Financial Crises and Unemployment: Beyond the Okun's Law

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Abstract[1]

We study the additional effect of financial crises (with respect to that passing through GDP changes) on the unemployment rate. The approach is based on a theoretical framework which, starting from the "Okun's Law", accounts for the effect of four types of financial crises. We formulate an operational model which belongs to the family of linear Mixed-Effects Models and implement an Expectation-Maximization algorithm. The model is fitted to data coming from a large panel of countries for the period 1980-2005. The results show evidence of additional effects of certain types of financial crises on the unemployment rate.

JEL Classification: C23, G01, J23, J29, J69

Key words: financial crises, labour market impact, Okun's Law, uncertainty

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1 Earlier versions of this paper were presented at the Sixteenth World Congress of the International Economic Association (Tsinghua University, Beijing, China, July 4-8 2011), at the Thirteenth AISSEC Conference (University of Macerata, June 23-25 2011) and at the Second STI-EACES Workshop (University of Bologna, May 27-29 2011). We thanks Karsten Staehr and many other participants to the above conferences for their useful comments. The usual disclaimer applies.

1. Introduction

In this paper, we propose a model to detect the additional effect on unemployment - with respect to that passing through GDP growth declines – specifically arising from financial crises. We interpret this additional effect as the consequence of the increase in the degree of "systemic uncertainty". The first link between GDP and unemployment has been thoroughly studied in the "Okun's Law" literature; the effect of uncertainty on economic decisions and on macroeconomic performance has also been extensively studied. But the two strands of literature have not been overlapping.

Concerning the last financial crisis and "Global Recession"[2], in a recent paper Elsby *et al.* (2010) claim that the Okun's Law performed remarkably well in the first part of the 2007 recession through the first quarter of 2009. However, the last nine months of 2009 witness a departure from the rule as the overall economic activity rebounded, but unemployment continued to rise. They attribute this divergence between employment and output to a high level of average labour productivity growth during the period.

As a matter of fact, a first possible deviation from Okun's rule can be discovered in the most "flexible" countries – such as the US, the UK, the Baltic states and Spain (in the latter case because of the huge number of temporary contracts ended during the recession) – where unemployment has shown an "over-reaction" to the output fall, with contemporaneous productivity gains. An opposite effect can be found in the countries (e.g., Germany, Italy, and some other European countries) where the immediate labour market response seemed slight compared to the huge GDP declines; this small reaction was due to labour hoarding practices, working time adjustments, and internal flexibilities that – especially when supported by labor policies (e.g., income support schemes) – has overcome the diminishing labour demand. However, in some of these countries, the labour market response has been just delayed and may increase in the medium run; there is an actual risk of persistence and structural unemployment.

In this paper, we are less interested in the unemployment[3] adjustments during or after recessions: lags between output falls and unemployment rises, intensity of the reactions, institutional features explaining the differentiated responses, etc. On the contrary,

2 While there are some remote suggestions that the last financial crisis was the outcome of labor market imbalances and not the vice versa (see e.g. Jagnathan et al, 2009), most of the literature agrees that the causality runs from crisis to labor markets (see e.g. Elsby et al, 2010; Hall, 2010 and Mulligan 2010).

3 Notice that the reaction of unemployment – differently from that of employment – may also depend on the endogenous behavior of labour supply (discouraged worker effects and the like).

we are more concerned about a possible “additional” effect arising from financial crises relative to that caused by GDP changes.

The theoretical framework and operational model we propose here are able to provide some econometric results about the comprehensive impact of financial crises - beyond their effect passing through GDP changes (Okun’s Law) - on unemployment rates. The reduced form of the model belongs to the class of linear mixed effect models; for a review on this family of models see McCulloch *et al.* (2008). Moreover, we distinguish the specific impact of particular types of financial crisis: Non-systemic banking crisis, Systemic banking crisis, Currency crisis, and Sovereign debt crisis.

The proposed model is estimated, by an Expectation-Maximization algorithm (Dempster *et al.*, 1977) on the basis of data concerning a large panel of countries observed for the period 1980-2005. We think that the channels hypothesized in our theoretical framework – especially the role played by systemic uncertainty - are useful to understand the global labor market impact of financial crises.

The key findings – besides the fact that GDP changes normally impact on unemployment with a lag – is that financial crises in many cases exhibit an additional impact on the unemployment rate: this is particularly true for Banking crises, both Systemic and Non-systemic.

The structure of the paper is as follows. Next section provides a review of the literature, both on Okun’s Law and on the role of uncertainty. The proposed theoretical framework and the operational model are presented in Section 3; they are used in our empirical estimations that are presented and discussed in Section 4. Section 5 concludes, providing some policy hints.

2. Literature Review

Two key strands of the existing economic literature - rarely originating joint studies - are relevant for our discussion: the first one refers to the so-called Okun's Law and the second one regards the role played on economic (and labor market) performance by the degree of uncertainty (and its changes).

2.1. Literature on Okun's Law

The existing literature has devoted particular attention to relationships between employment/unemployment changes and GDP dynamics, especially from a cyclical point of view.

Some preliminary questions are related to the definition of the (main) direction of causality: (i) is GDP growth (e.g. above a certain threshold) which increases employment (or reduces unemployment)? Or (ii) is employment growth (or reduction in unemployment) which increases GDP? Or (iii) do both GDP and (un)employment changes depend, mainly or exclusively, on many other variables, so that a simple and direct causal relationship cannot be said to exist? Theoretical discussions of the causal links between output and unemployment (or employment) have always been particularly important in the history of economic research. Considering the aims of this paper, we present only a brief review regarding the last three decades.

Okun (1970) defined a coefficient corresponding to the rate of change of real output associated with a given change of the unemployment rate, focusing on the estimation of "potential" GDP. So, in that seminal paper, unemployment was seen as the exogenous variable and real GDP growth as the dependent variable. In much empirical research estimating the Okun coefficient, causality is mostly assumed to be in the opposite direction, i.e., changes in output explain variations in unemployment. Prachowny (1993) considered the theoretical foundation of Okun's Law and derived empirical evidence for the US, supporting the view that the Okun equation is a useful proxy in macroeconomics. Erber (1994) estimated the Okun equation for a number of OECD countries, finding a significant negative correlation between unemployment and growth. Padalino and Vivarelli (1997) found that the Okun equation is valid for G-7 countries and that the growth-employment link in manufacturing is stronger than that for the total economy. Blinder (1997) counted the relation between unemployment and growth among the principles of macroeconomics in which "we should all believe", but he also argued that a simple equation between the percentage change of output and the absolute change in unemployment rates is "atheoretical, if not indeed antitheoretical". Baker and Schmitt (1999) estimated the Okun coefficient for a panel of OECD countries and found that employment intensity of growth was higher in the 1990s than in previous periods. Lee (2000) estimated the Okun equation for all OECD countries and stressed that the relationship is not stable over time and is different across countries, but concluded that the impact of growth on employment is still valid[4]. Solow (2000) argued that a good deal of European unemployment is due to lack of demand: he used the Okun equation and quantified the output gap for Germany. In short, notwithstanding the various empirical results, many studies suggest that the link between unemployment and growth is still a useful macroeconomic "rule of thumb"[5].

Many others researches investigated different aspects related to Okun's Law.[6] Also a very recent empirical literature refers to Okun's Law. For example, IMF (2010) examines the role of institutions and policies in explaining changes in Okun's Law across countries and over time; Beaton (2010) investigates the stability of Okun's Law for Canada and the United States using a time varying parameter approach. He finds structural instability, with the sensitivity of the unemployment rate to movements in output growth increasing recently in both countries; moreover, an asymmetric behavior in Okun's Law has been detected over the business cycle (in particular, the unemployment rate typically increases by more during recessions than it falls during expansions)[7]. IMF (2010) relates the Okun's coefficients – i.e. the elasticity of the unemployment rate with respect to output – to some key labour market reforms: employment protection legislation, unemployment benefits, temporary employment contracts; also wage flexibility (with a more decentralised wage system) may be important. Moreover, the response during recoveries may differ from that during recessions because of: (i) financial crises and stress, (ii) sectoral shocks, (iii) uncertainty, (iv) policies. From a methodological standpoint, IMF (2010) proposes a dynamic version of Okun's Law, in which the change in unemployment depends on the lagged values of the change in output, of the change in unemployment itself and some control variables (including a dummy to indicate a state of recession).[8]

Recently, Gordon (2010) argued that the tendency of aggregate hours to grow slowly and productivity to grow rapidly in an output recovery has exhibited a significant change in magnitude (over successive business cycles) from those predicted by Okun's Law. He shows that aggregate hours before 1986 responded to cyclical deviations by almost

4 Lee (2000) also used several methods to calculate the output elasticity of employment or unemployment.

5 It also exists a significant literature with a critical position: for example, Flaig and Rottman (2000) criticised the Okun coefficient literature because it neglects the influence of relative prices; indeed, they argue that the employment intensity of growth is clearly related to real labour cost; consequently, estimating a simple Okun equation is not appropriate, due to incorrect specification.

6 For example Thirlwall (1969); You (1979); Gordon (1984); Weber (1995); Attfield and Silverstone (1998); Kaufman (1988); Watts and Mitchell (1991); Freeman (2000); Sögner and Stiassny (2002); Apergis and Rezitis (2003); Perman and Tavera (2007); Knotek (2007); Huang and Lin (2008).

7 The existence of possible asymmetries over the cycle has been investigated also in less recent literature (e.g. Neftci, 1984; Rothman, 1991; Brunner, 1997).

8 An employment version of Okun's law is also estimated.

2/3 as much, whereas now the response is close to 1.25. On the other hand, productivity no longer shows pro-cyclical fluctuations at all, leaving modern real business cycle literature obsolete.

Concerning the impact of economic and financial crises, Fallon and Lucas (2002) address the question of how even short-lived crises impact labor markets. They argue that the financial crises of the 1990s resulted in cuts in real wages though employment was only slightly affected. In sharp contrast Hall (2010) argues that in the recent crisis employment situation could not improve because of the poor bargaining ability of the employers.

2.2. Literature on the Role of (Changes in) Uncertainty

According to an assorted literature, uncertainty is a persisting factor characterizing the functioning of the economic systems and conditioning the behavior of economic agents; consequently, it is reasonable to argue that a financial crisis produces a certain increase - at least temporarily - in the degree of (systemic) uncertainty, thus causing an additional impact on (un)employment.

In particular, many studies investigate, especially from a theoretical point of view, the role of uncertainty (and its changes) in affecting the functioning of economic systems, also through the conditioning of firm's behavior. Here we only consider a small part of the literature and, especially, the seminal works and some of the more recent researches.

As for the ground-breaking researches, we just recall Knight's (1921) distinction between risk and uncertainty and Keynes's (1936) considerations on the "weight of argument", especially with reference to the preference for liquidity. In the more recent literature, many authors consider the role of uncertainty, especially in a post-keynesian perspective (e.g. Dow and Hillard, 1995 and 2002). Vercelli (2002) distinguishes the soft uncertainty from the strong (or hard) uncertainty and explores the interaction between rationality and learning[9]. Sordi and Vercelli (2010) discuss the process of formation and revision of expectations in light of Keynes's epistemological view of the behavior of "bounded" rational agents under conditions of strong uncertainty. In particular, the authors argue that a lower "weight of argument" (i.e. a high degree of uncertainty) may be interpreted as an index of potential learning, and thus the higher the potential learning, the

9 He argues that only a theory of economic behaviour under "hard" uncertainty, which assumes "designing" rationality, allows for time irreversibility; it may satisfactorily account for strategic learning and thereby provide a comprehensive account of rationality.

higher the degree of intertemporal flexibility sought by a rational agent. Some researches (e.g. Jones and Ostroy, 1984; Kreps, 1979; Marshak and Nelson, 1962) previously investigated the relationship between uncertainty and flexibility and, in particular, showed how an increase in the degree of uncertainty suggests the adoption of more flexible strategies, i.e. solutions permitting a higher set of options. Bernanke (1983), Pindyck (1991) and Dixit and Pindyck (1993) analyse the effect of uncertainty on investment decisions by considering the role played by irreversibility. For example, if an investment has some characteristic of "irreversibility", due to the existence of "sunk costs", an increase in the degree of uncertainty will probably suggest to delay the realisation of that investment, waiting for a reduction of uncertainty and an increase in the value of the Keynes' "weight of argument".

Financial crises present times of heightened uncertainty. Recently, some papers have emphasized the importance of neo-classical growth models for the correct prediction of unemployment rates and GDP growth during the current financial crisis (see e.g Mulligan, 2010). However, they also find that due to uncertainties ensuing from financial crises, labour demand could be reduced and remain below pre-recession levels.

Hall (2010) argues that current macroeconomic models predict declines in real GDP and employment correctly, as witnessed in the current crisis, but are unable to show the failure of economies to recover after subsiding from the financial crisis. He also argues that while the causes of unemployment are relatively well understood, the same does not hold true for the employer's inability to bargain down the wages despite the availability of large unemployment pools.[10]

In other researches uncertainty is related to some specific aspects of labour markets (e.g. Malcom et al., 2002). Signorelli (1997) analyzes the impact of changes in the degree of uncertainty on (desired and actual) labour demand. He considers the firms' hiring decisions as a sort of investment (in "human capital") with a certain degree of irreversibility due to sunk costs (e.g. selection and training costs) and institutional factors (firing costs). An increase in the degree of uncertainty, as showed in some of the literature previously recalled, negatively affects the investment with a certain degree of irreversibility and, consequently, also (desired and actual) labour demand can be affected by changes in the degree of uncertainty. As to the recent literature following the global financial crisis, Hurd

10 Hagedorn and Manovskii (2008), in the context of real business cycle modelling, find a low bargaining weight even of the workers. However, at the same time, they find that wages are not much lower as compared to marginal product of labour because of outside opportunities.

and Susan (2010) consider household expectations and uncertainty of US household in the aftermath of crisis. Similarly, Huynh et al. (2010) discusses why labour markets recovery in Asia lagged behind the output growth after the current crisis.

To conclude, we can indeed state that a financial crisis is a situation in which the degree of uncertainty increases, thus leading to the mentioned effects on investment, labour demand and also unemployment.

3. Extended Okun's Model

In this section, we define the theoretical framework from which we derive the operational model employed for the econometric estimation.

3.1. Theoretical Framework

Starting from the Okun's Law, we emphasize the need to include the possible supplementary impact (additional to that caused by the fall in production predicted by the Okun's equation) of financial crises on the labor market. We argue that, if detected, this further effect is likely due to the increase of "systemic uncertainty" deriving (immediately or with short lags) from a financial crisis. In our view, therefore, financial crises can have a greater impact on the labor market with respect to simple economic recessions, because of their greater effect in increasing uncertainty and, through this additional channel, in further reducing (desired and actual)[11] labor demand[12]. For example, a firm facing a higher degree of uncertainty (causing less reliable expectations on future budgets and profits) is likely to reduce investments in "employment" (e.g., decreasing or delaying hiring), especially if characterized by high sunk costs and high degree of irreversibility due to firing costs. By sunk costs we mean search, selection, and training costs.

In the proposed theoretical framework, changes in unemployment are first explained by changes in GDP (consistently with the Okun's Law) but, in addition, we try to capture a possible supplementary factor which is peculiar of "financial crises". We interpret this effect as an increase (immediate or with lag) in the degree of systemic uncertainty, with

11 We do not investigate here this distinction (see Signorelli, 1997).

12 Two additional aspects - affecting GDP growth - are not investigated in the paper. The first one refers to the fact that the further reduction in labour demand will reduce available income and consumption with further negative effects on GDP dynamics. The second one refers to the possible reduction of the propensity to consume due to the increase in saving in condition of higher uncertainty.

possible further negative effects on labour market performance with respect to those due to GDP changes.

In order to get reliable econometric results, we control for many relevant aspects and variables. In particular we first consider a model in which: (i) the “persistence” in the dynamics of unemployment rate is captured by including autocorrelated error terms; (ii) the lagged effect of GDP dynamics on labour market indicators (e.g., due to labour “institutions” and labour hoarding strategies) is captured by the lagged values of GDP changes; (iii) the existence of cross country “institutional and structural” differences is controlled by the adoption of country-specific parameters. Then, we include, in the model dummy variables for the different types of crisis (Banking, Currency, and Debt), so as to measure the additional impact on the unemployment rate.

In short, we argue that the role of the changes in the degree of “systemic uncertainty” can explain the additional effect of crises with respect to the “standard” effect passing through the (current and past) GDP changes[13] and not simply determined by the inertia in unemployment variations.

3.2. Proposed Okun's model for the empirical estimation

Let N denote the number of countries and let T denote the number of periods of observation. Also let u_{it} denote the (percentage) unemployment rate for county i in period t, with $i=1,\ldots,N$ and $t=1,\ldots,T$, and let y_{it} denotes the GDP. A basic formulation of the Okus’s Law is based on the following assumption for each country i:

$$\Delta u_{it}=\alpha_i+\Delta y_{it}\beta_i+\varepsilon_{it}, \quad t=2,\ldots,T, \qquad (1)$$

where Δu_{it} is the increase of the percentage unemployment rate for country i in year t and Δy_{it} is the corresponding percentage increase of the GDP. Moreover, α_i is a country-specific intercept and β_i is a country-specific parameter measuring the impact of the GDP variation on the unemployment rate; this parameter is obviously expected to be negative. The error terms ε_{it}, $i=1,\ldots,N$, $t=1,\ldots,T$, are assumed to be independent and to have a Normal distribution with mean 0 and variance σ^2, in symbols $\varepsilon_{it}\sim N(0,\sigma^2)$.

13 We also control for possible differences in the coefficient when the GDP change is negative.

The above formulation is naturally extended to include a more sophisticated structure of dependence on the GDP changes. In particular, an interesting formulation, similar to that in Beaton (2010) and IMF (2010), is the following:

$$\Delta u_{it}=\alpha_i+\sum_{l=0}^{L_1}\Delta y_{i,t-l}\beta_{il}+\sum_{l=0}^{L_1} r_{i,t-l}\Delta y_{i,t-l}\gamma_{il}+\varepsilon_{it}\,,\quad t=\bar{L},\ldots,T\,, \tag{2}$$

where L_1 is the number of lags for the percentage increase of GDP, r_{it} is a dummy variable equal to 1 if there is a recession ($\Delta y_{it}<0$), and $\bar{L}=max(2,L_1+1)$. In this way, the Okun's parameters β_{il} are lag specific, whereas γ_{il} measures the differential effect of the GDP change when the latter is negative rather than positive. It may also be reasonable to include, in the above formulation, the lagged response variable among the regressors.

In this paper, we propose an extension of the Okun’s model which, further to the above generalization, allows us to estimate the impact of the financial crisis on the change of the unemployment rate. Let $d_{it}^{(c)}$ be a dummy equal to 1 when a crisis of type c is observed for country i in period t ; four different types of crisis – as specified in the next section – are considered (Non-systemic bank, Systemic bank, Currency, and Debt), so that $c=1,\ldots,C$, with $C=4$. The proposed model is based on the following assumption:

$$\Delta u_{it}=\alpha_i+\sum_{l=0}^{L_1}\Delta y_{i,t-l}\beta_{il}+\sum_{l=0}^{L_1} r_{i,t-l}\Delta y_{i,t-l}\gamma_{il}+\sum_{l=0}^{L_2} d_{i,t-l}^{(c)}\delta_l^{(c)}+\varepsilon_{it}\,,\quad t=\bar{L},\ldots,T\,, \tag{3}$$

where now $\bar{L}=max(2,L_1+1,L_2)$. The parameters of most interest for our analysis are those measuring the effect of the financial crises. In particular, each parameter $\delta_l^{(c)}$ measures the effect of crisis of type c at lag l . A further extension, which we implement to make the model more flexible, is that the error terms ε_{it} are assumed to be autocorrelated (AR(1)), with correlation coefficient ρ and stationary variance σ^2 . More explicitly, we assume that

$$\varepsilon_{it}\sim N(0,\sigma^2)\,,\ \text{if}\ t=\bar{L}\,,$$

$$\varepsilon_{it}\sim N(\varepsilon_{i,t-1}\rho,\sigma^2(1-\rho^2))\,,\ \text{if}\ t=\bar{L}+1,\ldots,T\,,$$

where $\sigma^2(1-\rho^2)$ is the conditional variance of ε_{it} given $\varepsilon_{i,t-1}$. This formulation takes into account that residual factors (with respect to those related to the GDP dynamics and financial crises) that affect the trend of unemployment rate may have a certain degree of persistence.

It has to be clear that equations (1) and (2), defining the ”basic” and “extended” versions of the Okun's model, are particular cases of equation (3), defining our proposed model. In particular, the basic Okun’s Law in (1) is a special case of our model when $L_1=0$, $L_2=-1$ (so that, by convention, the sum involving the dummy variables $d_{it}^{(c)}$ is removed) and the autocorrelation parameter ρ is equal to 0.

It is important to note that the proposed model is based on country-specific intercepts (α_i) and regression coefficients for the GDP effect (β_{il}, γ_{il}), but on common coefficients for the crisis effects ($\delta_l^{(c)}$). The motivation behind this restriction is that financial crises are rather uncommon events, especially for high income countries. Then, with the available dataset (see Section 4 for details and in particular Tables 1 and 2) and contrary to the GDP effect, it would not be possible to obtain reliable estimates for these effects if considered as country specific.

Moreover, in order to obtain stable estimates of the country-specific parameters we follow a random-effects approach, which is based on the assumption that these parameters have a specific distribution. In particular we consider the column vector $\boldsymbol{\theta}_i=(\alpha_i, \beta_{i0}, \ldots, \beta_{iL_1}, \gamma_{i0}, \ldots, \gamma_{iL_1})'$ containing all the parameters specific of country i and we assume that, for $i=1,\ldots,N$, $\boldsymbol{\theta}_i$ are independent and have a multivariate Normal distribution with mean $\boldsymbol{\mu}$ and variance-covariance matrix $\boldsymbol{\Sigma}_{\boldsymbol{\theta}}$, in symbols $\boldsymbol{\theta}_i \sim N(\boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}})$. On the other hand, for the motivations given above, the parameters of the crises are treated as fixed-parameters and are collected in the vector $\boldsymbol{\delta}=(\delta_1^{(1)}, \delta_1^{(2)}, \ldots, \delta_{L_2}^{(C)})'$.[14]

A *linear mixed effect model* (McCulloch et al., 2008) follows from the above assumptions which has reduced form

$$\Delta \boldsymbol{u}_i = \boldsymbol{X}_i \boldsymbol{\delta} + \boldsymbol{Z}_i \boldsymbol{\theta}_i + \boldsymbol{\varepsilon}_i, \tag{4}$$

where $\Delta \boldsymbol{u}_i$ is a vector with elements Δu_{it} for $t=\overline{L},\ldots,T$ and $\boldsymbol{X}_i$ and $\boldsymbol{Z}_i$ are suitable design matrices formulated according to (3), with $\boldsymbol{X}_i$ defined on the basis of the dummy variables $d_{it}^{(c)}$ and $\boldsymbol{Z}_i$ on the basis of GDP dynamics measured by the percentage annual increases Δy_{it}. Moreover, $\boldsymbol{\varepsilon}_i$ is a random vector with distribution $N(\boldsymbol{0}, \boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}})$, where $\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}}$ is the variance-covariance matrix of an AR(1) process with parameters ρ and σ^2. This

14 Note that if we assumed that even the parameters for the financial crisis were country specific and random, it would have been possible to test only the hypothesis that these parameters have zero mean by standard tools. Using fixed effects common to all countries, instead, we can test the hypothesis that a specific crisis has no effect for all countries, even if we acknowledge that the approach may be more restrictive.

matrix has all elements in the main diagonal equal to σ^2, whereas the element in the i-th row and j-th column is equal to $\sigma^2\rho^{|i-j|}$. Note that, when for country i the data are not available for all time periods $t=\overline{L},\ldots,T$, then $\Delta\boldsymbol{u}_i$ is made of elements Δu_{it} for only those certain values of t. This happens when both u_{it} and $u_{i,t-1}$ are defined, together with $y_{i,t-L_1},\ldots,y_{it}$ and $d_{i,t-L_2}^{(1)},d_{i,t-L_2}^{(2)},\ldots,d_t^{(C)}$. The design matrices $\boldsymbol{X}_i$ and $\boldsymbol{Z}_i$ and the random vector $\boldsymbol{\varepsilon}_i$ are defined accordingly; in particular, we now have that $\boldsymbol{\varepsilon}_i \sim N(\boldsymbol{0},\boldsymbol{A}_i\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}}\boldsymbol{A}_i')$, where $\boldsymbol{A}_i$ is a matrix obtained by removing, from an identity matrix of dimension $T-\overline{L}$, the rows corresponding to each time period t for which the required information is missing.

It is worth noting that the random-effects approach formulated above is based on a reduced number of fixed parameters to estimate, that is the parameters in $\boldsymbol{\delta}$ and $\boldsymbol{\mu}$, those in $\boldsymbol{\Sigma}_{\boldsymbol{\theta}}$, further to ρ and σ^2. For instance, with $L_1=1$ and $L_1=0$, we have 5 parameters in $\boldsymbol{\mu}$, 4 parameters in $\boldsymbol{\delta}$, 15 parameters in $\boldsymbol{\Sigma}_{\boldsymbol{\theta}}$. Overall, we then have 26 fixed-parameters to estimate. Nevertheless, as described in Appendix 1, it is possible to predict $\boldsymbol{\theta}_i$ for each country i, and then a much larger number of parameters, by using its specific conditional expected value given $\Delta\boldsymbol{u}_i$. We have to stress that, due to reduced amount of information, even a random-effects approach would not be viable to deal with country-specific coefficients for the crisis effects.

3.3. Estimation of the proposed Okun's model and selection of number of lags

Under the assumption that the GDP dynamics and the dynamics of financial crises are exogenous, expression (4) implies that the conditional distribution of $\Delta\boldsymbol{u}_i$ given $\boldsymbol{X}_i$, $\boldsymbol{Z}_i$, and $\boldsymbol{\theta}_i$ is $N(\boldsymbol{X}_i\boldsymbol{\delta}+\boldsymbol{Z}_i\boldsymbol{\theta}_i,\boldsymbol{A}_i\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}}\boldsymbol{A}_i')$. Then, marginalizing with respect to $\boldsymbol{\theta}_i$, we obtain the following distribution:

$$\Delta\boldsymbol{u}_i \sim N(\boldsymbol{X}_i\boldsymbol{\delta}+\boldsymbol{Z}_i\boldsymbol{\mu},\boldsymbol{Z}_i\boldsymbol{\Sigma}_{\boldsymbol{\theta}}\boldsymbol{Z}_i'+\boldsymbol{A}_i\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}}\boldsymbol{A}_i'),\quad i=1,\ldots,N. \tag{5}$$

On the basis of this result, we can estimate the model by maximizing its likelihood

$$L(\boldsymbol{\beta},\boldsymbol{\mu},\boldsymbol{\Sigma}_{\boldsymbol{\theta}},\rho,\sigma^2)=\prod_i f(\Delta\boldsymbol{u}_i;\boldsymbol{X}_i\boldsymbol{\delta}+\boldsymbol{Z}_i\boldsymbol{\mu},\boldsymbol{Z}_i\boldsymbol{\Sigma}_{\boldsymbol{\theta}}\boldsymbol{Z}_i'+\boldsymbol{A}_i\boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}}\boldsymbol{A}_i'), \tag{6}$$

where $f(.;.)$ denotes the density function of the multivariate normal distribution, which in the present case has parameters defined in (5). As usual, instead of directly maximizing the likelihood, we maximize the log-likelihood, that is the logarithm of (6), which is equal to:

$$l(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2) = \sum_i \log f\left(\Delta \boldsymbol{u}_i; \boldsymbol{X}_i \boldsymbol{\delta} + \boldsymbol{Z}_i \boldsymbol{\mu}, \boldsymbol{Z}_i \boldsymbol{\Sigma}_{\boldsymbol{\theta}} \boldsymbol{Z}_i' + \boldsymbol{A}_i \boldsymbol{\Sigma}_{\boldsymbol{\varepsilon}} \boldsymbol{A}_i'\right). \qquad (7)$$

Maximization of $l(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2)$ is performed by the Expectation-Maximization (EM) algorithm, see Dempster et al. (1977); see also Laird and Ware (1982) and Lindstrom and Bates (1988). A MATLAB implementation of this algorithm, suitably tailored to the analysis of the data used in this in paper, is available from the authors upon request and is briefly illustrated in Appendix 1. On the other hand, standard errors, which may be used to test specific hypotheses on the parameters, are computed by a parametric bootstrap method (Efron and Tibshirani, 1994; Davison and Hinkley, 1997) based, in our application, on 200 replications.

As is clear from assumption (3), the model formulation depends on the maximum number of lags in each component, that is L_1 and L_2. For selecting these quantities, we adopt the Akaike Information Criterion (AIC), which is very well known in the statistical literature; see Akaike (1973).[15] According to this criterion, the model to be selected among the available models is the one attaining the minimum of the following index

$$AIC = -2l(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\mu}}, \hat{\boldsymbol{\Sigma}}_{\boldsymbol{\theta}}, \hat{\rho}, \hat{\sigma}^2) + 2g, \qquad (8)$$

where $l(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\mu}}, \hat{\boldsymbol{\Sigma}}_{\boldsymbol{\theta}}, \hat{\rho}, \hat{\sigma}^2)$ is the maximum of the model log-likelihood (we have the maximum likelihood estimates $\hat{\boldsymbol{\beta}}$, $\hat{\boldsymbol{\mu}}$, $\hat{\boldsymbol{\Sigma}}_{\boldsymbol{\theta}}$, $\hat{\rho}$, and $\hat{\sigma}^2$ as argument) and g is the number of non-redundant parameters. The idea behind AIC is that the selected model reaches the best good compromise between fit to the data (measured by the log-likelihood) and model complexity (measured by the number of parameters).

4. Data and Empirical Results

The available data concern a large set of countries (see the list in Table 6 in Appendix 2) over the period 1980-2005.

As to the definition of financial crisis, it is obvious that national financial crises are very different from international financial crises.[16] However, in order to econometrically estimate the labour market impact of GDP changes – with the addition of specific dummies for financial crises – in our study we use the definition of "financial crisis" adopted by Honohan and Laeven (2005). These authors consider as financial crisis the occurrence of

15 For this aim we could also rely on the Bayesian Information Criterion (BIC) of Schwarz (1978), but AIC guarantees to select a model with a better fit even if less parsimonious.

16 For example, according to Bordo (2006) and Reinhart and Rogoff (2008a, 2008b, 2009), there were eight episodes of major international financial crisis since 1870.

either a Systemic banking crisis (when a country's corporate and financial sector experiences a large number of defaults and financial institutions and corporations face great difficulties repaying contracts on time) or a Non-systemic banking crisis (i.e., crisis limited to a small number of banks). They also consider two additional types of crises: Currency crisis and Debt crisis; data are taken from Laeven and Valencia (2008).

In order to choose a suitable model and compare different models, corresponding to different values of the maximum number of lags L_1 and L_2, we processed the dataset so that the same set of observations is available in all cases. In fact, we recall that using different values of the maximum number of lags affects the number of observations that may be exploited for model estimation. The resulting dataset includes the observation for country i in period t if: (i) both u_{it} and $u_{i,t-1}$ are available (so that Δu_{it} may be computed); (ii) $y_{i,t-3}, \ldots, y_{it}$ are available (so that we can use a value of L_1 equal to until 2); (iii) the dummy variables $d_{it}^{(c)}$ and $d_{i,t-1}^{(c)}$ are known (so that we can use a value of L_2 equal to until 1). The maximum values of L_1 (fixed at 2) and L_2 (fixed at 1) just mentioned are chosen on the basis of the evidence coming from the data.

The number of observations that is available, after having processed the dataset as described above, is equal to 1099 for 70 countries (see also Table 6 in Appendix 2 for the country list).

In Table 1 we show the number of observed financial crisis events and the number of countries that, for each type of crisis, experimented at least one crisis in the period of observation.

	Non-syst.bank	Syst.bank	Currency	Debt
n.countries with at lear one crisis	49	32	32	11
overall n.crises	209	37	44	11

Table 1. *Number of observed crises for each typology together with the number of countries experimenting at least one financial crisis in the considered period.*

We note that a reduced number of crisis events is observed; this is evident for Systemic bank, Currency and Debt crises. In particular, we only have 11 events of Debt crises. This enforces our choice of adopting a model with crisis effects common to all countries, whereas the other parameters, for which we have more support from the data, are assumed to be country specific.

On the dataset obtained as above, we fitted the proposed model for increasing values of L_1 and L_2, computing in each case the index AIC defined in (8). The range of values for L_1 and L_2 goes from -1 (GDP and financial crises are not used to predict the unemployment dynamics) to 2. We do not use larger values of L_1 and L_2 in order to avoid to drop too many observations. The results of this preliminary analysis are reported in Table 2.

L1	L2	max.lk.	n.par.	*AIC*
-1	-1	-1936.75	4	3881.50
-1	0	-1915.29	8	3846.58
-1	1	-1901.79	12	3827.58
-1	2	-1899.09	16	3830.17
0	-1	-1844.84	11	3711.68
0	0	-1838.93	15	3707.86
0	1	-1831.15	19	3700.30
0	2	-1829.27	23	3704.53
1	-1	-1831.12	22	3706.24
1	0	-1826.17	26	3704.35
1	1	-1818.88	30	3697.75
1	2	-1817.02	34	3702.04
2	-1	-1804.93	37	3683.85
2	0	-1798.91	41	3679.81
2	**1**	**-1792.55**	**45**	**3675.11**
2	2	-1791.04	49	3680.07

Table 2. *Results from a preliminary fitting of the proposed model on the unemployment rate data without including financial crisis dummies; for each considered value of* L_1 *(with* $L_2 = L_1$*), "max.lk." refers to the maximum value of the log-likelihood, "n.pars." to the number of parameters, whereas "AIC" refers to the values of the corresponding index used for model selection; in boldface are the data referred to the model with minimum AIC.*

The model that, according to AIC, seems to be adequate is that with $L_1 = 2$ (two lags of the GDP increase) and $L_2 = 1$ (one lag for the crisis dummies).

The estimates of average of the Okun's parameters (denoted above by $\boldsymbol{\mu}$) are reported in Table 4 under the basic formulation (with $L_2 = -1$), and the proposed one which includes the financial crisis information (with $L_2 = 1$). The table also reports the corresponding standard errors and the estimates (and standard errors) of the autocorrelation parameters ρ and stationary variance σ^2. Moreover, the predicted country-specific Okun's coefficients are reported in Table 6 in Appendix 2.

L2	intercept	Okun0	Okun1	Okun2	diff-Okun0	diff-Okun1	diff-Okun2	rho	si2
-1	0.455 ****	-0.166 ****	-0.055 **	0.063 ***	-0.056	0.041	-0.073	0.150	1.321
	(0.119)	(0.026)	(0.022)	(0.020)	(0.045)	(0.051)	(0.045)	(0.034)	(0.059)
1	0.390 ****	-0.159 ****	-0.056 **	0.063 ***	-0.018	0.038	-0.070 *	0.149	1.296
	(0.109)	(0.024)	(0.023)	(0.020)	(0.047)	(0.052)	(0.041)	(0.037)	(0.063)

Table 3. E*stimates of the average of the Okun's parameters (collected in* $\boldsymbol{\mu}$ *) measuring the impact of the GDP dynamics on the unemployment rate dynamics for each income group, together with the estimates of the autocorrelation coefficient (* ρ *) and the stationary variance (* σ^2 *) of the error terms. "Intercept" refers to the mean of the parameters* α_i *, "Okun0" to the mean of the parameters* β_{i0} *, "Okun1" to the mean of the parameters* β_{i1} *, and "Okun2" to the mean of the parameters* β_{i2} *, whereas "diff-Okun0", "diff-Okun1" and "diff-Okun2" refer to the means of the parameters* γ_{i0} *,* γ_{i1} *, and* γ_{i2} *respectively; (*) stands for significantly different from 0 at the 10%, (**) at the 5%, (***) at the 1%, and (****) at 0.1%.*

We note that the Okun's estimates have the expected sign for lag 0 and lag 1 and that the inclusion of the financial crisis dummies slightly affects these estimates. Moreover, the estimate of the autocorrelation coefficient ρ is close to 0 in all cases, even if we have to reject the hypothesis that it is exactly equal to 0. This leads to the conclusion that the effect of further factors affecting the unemployment rate dynamics (with respect to GDP and financial crises) have a moderate persistence.

The estimates of the parameters measuring the financial crisis effect under the model with $L_2=1$ are reported in Table 4.

lag	Non-syst.bank	Syst.bank	Currency	Debt
0	0.338 **	0.441 **	0.169	-0.528
	(0.157)	(0.212)	(0.209)	(0.433)
1	-0.138	0.670 ***	-0.331	0.081
	(0.141)	(0.238)	(0.214)	(0.420)

Table 4. *Estimates of the parameters for the crisis effects (* $\delta_l^{(c)}$ *) under the model with* $L_1=2$ *and* $L_2=1$ *; in parentheses are reported the standard errors; (*) stands for significantly different from 0 at the 10%, (**) at the 5%, (***) at the 1%, and (****) at 0.1%.*

From the above table, we conclude that Non-systemic bank crisis (contemporary) and Systemic bank crisis (contemporary and one year lagged) have a significant effect on the unemployment rate. As expected, the sign of the parameter estimate for each crisis dummy is positive in all cases in which this dummy is significant. The (unexpected) negative coefficients for Currency and Debt crises – which in any case are not significant – are probably due to the limited number of observations, that moreover refer to the less developed countries (in which there are often problems with the quality of statistical data).[17]

In order to better interpret the parameter estimates in Table 4, we computed the expected increase of the percentage unemployment rate – under different scenarios – corresponding to different values of the GDP percentage increase. In order to give stability to these predictions, only significant regression coefficients at the 5% level are considered. The simulation results are reported in Table 5.

	GDP increase rate										
Scenario	**-5,0**	**-4,0**	**-3,0**	**-2,0**	**-1,0**	**0,0**	**1,0**	**2,0**	**3,0**	**4,0**	**5,0**
No crises	1,27	1,10	0,92	0,74	0,57	0,39	0,23	0,07	-0,09	-0,25	-0,41
Crisis 1	1,61	1,44	1,26	1,08	0,90	0,73	0,57	0,41	0,25	0,09	-0,07
Crisis 2	1,72	1,54	1,36	1,18	1,01	0,83	0,67	0,51	0,35	0,19	0,04
Crisis 3	1,95	1,77	1,59	1,41	1,24	1,06	0,90	0,74	0,58	0,42	0,26
Crises 1+2	2,05	1,88	1,70	1,52	1,35	1,17	1,01	0,85	0,69	0,53	0,37
Crises 1+3	2,28	2,11	1,93	1,75	1,58	1,40	1,24	1,08	0,92	0,76	0,60
Crises 2+3	2,39	2,21	2,03	1,86	1,68	1,50	1,34	1,18	1,02	0,86	0,71
Crises 1+2+3	2,72	2,55	2,37	2,19	2,02	1,84	1,68	1,52	1,36	1,20	1,04

Table 5. *Simulation results in terms of evolution of the unemployment rate for each income group due to an increase of the GDP and presence/absence of specific financial crises; "Crisis 1" stands for Non-systemic bank crisis (lag 0), "Crisis 2" for Systemic bank crisis (lag 0), and "Crisis 3" for Systemic bank crisis (lag 1).*

The meaning is that – while for instance a 5 per cent fall in GDP leads normally to 1.27 per cent increase in the unemployment rate (this is the "standard" effect of a recession without financial crises) – in presence of financial crises there is an additional effect, causing a greater increase in unemployment: 1.61 per cent in case of a Non-systemic bank crisis, 1.72 per cent with a Systemic bank crisis, etc.; the highest effect (with a combination of the two crises at different lags) is 2.72 per cent, i.e. about 1.5 per cent additional impact on unemployment relative to the "no crises" scenario. Please also note that – in case of Systemic bank crisis – an hypothetical positive GDP growth at 5 per cent would not be sufficient to reduce the unemployment rate.

5. Conclusions and Policy Implications

In this paper we have seen that financial crises can have deep effects on labour markets, not only because of the consequent recessions – the fall in production reduces

17 However, a possible explanation of the negative sign at lag 1 for Currency crisis is that the consequent devaluation may lead to a (lagged) increase in labour demand (at least for firms expecting to augment their exports).

labour demand – but also due to the “systemic uncertainty” that further dampens down employment and increases unemployment. As a matter of fact, the results of our empirical estimates show that in many cases – especially clear in the case of Systemic and Non-systemic bank crises – there is an additional impact of financial crises on unemployment rates with respect to the simple effect of GDP changes (Okun's Law). This important result is obtained even after controlling for many aspects, like the lagged impact of GDP changes, the inertia of the dependent variable (i.e. the unemployment rate), country specific factors, etc.

The main policy implication is that policy makers should be well aware of all the consequences of financial crises, not only for their direct effects on labour market (passing trough the GDP changes) but also for a possible additional effect, due to the increase in the degree of uncertainty. During financial crises “systemic uncertainty” normally increases and it negatively affects (desired and actual) labour demand with further negative effects on labour market performance[18]. So, the macroeconomic and social costs of financial crises - especially in terms of labour market performance - go well beyond their impact passing through GDP decline.

Although our empirical estimations concerned past financial crises (for the period 1980-2005), the main findings are helpful also in understanding the impact of the most recent “global” crises (2007-08) and the channels leading to higher unemployment in most countries of the world. Indeed, it seems that economic policies have already taken into account such effects. As a matter of fact, all macroeconomic policies – including easy monetary policies and huge packages of “fiscal stimuli” (e.g. the Obama's package in the US) – have been fundamental, in 2008-09, to reduce the degree of uncertainty, to make nearer the recovery and to limit the labour market impact.[19]

Unfortunately, uncertainty has not been completed removed and still plays a role, because recovery – after the Great Recession – has been feeble so far, with the addition of uncertainty elements caused by the sovereign debt crises (at least in the EU countries). From this point of view and looking at future developments, both measures to increase the

18 Further effects (not considered in our empirical investigations) may occur. As already mentioned in a previous footnote, the increase of uncertainty determined by a financial crisis negatively affects the propensity to consume (due to a higher desired saving to address a more uncertain future) and so - also through this channel - it influences the GDP dynamics.

19 The unemployment rate rose in the US up to a maximum value of 10%, compared to 25% after the Great Depression in the 1930’s.

credibility of sound macroeconomic policies – thus lessening uncertainty – and also specific labour market policies – in particular "active" policies to reduce structural unemployment – are appropriate. In addition, the last crisis highlighted the need for a better "regulatory system" and governance at world level, in order to reduce the risk of new financial crises, with the related huge economic and social costs, due to both economic recession and high uncertainty.

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Appendix 1: EM algorithm for maximum likelihood estimation

The log-likelihood $l(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2)$, whose expression is given in (7), is maximized by the EM algorithm (Dempster et al., 1977), which is a well-known iterative algorithm in the statistical literature. This algorithm exploits the *complete log-likelihood*, which in our case corresponds to the log-likelihood that we could compute if we knew the random vectors $\boldsymbol{\eta}_i = \boldsymbol{\theta}_i - \boldsymbol{\mu}$, $i=1,\ldots,N$. These represent the *missing values* of the problem.

The complete log-likelihood may be expressed as the sum of two components, that is $l'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2) = l_1'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2) + l_2'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2)$, where

$$l_1'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2) = -\frac{1}{2} \sum_i \log|2\pi\boldsymbol{\Sigma}_{\boldsymbol{\theta}}| + \boldsymbol{\eta}_i' \boldsymbol{\Omega}_i^{-1} \boldsymbol{\eta}_i$$

refers to the marginal distribution of each $\boldsymbol{\eta}_i$ and $l_2'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2)$ has a similar expression based on the conditional distribution of each vector $\Delta \boldsymbol{u}_i$ given $\boldsymbol{\eta}_i$.

Starting from suitable initial values for the parameters, indicated by $\boldsymbol{\beta}^{(0)}$, $\boldsymbol{\mu}^{(0)}$, $\boldsymbol{\Sigma}_{\boldsymbol{\theta}}^{(0)}$, $\rho^{(0)}$, and $\sigma^{2(0)}$, at the h-th iteration the EM algorithm updates the current parameter estimates by performing the following two steps (E-step and M-step):

E-step: on the basis of the parameter values obtained at end of the the previous iteration, $\boldsymbol{\beta}^{(h-1)}$, $\boldsymbol{\mu}^{(h-1)}$, $\boldsymbol{\Sigma}_{\boldsymbol{\theta}}^{(h-1)}$, $\rho^{(h-1)}$, and $\sigma^{2(h-1)}$, compute the expected value of the complete log-likelihood $l'(\boldsymbol{\beta}, \boldsymbol{\mu}, \boldsymbol{\Sigma}_{\boldsymbol{\theta}}, \rho, \sigma^2)$ with respect to the distribution of each random vector $\boldsymbol{\eta}_i$ given $\boldsymbol{y}_i$. It can be easily shown that $\boldsymbol{\eta}_i | \boldsymbol{y}_i \sim N(\boldsymbol{\nu}_i, \boldsymbol{\Omega}_i)$, where $\boldsymbol{\nu}_i$ and $\boldsymbol{\Omega}_i$ are obtained by standard rules about the multivariate Normal distribution; in particular, we have

$$\boldsymbol{\nu}_i = \boldsymbol{\Sigma}_\theta (\boldsymbol{Z}_i \boldsymbol{\Sigma}_\theta \boldsymbol{Z}_i{}' + \boldsymbol{A}_i \boldsymbol{\Sigma}_\varepsilon \boldsymbol{A}_i{}')^{-1} (\boldsymbol{y}_i - \boldsymbol{X}_i \boldsymbol{\beta} - \boldsymbol{Z}_i \boldsymbol{\mu}), \quad i = 1, \ldots, N. \tag{10}$$

M-step: update the parameter values by maximizing the expected value of the complete log-likelihood computed at the E-step. Note that explicit expressions exist to update each block of parameters.

The algorithm described above is stopped at convergence, that is when the difference between two consecutive log-likelihood is negligible. More precisely, we consider the convergence to be reached when

$$l(\boldsymbol{\beta}^{(h)}, \boldsymbol{\mu}^{(h)}, \boldsymbol{\Sigma}_\theta^{(h)}, \rho^{(h)}, \sigma^{2(h)}) - l(\boldsymbol{\beta}^{(h-1)}, \boldsymbol{\mu}^{(h-1)}, \boldsymbol{\Sigma}_\theta^{(h-1)}, \rho^{(h-1)}, \sigma^{2(h-1)}) < \tau,$$

where $\tau > 0$ is a small tolerance level. In our application we chose $\tau = 10^{-5}$. As maximum likelihood parameter estimates, denoted by $\hat{\boldsymbol{\beta}}$, $\hat{\boldsymbol{\mu}}$, $\hat{\boldsymbol{\Sigma}}_\theta$, $\hat{\rho}$, and $\hat{\sigma}^2$, we take the solution at convergence. Note that, as a byproduct of the algorithm, we have the prediction of each random vector $\boldsymbol{\theta}_i$, which is simply obtained as $\hat{\boldsymbol{\theta}}_i = \hat{\boldsymbol{\mu}} + \boldsymbol{\nu}_i$, $i = 1, \ldots, N$, where $\boldsymbol{\nu}_i$ refers to the conditional expected value computed at the last E-step; see expression (10).

Appendix 2: Estimated Okun's coefficients for individual countries

countryname	group	n.obs.	intercept	Okun0	Okun1	Okun2	diff-Okun0	diff-Okun1	diff-Okun2
Algeria	2	1	0.953	-0.322	-0.172	0.155	-0.023	0.115	-0.144
Argentina	3	21	-0.014	-0.172	0.048	0.110	-0.007	0.119	-0.218
Australia	4	22	0.789	-0.338	-0.119	0.178	-0.001	0.227	-0.284
Austria	4	22	0.324	-0.130	-0.044	0.046	-0.018	0.025	-0.054
Bangladesh	1	3	0.233	-0.101	-0.026	0.025	-0.017	0.003	-0.029
Belgium	4	21	0.670	-0.242	-0.117	0.104	-0.025	0.038	-0.069
Bolivia	2	11	0.930	-0.340	-0.165	0.167	-0.022	0.119	-0.160
Brazil	3	15	0.178	-0.122	-0.009	0.047	-0.015	0.021	-0.066
Bulgaria	3	11	-0.393	0.059	0.102	-0.082	-0.015	-0.156	0.121
Canada	4	22	0.667	-0.236	-0.114	0.103	-0.021	0.066	-0.094
Chile	3	22	0.112	-0.166	0.040	0.065	0.043	0.265	-0.322
China	2	23	-0.054	-0.041	0.036	-0.003	-0.014	-0.022	-0.018
Colombia	2	20	1.016	-0.332	-0.216	0.187	-0.088	-0.105	0.063
Costa Rica	3	20	0.143	-0.125	-0.017	0.051	-0.049	-0.138	0.082
Czech Republic	4	11	0.490	-0.142	-0.085	0.046	-0.024	0.013	-0.024
Denmark	4	21	0.559	-0.249	-0.082	0.102	-0.009	0.075	-0.119
Dominican Republic	2	13	0.085	0.024	-0.003	-0.077	-0.009	-0.069	0.088
Ecuador	2	17	0.146	-0.194	0.041	0.089	0.052	0.339	-0.405
Egypt, Arab Rep.	2	16	-0.119	-0.015	0.051	-0.021	-0.009	-0.020	-0.015
El Salvador	2	17	-1.019	0.253	0.232	-0.209	-0.002	-0.249	0.222
Estonia	4	15	0.238	-0.060	-0.033	-0.002	-0.017	-0.014	0.004
Finland	4	22	1.028	-0.280	-0.197	0.111	-0.023	0.073	-0.071
France	4	22	0.675	-0.230	-0.119	0.101	-0.026	0.048	-0.074
Georgia	2	6	-0.112	-0.015	0.049	-0.030	-0.009	-0.044	0.013
Germany	4	13	0.556	-0.221	-0.089	0.106	-0.022	0.071	-0.111
Greece	4	21	0.208	-0.080	-0.024	0.015	-0.020	-0.012	-0.009
Guatemala	2	3	0.351	-0.151	-0.047	0.062	-0.017	0.046	-0.080
Hong Kong, China	4	22	0.325	-0.121	-0.057	0.059	-0.044	-0.045	0.011
Hungary	4	12	0.489	-0.223	-0.066	0.103	-0.004	0.129	-0.175
Indonesia	2	10	-0.097	0.029	0.029	-0.047	-0.033	-0.131	0.113
Ireland	4	21	0.551	-0.221	-0.083	0.100	-0.011	0.101	-0.137
Israel	4	21	0.296	-0.124	-0.036	0.050	-0.016	0.049	-0.080
Italy	4	22	-0.037	0.002	0.024	-0.041	-0.018	-0.073	0.058
Jamaica	3	20	0.068	-0.111	0.012	0.017	-0.017	-0.077	0.028
Japan	4	22	0.155	-0.080	-0.011	0.014	-0.018	-0.017	-0.011
Jordan	2	10	2.151	-0.845	-0.396	0.531	-0.036	0.479	-0.600
Kazakhstan	3	10	0.477	-0.147	-0.082	0.056	-0.025	0.025	-0.045
Korea, Rep.	4	22	0.201	-0.148	-0.022	0.087	-0.041	-0.017	-0.047
Latvia	3	9	0.919	-0.297	-0.166	0.130	-0.019	0.099	-0.117
Lithuania	3	11	0.667	-0.229	-0.118	0.098	-0.029	0.027	-0.052
Malaysia	3	16	0.234	-0.066	-0.033	-0.002	-0.021	-0.039	0.028
Mexico	3	13	0.217	-0.102	-0.017	0.024	-0.008	0.037	-0.063
Morocco	2	6	0.124	-0.091	-0.003	0.022	-0.021	-0.033	-0.004
Netherlands	4	21	0.541	-0.167	-0.097	0.069	-0.032	0.014	-0.032
New Zealand	4	14	-0.146	0.009	0.044	-0.011	-0.032	-0.058	0.019
Nicaragua	2	15	0.893	-0.300	-0.159	0.128	-0.017	0.093	-0.115
Norway	4	22	0.579	-0.182	-0.100	0.072	-0.023	0.043	-0.060
Pakistan	1	10	0.059	-0.043	0.007	0.002	-0.020	-0.018	-0.010
Paraguay	2	17	0.301	-0.220	-0.021	0.100	-0.004	0.085	-0.153
Peru	2	14	0.431	-0.131	-0.053	0.042	0.013	0.186	-0.194
Philippines	2	22	0.121	-0.086	0.020	0.014	0.026	0.180	-0.205
Poland	3	13	0.568	-0.228	-0.092	0.127	-0.025	0.105	-0.151
Portugal	4	22	0.652	-0.219	-0.110	0.091	-0.016	0.078	-0.100
Romania	3	10	0.047	-0.022	0.009	-0.029	-0.015	-0.045	0.032
Russian Federation	3	10	0.442	-0.183	-0.073	0.083	-0.034	-0.016	-0.023
Singapore	4	21	0.275	-0.090	-0.055	0.061	-0.057	-0.060	0.023
South Africa	3	10	0.090	-0.074	0.006	0.024	-0.016	0.019	-0.056
Spain	4	22	1.590	-0.500	-0.305	0.259	-0.032	0.199	-0.223
Sri Lanka	2	14	0.425	-0.142	-0.066	0.042	-0.016	0.022	-0.039
Sweden	4	22	0.786	-0.257	-0.140	0.112	-0.022	0.075	-0.096
Switzerland	4	13	0.477	-0.185	-0.075	0.078	-0.020	0.047	-0.080
Thailand	2	14	0.149	-0.084	-0.010	0.021	-0.022	-0.020	-0.012
Tunisia	2	4	0.362	-0.147	-0.051	0.055	-0.018	0.029	-0.060
Turkey	3	20	0.141	-0.065	-0.014	0.015	-0.029	-0.041	0.013
Ukraine	2	9	0.215	-0.087	-0.013	0.012	0.004	0.084	-0.101
United Kingdom	4	20	0.686	-0.235	-0.119	0.092	-0.019	0.047	-0.069
United States	4	22	0.700	-0.255	-0.121	0.119	-0.024	0.070	-0.104
Uruguay	3	17	0.462	-0.141	-0.075	0.056	-0.018	0.065	-0.080
Venezuela, RB	3	21	0.716	-0.228	-0.118	0.082	-0.002	0.123	-0.134
Vietnam	1	2	0.340	-0.132	-0.048	0.041	-0.017	0.015	-0.040

Table 6. *Predicted values of the Okun's parameters under the model for the unemployment rate with* $L_1 = 2$ *and* $L_2 = 1$ *for each country for which we enough information.*