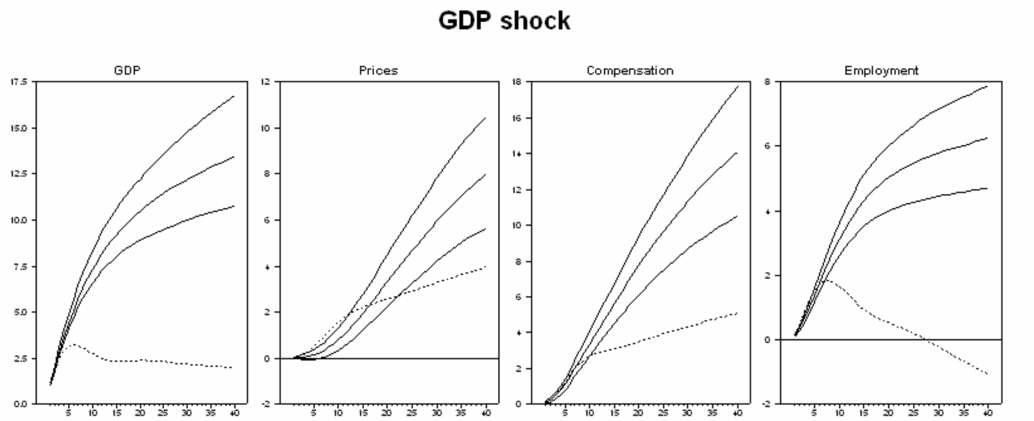
[26] The impulse responses corresponding to Chart 12 are shown in Chart A1 in the Annex 1. The basic features of the model replicate the previous findings. The reaction to an output shock would be inline with an increase in demand inducing higher prices and lower unemployment. A shock to compensation per employee can be seen as a cost push shock which drives up unemployment, but due to its demand implications does not significantly lower output. Finally, an unemployment shock is associated with initial output losses, but increasing real wage growth, which eventually should stimulate demand and stabilizes growth in the unemployment rate.

real wage rigidity during financial crises since compensation per employee tends to accelerate following a positive output shock, while this is not the case for output itself, which tends to die out. As a result, the unemployment rate shows an extreme reaction, shooting up rather strongly after an initial decline. This should reflect the employment reaction described above and the fact that the increase in unemployment inflows is not cancelled out increasing non-participation decisions, although in some cases past crises have also led to a persistent decline in participation rates. As before, the unemployment reaction is less pronounced when estimates are based on the entire set of recessions. In that case, real wages show less upward drift and unemployment actually tends to follow the normal pattern also during non-crisis periods.

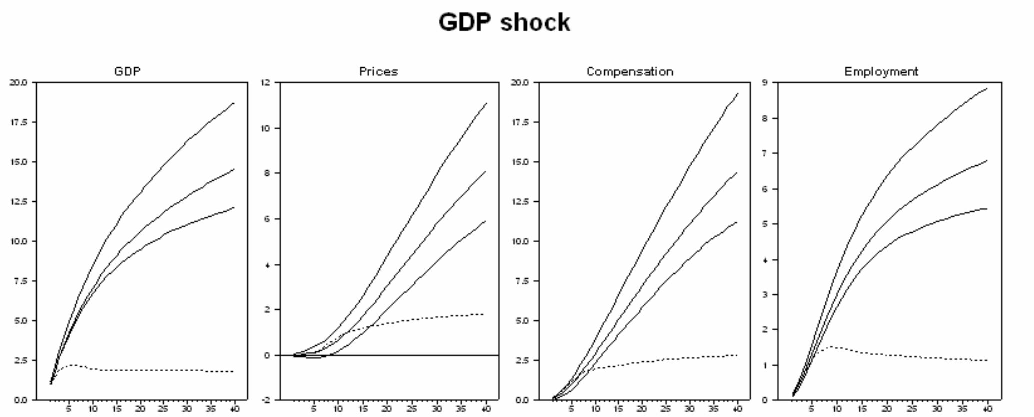
The results shown in this section suggest that labour market reactions in the context of financial crisis deviate very much from standard patterns found in 'normal times'. There is some indication of nominal and real wage rigidity, meaning that wages do not react to deteriorations in output and the labour market situation thereby undermining labour demand, which is not as evident in other circumstances. There does not seem to be any systematic difference between compensation per employee and wage rates suggesting that the wage drift is not playing a crucial role in the adjustment process of past recessions following financial crises. Some of these findings however seem to be related to the inclusion of rather extreme observations following systemic crisis.

Chart 13. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4

(A) Financial crises



(B) Recessions



(C) Systemic crises

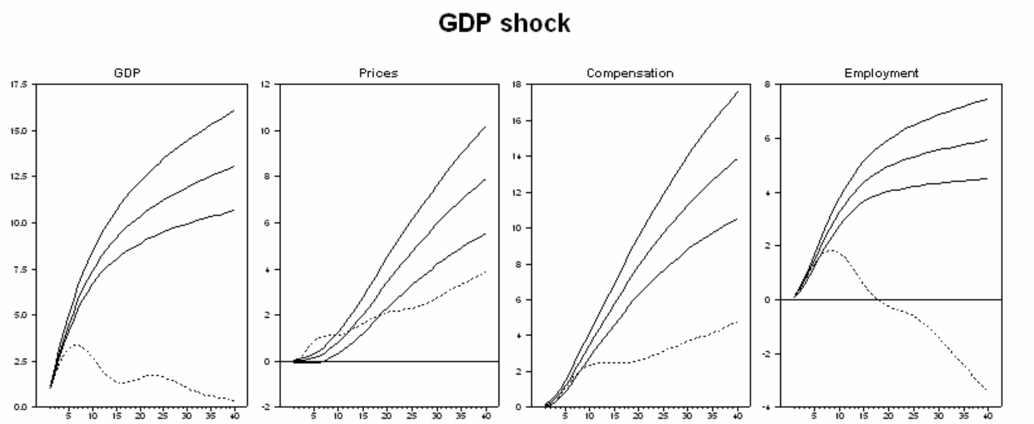
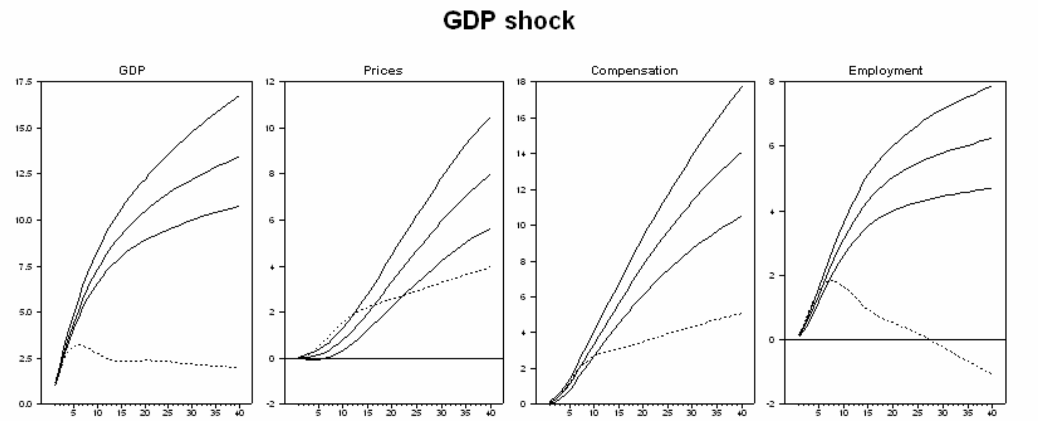
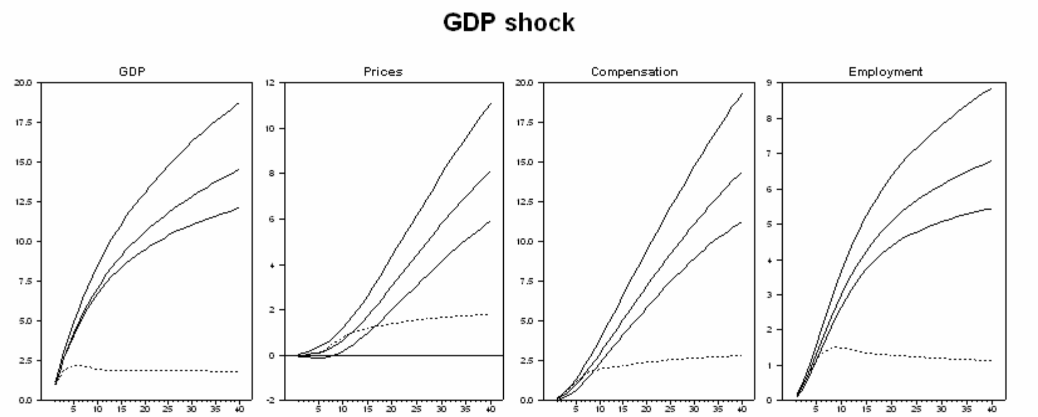


Chart 13. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4

(A) Financial crises



(B) Recessions



(C) Systemic crises

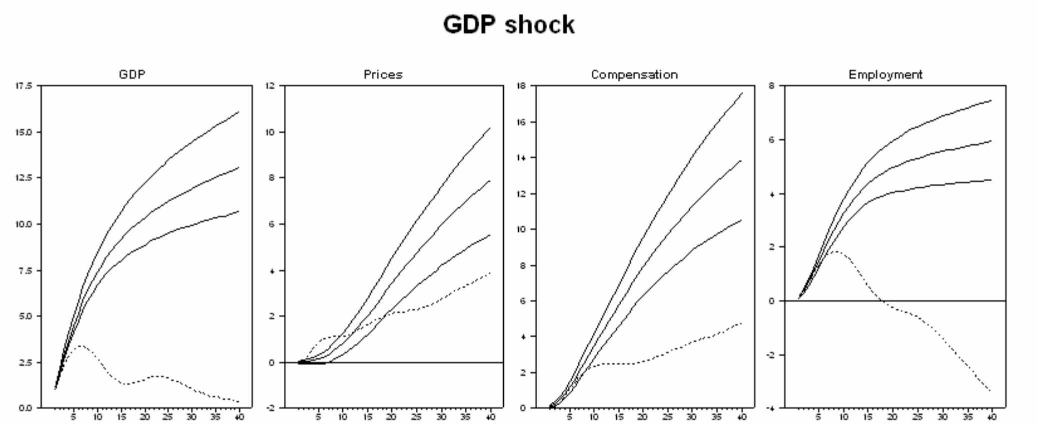
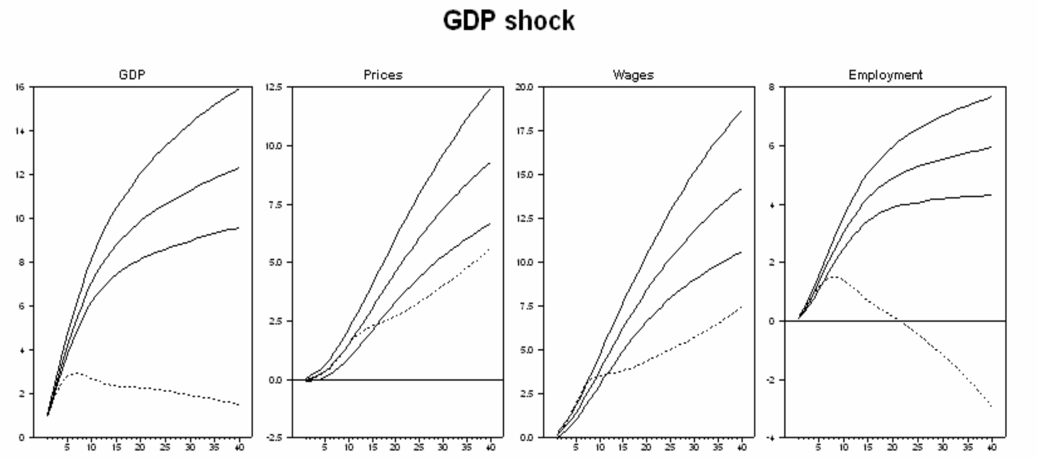


Chart 14. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4

(A) Financial crises



(B) Recessions

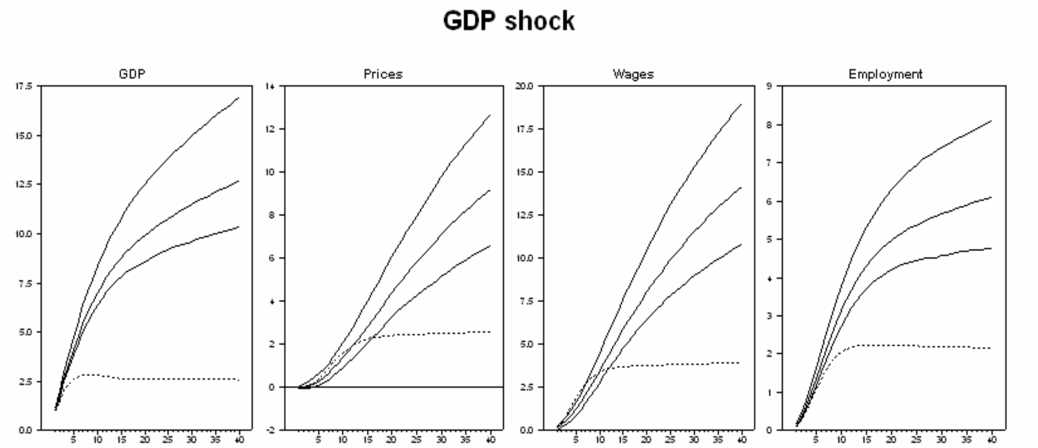
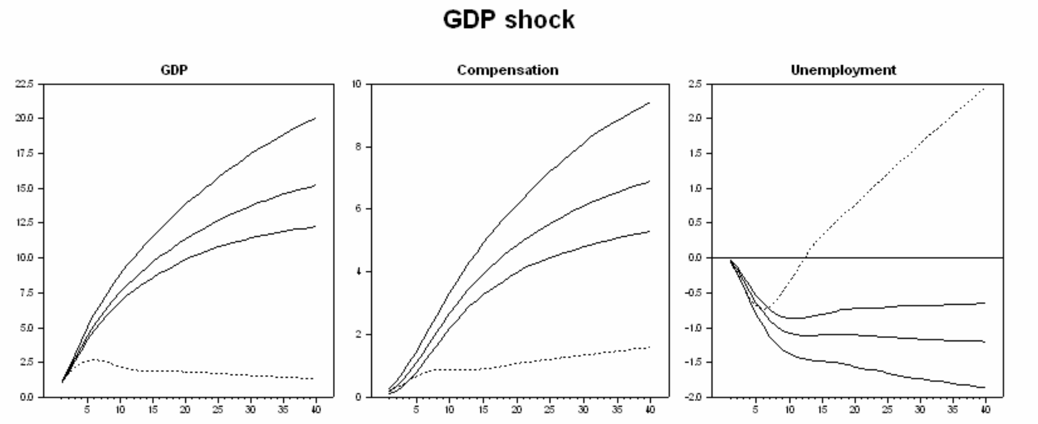
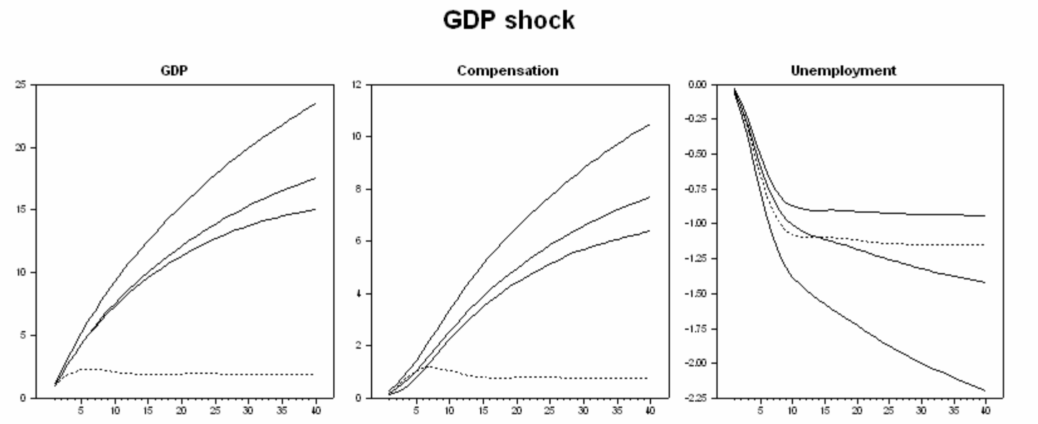


Chart 15. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4

(A) Financial crises



(B) Recessions



5.2 Wages and output during crisis episodes – ERM II and the "Great Recession"

Bernanke and Carey (1996) posed the question why, in the Great Depression, the observed world wide decline in the nominal aggregate demand was associated with such a strong contraction of real output and employment. In this section, we extend the analysis of Bernanke and Carey (1996) for the recent financial crises by estimating the (reduced form) aggregate supply and nominal wage adjustment equations during the ERM II crisis (1992-1993) and the current, still on going, crisis (2008-2009). The two crisis episodes studied here have some resemblance to the Great Depression and hence motivate this choice. In all crises, unfavourable monetary and financial conditions triggered the sharp downward adjustment of aggregate output and prices. Monetary (or credit) contraction was quickly transmitted across the countries through common monetary policies and financial markets. These episodes are therefore potentially ideal testing grounds for the hypothesis that nominal rigidities play a key role in transmitting monetary shocks to the real economy.

5.2.1 The Model

The aggregate supply curve and the wage adjustment equations to be estimated are motivated by the supply block of the (reduced form) model from Eichengreen-Sachs (1985) and further applied by Bernanke and Carey (1996). In this model, equations for aggregate supply and nominal wages are given as follows:

$$q_{it} = \delta_q q_{it-1} - \alpha_w w_{it} + \alpha_p p_{it} + z_{it}^{'}\beta + \varepsilon_{it}^{q} \quad (6)$$

$$w_{it} = \delta_w w_{it-1} + \beta_p p_{it} - \mu_u u_{it} - \mu_{\Delta u}\Delta u_{it} + z_{it}^{'}\lambda + \varepsilon_{it}^{w}. \quad (7)$$

q is the real output, w is the nominal wage rate, p is the price level, u is the unemployment rate and Δu_{it} denotes a change in the unemployment rate. i indexes country and t indexes time. $z_{it}^{'}\beta$ represents other control variables (including supply shifters), and ε_{it}^{q} and ε_{it}^{w} are the error terms. The error terms contain two orthogonal components: the fixed effects μ_i and the idiosyncratic, country-specific effects ν_{it}. All the variables, except the unemployment rate, are in logarithms.

In equation (6), the lagged output term captures possible adjustment costs of supply. According to Bernanke and Carey (1996), the aggregate supply equation allows distinguishing the effects of prices on output operating through either the nominal wage or the price channel, since the coefficients for the nominal wage and the price level are not restricted to be equal *a priori*. They argue that when *only* the nominal wage channel is operative, then α_w and α_p should be equal in (6). In this situation, there is an inverse relationship between output and real wage given by

$$q_{it} = \delta_q q_{it-1} - \alpha(w_{it} - p_{it}) + z_{it}^{'}\beta + \varepsilon_{it}^{q}. \quad (8)$$

This equation simply states that a lower price level (e.g. due to monetary contraction) depresses aggregate supply by increasing the real wage by the firms (which implies that nominal wages must adjust imperfectly)[27]. Both Bernanke and Carey (1996) and Eichengreen and Sachs (1985) take a view that the cross-sectional differences in output (after controlling for nominal wage effects) are primarily due to differences in the state of aggregate demand[28]. Yet additional regressors $z_{it}'\beta$ are used to reduce the omitted variable bias in the estimation and control for factors that can shift the supply. Our primary additional supply shifter is productivity, which we measure by real output per employment. Bernanke and Carey (1996) used various instruments such as the discount rate, monetary aggregate M1, and import prices to improve on identification of the supply equation[29]. Our primary additional instrument is the short-term interest rate. This reflects differing monetary policy responses and thus differing states of aggregate demand across countries.

Regarding the wage equation, β_p measures the degree to which the nominal wage responds to contemporaneous changes in the price level. δ_w captures the impact of the lagged nominal wage and is our measure of nominal wage inertia. Furthermore, the real product wage is allowed to respond both to the unemployment rate and to the change in the unemployment rate. The effects are captured by the parameters μ_u and $\mu_{\Delta u}$, respectively. Note that equation (7) nests the partial adjustment wage mechanism, where $\delta_w + \beta_p = 1$. In this case, the real wage adjustment equation can be written as follows (ignoring additional control variables for simplicity):

$$w_{it} - p_{it} = \delta_w (w_{it-1} - p_{it}) - \mu_u u_{it} - \mu_{\Delta u} \Delta u_{it} + \varepsilon_{it}^q . \tag{9}$$

Following Bernanke and Carey (1996), we test whether this restriction holds in the data. If the restriction holds, we then estimate the restricted version of the wage adjustment equation.

To repeat, the main hypothesis is that if the nominal wage channel is the key explanation behind a sudden and prolonged drop in output, we should find that $\hat{\alpha}_w$ and $\hat{\alpha}_p$ are equal and economically and statistically significant. This is a necessary and sufficient condition for the argument that prices affect output through the real-wage channel only, and the inverse relationship between output and real wage, if it exists, reflects imperfect adjustment of nominal wages to aggregate demand shocks.

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[27]Eichengreen and Sachs (1985) estimated the latter equation without additional controls $z_{it}'\beta$ and without the output adjustment term. Furthermore, their analysis contained only a subset of the data used in Bernanke and Carey (1996).

[28] They argue that the Great Depression provided a good opportunity to identify aggregate supply due to differing monetary policy responses across the countries which belonged, or did not belong, to the gold-exchange standard. This is the crucial identifying assumption behind the aggregate supply equation. During the ERM II crisis, the situation was somewhat comparable since only a subset of countries actually belonged to the ERM and/or abandoned the ERM at different points of time.

[29]Additional instruments can also improve potential biases arising from the measurement problems. The measurement problems associated with the nominal wage rate can be particularly problematic.

5.2.2 The data and some graphical evidence

For the empirical analysis we use quarterly data on industrial production, nominal wage rates, the producer price index and the unemployment rate for 22 OECD countries[30] to estimate the supply block of Eichengreen and Sachs (1985) and Bernanke and Carey (1996) model given in equations (6)-(7).[31] In the estimation, we focus on the periods 1992Q1-1993Q2 (ERM II crisis) and 2008Q2-2010Q2 (Great Recession). In the Figures that follow, we have normalized both the industrial production and the real wage (or the nominal-wage and the price level) prior to these two crisis episodes to equal one for each country. The periods, and hence the point of normalisation, are chosen based on identified business cycle peaks. However, it should be noted that there is some arbitrariness regarding the point of normalization since not all the countries experienced the business cycle peak at the same time.[32] This is especially the case in the ERM II crisis. Regarding the Great Recession, we focus on the period 2008Q2-2010Q2, where the endpoint is dictated by the data availability. The business cycle peak is more synchronized during the current crisis than during the ERM II crisis. Given the prolonged contraction of output and the relatively slow adjustment of the labour markets, we use the longer period in the Great Recession relative to ERM II crisis.

Chart 16 shows the relationship between the normalized industrial production and the real wage for the countries of our sample in six consecutive quarters starting from 1992Q1. The most distinctive feature of Chart 16 is that the cross-sectional relationship between industrial production and the real wage changes over time. At the beginning of the sample period, the cross-sectional variation in the real wage is not clearly associated with the cross-sectional variation in output. However, as some of the economies started diving deeper into the recession, the negative association between the output and the real wage becomes rather strong: Towards the end of the sample, countries with high real wages had also typically low output[33]. This negative relationship between output and real wage is very clear during the last three critical quarters of the ERM II crisis (1992Q4-1993Q2).

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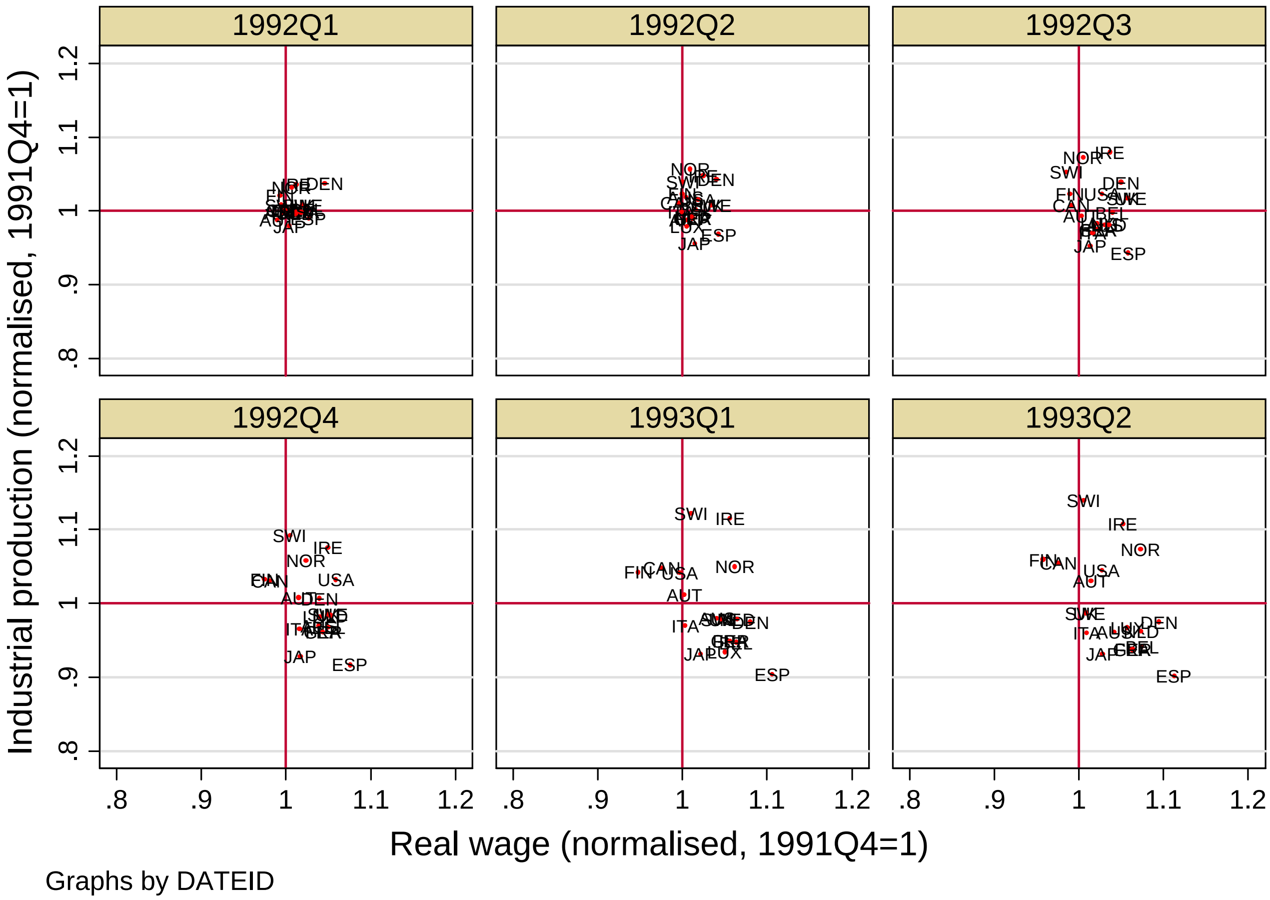
[30]Countries included in the sample are (abbreviations in the brackets) Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Switzerland (SWI), Czech Republic (CZE), Germany (GER), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), United Kingdom (GBR), Greece (GRC), Ireland (IRE), Italy (ITA), Japan (JAP), Luxembourg (LUX), Netherlands (NLD), Norway (NOR), New Zealand (NZ), Portugal (PRT), Slovak Republic (SVK), Sweden (SWE) and USA (US).

[31] The producer price index is used to deflate the nominal wage rate series in the relevant regressions. Deflating the nominal wage by the producer price index gives the real product wage which is relevant to labour demand decisions of the firms. Note that Bernanke and Carey (1996) used annual data and the nominal wages were deflated by the wholesale price index. Bernanke and Carey (1996) were forced to use the wholesale price index due to data availability.

[32] In Table A6 in the Annex 1 (for details, see section 2) business cycle dates are identified around the two crisis. In the ERM II crisis period, the countries can roughly be divided into two categories. The Nordic countries, Australia, New Zealand, the UK, Canada, and the US experienced the business cycle peak around 1990s. Spain, Norway, Denmark, France, Germany, Greece, Italy, Switzerland, and Portugal entered into the recession somewhat later in 1992. In the majority of the countries, the trough was reached during the first half of 1993 and the recession lasted at least 4 quarters. In Table , it can also be seen that the countries that entered into the recession early, experienced more a prolonged output contraction. These considerations in hand, we have chosen to focus in the estimation on the period 1992Q1-1993Q2. This captures the critical quarters of the ERM II crisis, following the peaking of the German interest rate in the summer 1992.

[33]It is possible that a negative labour supply shock generated the negative association between output and real wage towards the end of the crisis. However, it is hard to believe that a similar shock would have hit all the countries simultaneously and with such an important magnitude.

Chart 16. Industrial production and real wages during the ERM II crisis



Note: Chart shows the evolution of industrial production and real wage during the ERM II crisis in the sample of OECD countries. Real wage and industrial production are normalised to unity in 1991Q4. For definition of the variables, see the main text.

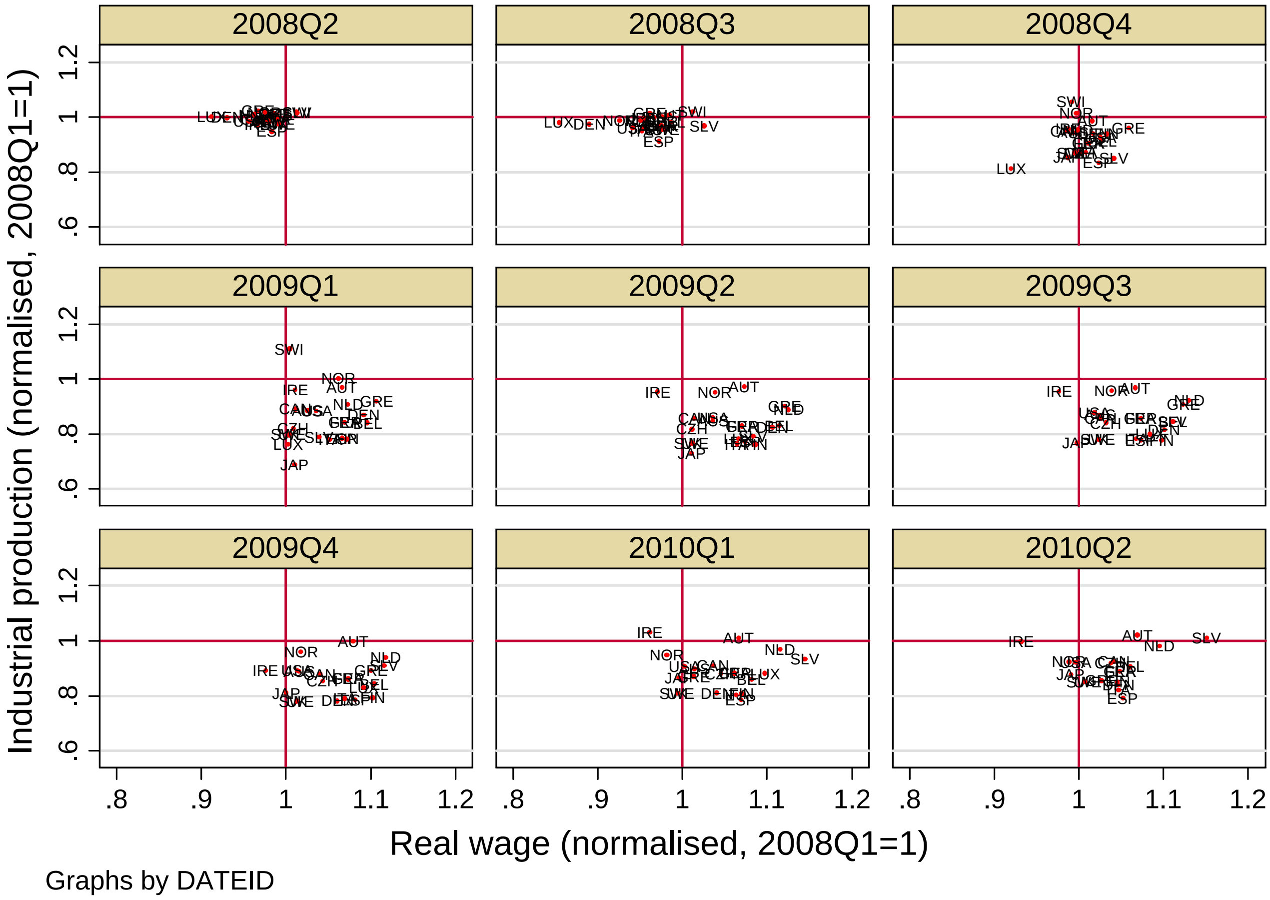
The graphical evidence on the downward sloping output curve in the panel of countries agrees well with the simple static regression for the industrial output (y) and the real product wage ($w-p$). After controlling for time and fixed effects, we obtain the following relationship:

$$y = \underset{(2.06)}{0.01} - \underset{(4.14)}{0.59}(w-p) \qquad (10)$$
$$R^2 = 0.16, \ \#Obs. = 114$$

Absolute (robust and small sample corrected) t-values are reported in parenthesis. The coefficient for the real wage is strongly statistically significant and negative.

Chart 17 depicts the evolution of industrial output and real wage during the current crisis, from the start until the latest available quarterly data point of 2010Q2. Variation in the cross-sectional pattern in the Great Recession looks somewhat different when compared to the ERM II crisis. Evidence on the negative relationship between the industrial production and the real wage seems weaker. Note also that, by 2010Q2, industrial output is still *below* 2008Q1 level in most of the countries of our sample. As illustrated in the previous Figure, which looked at the ERM II crisis, some countries had already started pulling out from the recession after 6 quarters since the peak of the business cycle. At the same time, note that there are several countries where the real product wage had fallen below 2008Q1 level already prior to 2009Q1. This is in contrast to the ERM II crisis, where the real wage shows far more inertia. This is consistent with the earlier stylized facts according to which a decline in real compensation has been larger in recessions following a severe banking crisis. In the Great Recession, and towards 2010Q2, we can already see some evidence of rebounding of the industrial output and real wage. However, a negative association between industrial production and real wage is not apparent even towards the end of the sample.

Chart 17. Industrial production and real wages during the 'Great Recession'



Note: Chart shows the evolution of industrial production and real wage during the Great Recessions in the sample of OECD countries. Real wage and industrial production are normalised to unity in 2008Q1. For definition of the variables, see the main text.

A simple fixed effects regression (after controlling also for the time effects) between the industrial output (y) and the real wage ($w-p$) results now into the following relationship:

$$y = \underset{(10.39)}{-0.11} + \underset{(1.51)}{0.18}(w - p)$$
$$R^2 = 0.44, \ \#Obs. = 191 \qquad (11)$$

This relationship appears dramatically different with respect to the ERM II period: There is no statistically significant association between the output and the real product wage whatsoever. If anything, the relationship is positive.

5.2.3 Aggregate Supply

We turn now to discuss the results on the estimation of aggregate supply curve (as given in (6)) for the two crisis periods. The estimation results from various specifications are provided in Table 12. Column I report the results without controlling for time effects and productivity. Column II contains the results after controlling for both the time effects and productivity. Column III reports the results using the short-term interest rate as an additional instrument. Finally, Column IV shows the results after imposing the restriction that $\alpha_w = \alpha_p$.

In both periods, aggregate supply exhibits some degree of sluggishness. The estimated coefficient for the lagged industrial output is around 0.70 during the ERM II and about 0.60 in the Great Recession. In both cases, this coefficient is is precisely determined (see row δ_q in Columns I-IV). After controlling for the time effects, the GMM estimators lie between the upper and lower bounds. [34] This indicates that GMM method copes well with the potential biases caused by the endogeneity of the lagged dependent variable.

Estimation results for the aggregate supply equation during the ERM II crisis are supportive to the view that nominal wage rigidity contributed to the sharp drop in output during the crisis. The estimated coefficient for the nominal wage is positive and we *cannot* reject the hypothesis that $\alpha_w = \alpha_p$. Note, however, that the estimated coefficient for the price level term is imprecise. Introducing the nominal interest rate as an additional instrument improves somewhat the precision of the estimated coefficients (see Column III). Productivity, treated here as a strictly exogenous variable, enters significantly to the aggregate supply equation during the ERM II crisis, but its inclusion does not dramatically change the coefficients for the lagged output and the wage terms.

In Column IV (ERM II crisis) we impose the restriction that $\alpha_w = \alpha_p$. The coefficient for the real wage is now even more tightly estimated. It is statistically significant at 5% level. Its magnitude is also in accordance with the unrestricted coefficients from Columns (I-III). Sargan and Hansen tests, as well as the test for the first and second order serial correlation suggest that the equation is well specified. The only concern is that the coefficient for the lagged output term is slightly below the lower bound established in row ($\delta_q^{FE}, \delta_q^{OLS}$). The "long run" elasticity of real wage is 1.75. This suggests again the

[34] As discussed by Bond, S. (2002), the lower and upper bounds were established by estimating the respective models by OLS and by the standard FE methods. See row ($\delta_q^{FE}, \delta_q^{OLS}$).

potentially important role of nominal wage rigidity in explaining a drop in industrial output during the ERM II crisis.[35]

The Great Recession is different. The nominal wage enters into the model typically with the correct sign, but after controlling for time effects, it is very imprecisely estimated (see Columns (Great Recession) I-III). Although the test for the equality of the nominal-wage and price level coefficients fail to reject the null hypothesis, this acceptance is very much due to the imprecision of both parameter estimates (α_w, α_p). In fact, we also cannot reject the hypothesis that $\alpha_w = 0$ when we control for the time effects. Another difference is that the productivity term does not enter the aggregate supply equation with significant positive sign. Using nominal interest rate as additional instrument improves somewhat the precision of the estimates, but does not change the point estimates importantly.

In Column IV, we estimate the aggregate supply curve with the restriction that $\alpha_w = \alpha_p$. The productivity term is kept for the final specification. The coefficient on the real wage remains negative, but it is nowhere near statistically significant. This result does not change if we drop the productivity and/or do not use the short-term interest rate as additional instrument. Moreover, estimating the same set of equations for a shorter period (2008Q2-2009Q3) leaves the results qualitatively the same. Combining this evidence with the preliminary analysis leads us to conclude that there is no direct support for the nominal wage channel at work in the Great Recession.[36]

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[35]This long-run elasticity is somewhat larger than in the Bernanke and Carey (1996) study. However, they also estimated the long elasticity that exceeds unity.

[36]We have repeated the analysis using the GDP deflator as our price/nominal wage deflator variable. Qualitatively the results remain the same for the current crisis period. Although the real wage enters into the specification similar to Column IV with a correct sign, it is not statistically significantly different from zero.

Table 12. Estimates for aggregate supply model

	$q_{it} = \delta q_{it-1} - \alpha_w w_{it} + \alpha_p p_{it} + z_{it}'\beta + \epsilon_{it}^q$							
		ERM II Crisis				**Great Recession**		
	I	II	III	IV	I	II	III	IV
δ_q	0.75	0.72	0.68	0.68	0.51	0.60	0.69	0.62
	(4.13)	(5.37)	(6.31)	(6.31)	(3.84)	(4.81)	(4.87)	(5.34)
α_w	0.40	0.39	0.42	0.56	0.66	0.14	0.18	0.06
	(1.98)	(1.71)	(1.86)	(2.17)	(1.68)	(0.28)	(0.40)	(0.19)
α_p	0.79	-0.19	-0.01	--	0.53	0.05	0.05	--
	(1.60)	(0.40)	(0.05)		(3.12)	(1.16)	(0.18)	
pro	--	0.82	0.84	0.72	--	1.59	1.67	1.76
		(3.32)	(3.26)	(3.52)		(1.38)	(1.49)	(1.46)
time	NO	YES	YES	YES	NO	YES	YES	YES
I(*str*)	NO	NO	YES	YES	NO	NO	YES	YES
# Inst	15	21	19	17	18	20	21	21
# Obs/groups	114/19	114/19	114/19	114/19	191/22	182/21	182/21	182/21
$F_{\alpha_w=\alpha_p}$	0.24	0.26	0.36	--	0.72	0.83	0.73	--
Sargan	0.43	0.73	0.61	0.97	0.000	0.29	0.36	0.46
Hansen	0.44	0.65	0.60	0.59	0.13	0.60	0.73	0.35
AR(1)- test	0.026	0.007	0.008	0.037	0.92	0.082	0.086	0.053
AR(2)- test	0.66	0.87	0.77	0.59	0.96	0.22	0.21	0.17
($\delta_q^{FE}, \delta_q^{OLS}$)		(0.73, 1.09)				(0.61,0.98)		

Note: The dependent variable is the industrial production. The construction of variables and definitions are contained in the main text. Time effects are controlled when indicated (time=YES) using separate time dummies. The robust t- values are given in parenthesis. T-values are robust to heteroskedasticity and arbitrary patterns of autocorrelation within the countries. Estimated parameters are based on one-step difference-GMM. For the equality of the parameter test (F-test), Sargan, Hansen and AR tests, respective p-values are shown "pro" is productivity, "time" are the time effects and "I(str)" refers to whether the short-term interest rate has been used as an additional instrument or not. In Column IV we have imposed the restriction $\alpha_w = \alpha_p$. In this case, α_w refers to the elasticity of industrial output with respect to the real product wage.

5.2.4 Wage Adjustment Equation

We now turn to discuss the estimation results regarding the wage adjustment equation. The results are provided in Table 13. We follow the same strategy as in the estimation of the supply curve by introducing additional controls and restrictions progressively. Column I shows the results without controlling for the time effects while in Column II the time effects are introduced. In Column III we control also for productivity and change in the unemployment rate. Finally, in Column IV we impose the restriction that $\beta_p + \delta_w = 1$. Furthermore, in order to check for possible misspecification, we have estimated the respective equations by OLS and by FE methods.

Table 13. Estimates for wage adjustment equation

$$w_{it} = \delta_w w_{it-1} + \beta_p p_{it} - \mu_u u_{it} - \mu_{\Delta u} \Delta u_{it} + z'_{it} \lambda + \varepsilon_{it}^{w}.$$

	ERM II Crisis				Great Recession			
	I	II	III	IV	I	II	III	IV
δ_w	0.92	0.86	0.84	0.81	0.69	0.83	0.94	0.80
	(15.51)	(5.44)	(5.51)	(11.19)	(4.42)	(6.76)	(6.32)	(6.13)
β_p	0.29	0.41	0.35	--	0.04	0.09	0.11	--
	(2.07)	(1.77)	(1.28)		(0.95)	(1.25)	(1.18)	
μ_u	0.029	0.040	0.037	0.029	-0.008	0.002	0.005	-0.001
	(2.34)	(3.18)	(2.81)	(4.42)	(0.73)	(0.41)	(0.53)	(0.07)
$\mu_{\Delta u}$	--	--	0.008	--	--	--	--	--
			(0.27)				--	
pro	--	--	-0.08	--	--	--	0.23	0.20
			(0.20)				(1.80)	(2.34)
time	NO	YES	YES	YES	NO	YES	YES	YES
# Inst	18	17	18	17	18	17	21	17
# Obs/groups	114/19	114/19	114/19	114/19	190/22	190/22	182/21	182/21
$\beta_p + \delta_w = 1$	0.17	0.16	0.45	--	0.11	0.58	0.74	--
Sargan test	0.31	0.11	0.085	0.086	0.077	0.11	0.000	0.13
Hansen test	0.34	0.32	0.26	0.26	0.47	0.12	0.24	0.38
AR(1) test	0.067	0.067	0.066	0.050	0.039	0.030	0.006	0.040
AR(2) test	0.21	0.15	0.079	0.18	0.15	0.13	0.26	0.41
$\delta_w^{FE}, \delta_w^{OLS}$	(0.48, 0.98)				(0.72, 1.01)			

Note: The dependent variable is the nominal wage rate. The construction of variables and definitions are contained in the main text. Time effects are controlled when indicated (time=YES) using separate time dummies. The robust t- values are given in parenthesis. T-values are robust to heteroskedasticity and arbitrary patterns of autocorrelation within the countries. Estimated parameters are based on one-step difference-GMM estimator. For equality of the parameter test (F-test), Sargan, Hansen and AR -tests, respective p-values are shown In Column IV, we have imposed the restriction that $\beta_p + \delta_w = 1$. In this case, δ_w refers to the partial adjustment coefficient (see equation 9).

Our first observation is that nominal wage adjustment has been relatively slow in both crises. The coefficients for the lagged nominal wage (i.e. our measure of nominal wage inertia) are somewhat above 0.80 in both crises. The coefficient on the price level is precisely estimated in the ERM II crises and its economically sizable (see Columns ERM II Crisis, I-III). In the Great Recession, the price level term is smaller and clearly less precisely estimated. Nevertheless, in both cases, we cannot reject the hypothesis that $\beta_p + \delta_w = 1$. This suggests that the wages follow a partial adjustment mechanism. The coefficient for the unemployment rate is positive and well determined only in the ERM II crises (see Columns ERM II Crisis, I-III). The productivity term is not significant, and neither is the change in the unemployment ($\mu_{\Delta u}$). After imposing the restriction, $\beta_p + \delta_w = 1$, the results confirm the same pattern. The real product wage adjusts to its new equilibrium slowly in both crises. The key misspecification tests are passed in all the cases. One cannot tell apart the differences in the speed of adjustment. However, in the Great Recession, there is evidence that the real wage adjusts to productivity developments, while in the ERM II crises, the real wage adjusts to unemployment rate.

The estimated coefficients in Column ERM II Crisis, IV suggest the following partial adjustment mechanism for the real wage ($w-p$):

$$(w-p) = \underset{(11.19)}{0.81}(w_{-1}-p) - \underset{(4.42)}{0.03}u. \tag{12}$$

Absolute (robust) t-values are given in the parenthesis. w_{-1} denote the one-quarter lagged nominal wage. This equation implies a reasonably high degree of nominal wage inertia. It rejects the hypothesis that wages are flexible ($\delta_w = 0$) with a very high margin. The unemployment rate is highly significant, implying that a higher unemployment rate leads to a moderately lower real wage.

In the current crisis, so far, the wage adjustment is different. Although there we find a similar degree of inertia in the nominal wage adjustment as indicated by the estimated values for δ_w, the coefficient for the price level term and the unemployment rate are imprecise and small. At the same time, the productivity term is positive and statistically significant. As in the case of the ERM II crisis, however, we cannot reject the restriction that $\beta_p + \delta_w = 1$. After imposing this, we arrive to following partial wage adjustment equation (after dropping the unemployment rate) in the Great Recession (see Column Great Recession, IV):

$$(w-p) = \underset{(6.13)}{0.80}(w_{-1}-p) + \underset{(2.30)}{0.20}\, pro \tag{13}$$

Absolute (robust) t-values are given in the parenthesis. The coefficient for the (log) productivity is significant at the 5% level. Note that the above equation implies that the long-run elasticity of real wage to productivity is unity. Similarly, to the wage adjustment equation in the ERM II crisis, also this equation implies a relatively high degree of nominal wage inertia. Certainly, we can reject the hypothesis that wages are flexible. Yet the difference to the ERM II crisis is that there is a relatively clear association between productivity and the real wage in the Great Recession, absent in the ERM II crisis. This result seems well aligned with the aggregate supply curve findings of the previous subsection. In the Great Recession, the real wage response (especially early in the recession) have cushioned some of the impact of the negative demand shock on output as the real wage have responded to the change in productivity. In the ERM II crisis, the real wage has been de-coupled from the productivity development. Instead, the moderate response of real wage to unemployment in equation (12) could reflect fairly a-cyclical and delayed response of the real wage to demand shocks. The analysis in section 2 again supports the finding i.e. that wages are temporarily detached from the labour market situation until the crisis feeds fully into unemployment. Hence, in overall the econometric evidence in this section warrants reasonably strong support for the hypothesis that the wage inertia was an important determinant of aggregate supply during the ERM II crisis but less so in the Great Recession.

6. Concluding remarks

This paper has explored the repercussions of past financial crisis to the labour markets, focusing on the role of wage rigidities and hysteresis in OECD countries from 1970s to the present. We find substantial evidence that the labour markets react to financial crisis stronger than those of other downturns. The shadow of recessions in terms of higher unemployment and long-term unemployment depends naturally on the the severity of the recession, but importantly also on the flexibility at the micro-level and the ability to restructure the economy as captured by worker flows. We also find that some downward nominal and real wage rigidity has added to the stronger employment and output losses following financial crises. When looking at individual episodes, this pattern is confirmed for the ERM II crisis in the early 1990s, but seems to be less the case in the Great Recession.

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ANNEX 1: TABLES AND CHARTS

Table A1: Dates of troughs identified in sample of countries (1970 to 2008)

	Number of troughs	Dates of troughs in GDP
Australia	5	1972Q1 1975Q4 1977Q4 1983Q2 1991Q2
Belgium	6	1975Q2 1977Q2 1981Q3 1983Q1 1993Q2 2001Q4
Canada	3	1980Q3 1982Q4 1991Q1
Denmark	6	1975Q2 1981Q2 1988Q2 1993Q2 1997Q4 2006Q4
Finland	6	1971Q1 1975Q4 1977Q2 1981Q1 1993Q2 2001Q4
France	2	1975Q1 1993Q2
Germany	6	1975Q2 1980Q4 1982Q3 1993Q1 1996Q1 2003Q2
Greece	7	1974Q3 1977Q2 1981Q2 1983Q2 1990Q3 1993Q1 1995Q2
Ireland	2	1983Q2 1986Q2
Italy	8	1975Q2 1977Q3 1982Q4 1993Q3 1996Q4 2001Q4 2003Q2 2005Q1
Japan	3	1993Q4 1999Q1 2001Q4
Luxembourg	4	1975Q3 1981Q2 2001Q2 2003Q1
Netherlands	5	1973Q3 1975Q1 1979Q1 1980Q3 1982Q4
New Zealand	10	1970Q4 1973Q3 1975Q2 1978Q1 1980Q2 1983Q1 1986Q1 1987Q4 1991Q2 1998Q1
Norway	3	1980Q3 1988Q4 1993Q1
Portugal	4	1975Q2 1984Q2 1993Q3 2002Q4
Spain	4	1975Q2 1979Q1 1981Q2 1993Q2
Sweden	3	1977Q1 1981Q4 1993Q1
Switzerland	8	1976Q1 1983Q2 1991Q2 1992Q4 1995Q2 1999Q2 2001Q3 2003Q1
United Kingdom	4	1974Q1 1975Q3 1981Q1 1991Q3
United States	5	1970Q4 1975Q1 1980Q3 1982Q1 1991Q1

Table A2: Details on developments during financial crisis episodes

	Business cycle dates			Duration (quarters)			Amplitude (%GDP)	
	Previous peak	**Trough**	**Subsequent peak**	**Recession**	**Recovery**	**Expansion**	**Recession**	**Expansion**
Systemic crises								
Spain	1978Q2	1979Q1	1980Q4	3	3	7	-0.4	2.0
Finland	1989Q4	1993Q2	2001Q1	14	14	31	-12.3	41.1
Sweden	1990Q1	1993Q1	2008Q1	12	7	60	-5.6	57.7
Norway	1988Q1	1988Q4	1992Q3	3	4	15	-3.0	12.4
Japan	1993Q1	1993Q4	1997Q1	3	3	13	-1.6	8.9
Non-systemic crises								
Australia	1990Q1	1991Q2		5	5		-1.8	
Denmark	1986Q4	1988Q2	1992Q3	6	5	17	-0.6	6.7
France	1992Q3	1993Q2	2008Q1	3	4	59	-1.2	37.7
Germany	1980Q1	1980Q4	1982Q1	3	1	5	-1.2	1.5
Greece	1992Q1	1993Q1	1994Q3	4	6	6	-4.7	5.4
Italy	1992Q1	1993Q3	1996Q1	6	3	10	-1.9	7.1
Japan	1997Q1	1999Q1	2001Q1	8	7	8	-3.3	4.7
New Zealand	1986Q3	1987Q4	1990Q4	5	22	12	-4.9	4.8
United Kingdom	1973Q2	1974Q1	1974Q3	3	11	2	-3.4	2.8
United Kingdom	1990Q2	1991Q3	2008Q2	5	8	67	-2.5	58.0
Canada	1981Q2	1982Q4	1990Q1	6	4	29	-4.9	34.2
All recessions								
Mean				3.7	4.6	21.6	-2.9	23.6
Median				3.0	3.0	15.0	-2.1	13.5

Notes: The duration of a recession (expansion) counts the number of quarters between a peak and trough (between a trough and peak). The amplitude of a recession (expansion) measures the percentage change in GDP between a peak and trough (between trough and peak). The duration of a recovery measures the number of quarters after a trough before activity has recovered to the level of the previous peak.

Table A3: Details on changes in macroeconomic variables during recessions

	Duration (years)		Amplitude (% change during recession)					
	Recession	Recovery	GDP	Employment	Participation	Unemployment	Real compensation	Real unit labour costs
Systemic crises								
Mean	7.0	6.2	-4.6	-6.2	-2.0	4.8	-9.6	-3.5
Standard deviation	5.5	4.7	4.7	7.7	2.5	5.6	9.3	4.8
Coefficient of variation	0.8	0.8	-1.0	-1.2	-1.2	1.2	-1.0	-1.4
Observations	5	5	5	5	5	5	3	3
Non-systemic crises								
Mean	4.9	6.9	-2.8	-1.6	-0.6	1.6	-1.3	0.4
Standard deviation	1.6	5.7	1.6	2.0	1.3	1.8	3.3	2.6
Coefficient of variation	0.3	0.8	-0.6	-1.2	-2.0	1.1	-2.5	6.1
Standard deviation	11	11	11	10	8	10	8	8
'Normal' cycles								
Mean	3.7	4.6	-2.9	-0.7	-0.1	1.2	-0.6	1.5
Standard deviation	2.2	5.3	2.9	2.8	1.2	1.8	3.7	3.3
Coefficient of variation	0.6	1.2	-1.0	-4.0	-8.3	1.6	-6.3	2.3
Standard deviation	101	101	101	94	76	93	58	58

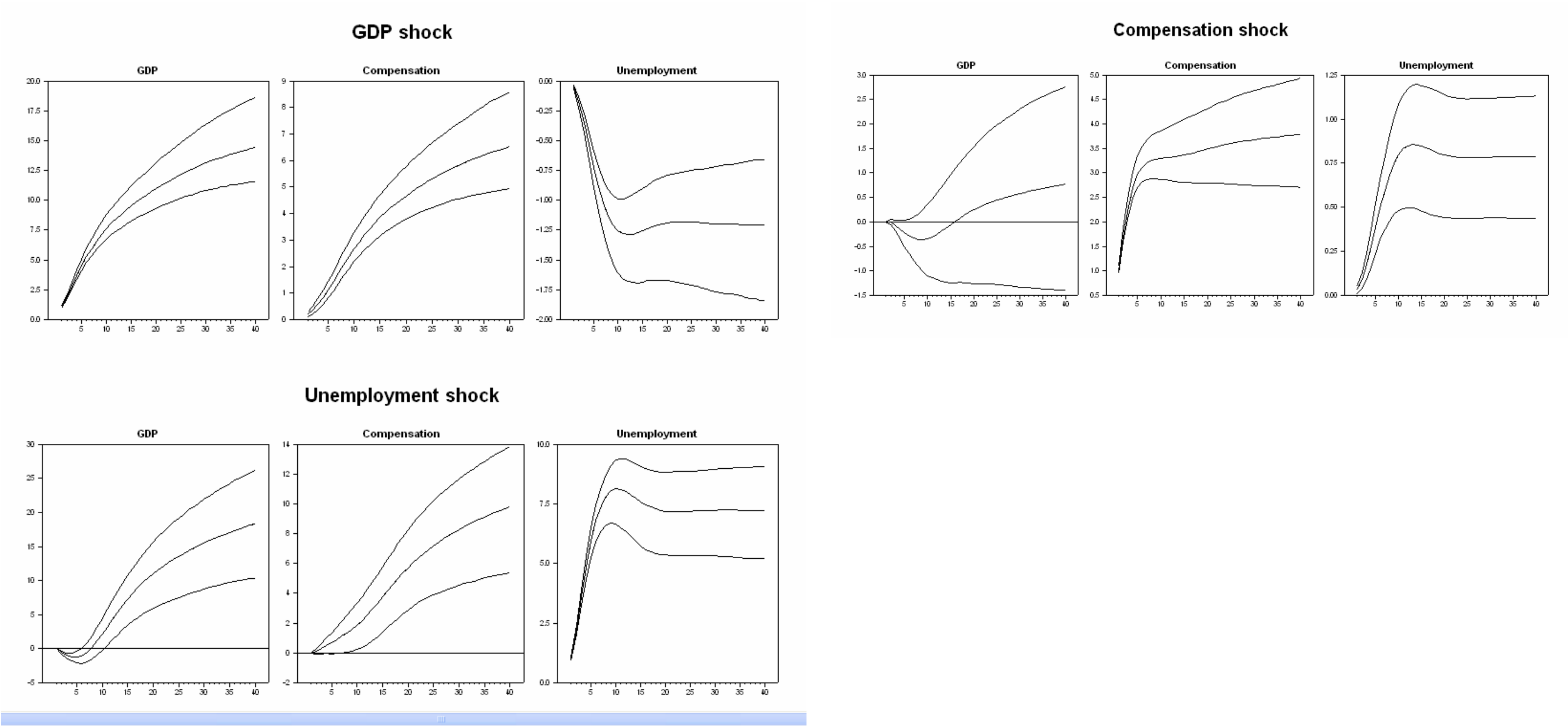
Notes: The duration of a recession counts the number of quarters between a peak and trough in GDP; the duration of a recovery measures the number of quarters after a trough before GDP has recovered to the level of the previous peak. The amplitude of a variable measures the percentage change during the recessionary period (i.e. between the trough and peak in GDP).

Table A4: Asymmetries – changes to sample period

	All (1)	1970s (2)	1980s (3)	1990s (4)	2000s (5)
GDP deflator (PGDP)	0.701 ***	0.467 ***	0.527 ***	0.102	-0.186 **
PCD-PGDP wedge	0.361 ***	0.275 **	0.104	0.019	-0.254 ***
Productivity	0.175 ***	0.108	0.183 **	0.224 **	0.084 **
Oil	0.004 ***	0.010 **	0.004 *	-0.001	0.001
US-dollar exchange rate	-0.008 *	-0.024	-0.013 **	0.010	-0.007
Unempl. gap negative	0.000	-0.004	-0.001	-0.005 ***	0.000
Unempl. gap positive	-0.002 ***	-0.003 **	-0.001 **	-0.001	-0.003 *
Constant	0.006 ***	0.017 ***	0.009 ***	0.008 ***	0.011 ***
Number of observations	2312	452	598	636	626
F-test: no wage asymmetries*	0.159	0.778	0.998	0.024	0.282
No. positive unemp. gap periods	1249	268	337	363	281
R-Squared	0.462	0.388	0.443	0.138	0.019

Notes: specification as in equation (1). Stars denote p-values for significance of coefficients: * p<0.1; ** p<0.05; *** p<0.01. Dependent variable is first difference of log compensation per employee. Explanatory variables are: first differences of log GDP deflator (PGDP), and the difference between consumer price inflation and the GDP deflator ("PCD-PGDP wedge"), productivity, oil price and USD exchange-rate. The unemployment gap is measured as the unemployment rate less estimated NAIRU (using an HP filter) and the observations have been separated into those above and below zero. The F-test shows the p-values for the hypothesis that the coefficients on the unemployment gaps (positive and negative) are the same.

Chart A1. Impulse responses to orthogonal one unit shock, sample 1980:Q1 to 2008:Q4.



Note: Chart shows the impulse response functions corresponding to Chart 12 in the main text, but including change in the unemployment rate in the VAR, instead of employment.

Table A5. Timing of ERM II and Great Recession

	ERM II Crisis			Current Crisis
	Peak	Trough	Duration	Peak
Finland	1989Q4	1993Q2	14	--
Sweden	1990Q1	1993Q1	12	--
Italy	1992Q1	1993Q3	6	2008Q1
Spain	1992Q1	1993Q2	5	2008Q2
Australia	1990Q1	1991Q2	5	--
United Kingdom	1990Q2	1991Q3	5	2008Q2
Portugal	1992Q2	1993Q3	5	2008Q2
Canada	1990Q1	1991Q1	4	2007Q4
Germany	1992Q1	1993Q1	4	2008Q1
Greece	1992Q1	1993Q1	4	--
Belgium	1992Q2	1993Q2	4	--
France	1992Q3	1993Q2	3	2008Q1
Denmark	1992Q3	1993Q2	3	2008Q2
Norway	1992Q3	1993Q1	2	2008Q1
New Zealand	1990Q4	1991Q2	2	2007Q4
Japan	1993Q1	1993Q4	2	2008Q1
Switzerland	1992Q1	1992Q4	2	2008Q2
USA	1990Q3	1991Q1	2	2008Q2
Ireland	--	--	0	2007Q1
Netherlands	--	--	0	2008Q3
Luxembourg	--	--	0	n.a.
Austria	n.a.	n.a.	n.a.	n.a.
Slovak Republic	n.a.	n.a.	n.a.	n.a.

Note: Table shows relevant business cycle statistics for the ERM II crisis and for the Great Recession episodes. For the details on the method of identifying the business cycle peak and trough, see section 2 and references therein. n.a. denotes not available, -- denotes that the method did not identify a business cycle peak or through close to that particular period.

ANNEX 3: FURTHER DETAILS ON THE SPECIFICATION OF THE BERNANKE AND CAREY MODEL

In our preferred specifications, we treat the right-hand-side variables of output and wage adjustment equations as predetermined or endogenous. This means that they can potentially be correlated with the past and possibly with the current errors. This is achieved by using an appropriate set of internal instruments for the right-hand-side variables. The appropriate instrument set is chosen primarily on the basis of Sargan and Hansen tests for over-identifying restrictions.

In order to avoid over-fitting of the endogenous right-hand-side variables, we limit our instrument set such that the total number of instruments does not exceed the number of available cross-sections. Too many instrumental variables lead to bias, which increases as the number of instruments rises. It can also dramatically weaken the Hansen test statistics for over-identifying restrictions (the joint validity of the instruments) by generating implausibly high p-values. Note that in our data set, the number of available cross-sections is relatively small. This makes the over-fitting problem and the resulting bias of the adjustment parameters in the supply and the wage equations more severe.[37]

In order to avoid misspecification, we first establish the upper and the lower bounds for the estimated (adjustment) parameter (the coefficient for the lagged dependent variable in the output equation). The bounds are obtained by estimating the respective equations using both OLS and the standard fixed effects estimator (FE). The OLS estimator should give the upper bound while the FE estimator should give the lower bound. The GMM estimator of the adjustment parameter should then lie somewhere between, or at least close to, OLS and FE estimator. Otherwise, there is good reason to believe that the model estimated by the GMM is misspecified.[38] Given that our measure for the degree of nominal wage inertia relies on the estimated value of the lagged dependent variable in the wage adjustment equation, avoiding the misspecification is crucial.

[37]Note that Arellano-Bond type panel estimators are originally designed for the situation where time series dimension is small, and cross-section dimension is large (small T, large N type of panels).
[38]See Bond (2002).