Stability of activity–unemployment relationship in a codependent system

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A recursive codependence analysis is proposed for investigating the stability of the activity–unemployment relationship. Besides some noticeable statistical advantages, this new method provides a more accurate evaluation of conjunctural employment policies. It appears that for most countries, the delay necessary to absorb a shock is low, indicating that conjunctural stabilization mechanisms and/or employment policies serve their purpose.

I. INTRODUCTION

The strong persistence of the unemployment rate since the mid-1970s has led European policymakers and economists to seriously reconsider the link between economic activity and unemployment. In the empirical literature, most studies have considered this relationship within static linear models (Okun, 1962; Smith, 1975; Mossa, 1997) or VAR (Blanchard and Quah, 1989; Evans, 1989; Hénin and Jobert, 1993). Nevertheless, only few studies have simultaneously coped with two major weaknesses, namely the lack of dynamics within the joint (at least) bivariate process and the stability through time of this relationship.

In developing the codependence methodology, Gourieroux and Peaucelle (1993) show how it is possible to estimate a 'stable long-run' relationship, within a stationary dynamic system. This framework allows us to test for the shortest reaction time necessary for the activity–unemployment system to reach equilibrium after a shock. This provides another useful tool to assess the efficiency of conjunctural stabilization mechanisms as well as economic policies. To this approach a recursive estimation of the codependence degree (and vector) is added in order to evaluate the potential deformation in output–unemployment short-run movements.

The paper is organized as follows. In Section II, the methodology is briefly formulated. Section III compares empirical results for 11 OECD countries. Section IV concludes.

II. METHODOLOGY

The analysis of common-cyclical features has recently been the subject of many investigations. Tiao and Tsay (1989), Engle and Kozicki (1993), Gourieroux and Peaucelle (1993), Vahid and Engle (1993, 1997) and Ahn (1997) have shown it constitutes a powerful tool for analysing common short-term dynamics in a multivariate model. Empirical applications have been proposed to study relative purchasing power parity (Gourieroux and Peaucelle, 1993), permanent income hypothesis (Jobert, 1995), real interest rate differentials (Kugler and Neusser, 1993), real business cycle models (Issler and Vahid, 1992), convergence of economies (Beine and Hecq, 1998) or sectoral output (Engle and Issler, 1995).

Codependence: theoretical backgrounds

Gourieroux and Peaucelle (1993) treat the common feature issue in a vector moving average context, a framework called Codependence. Consider \( x_t \), an \( n \)-dimensional stationary vector process, admitting a multivariate moving average representation of order \( q \), such that:

\[
x_t = \mu + \epsilon_t + \Theta_1 \epsilon_{t-1} + \cdots + \Theta_q \epsilon_{t-q} \quad t = 1, \ldots, T \tag{1}
\]

where \( \mu \) is a vector of constants, \( \epsilon_t \) is a multivariate Gaussian white noise with its variance-covariance matrix \( \Omega_\epsilon \); \( \Theta_j, j = 1, \ldots, q \) are square matrices of size \( n \).
In general, the order of persistence of a linear combination $z_t$, such that:

$$z_t = \beta'm + \beta'\varepsilon_t + \beta'\Theta_{t-1} + \cdots + \beta'\Theta_{t-q}$$

$$i = 1, \ldots, T$$

is at most $q$. Time series are called codependent (Cod hereafter) if that order is less than $q$ and equal to $q - b$, where the degree of codependence is the integer $b$ with $0 \leq b \leq q$. Codependence holds for the VMA process (Equation 2) if there exists a $(n \times s)$ matrix $\beta$ whose columns span the codependence space such that $\beta'\Theta_{q-b} \neq 0$ but $\beta'\Theta_{q-b} = 0$ for all $k < b$. In terms of reduced rank of some matrices, codependence implies that $\text{rank}([\Theta_1 : \cdots : \Theta_{q-b}]) = n$ but $\text{rank}([\Theta_{q-b+1} : \cdots : \Theta_s]) < n$.

**Codependence in output-unemployment relationship**

Let us now consider a similar model as in Blanchard and Quah (1989), where the dynamics of the variation of the unemployment rate $\Delta U_t$, and the growth rate of economic activity $\Delta Y_t$, is governed by a VMA(2) process:

$$\begin{align*}
(\Delta U_t) &= (\beta_1 \theta_1 + \beta_2 \theta_2) \begin{pmatrix} \varepsilon_{t-1} \\ \varepsilon_{t-2} \end{pmatrix} \\
&+ (\beta_3 \theta_3 + \beta_4 \theta_4) \begin{pmatrix} \varepsilon_{t-2} \\ \varepsilon_{t-3} \end{pmatrix} + \varepsilon_t
\end{align*}$$

If we ignore the underlying structure in moving average matrices, the previous specification requires the estimation of eight mean parameters (plus the variances and the autocovariance). Economic interpretation is particularly difficult and inference less accurate when having a lot of parameters. However, recognizing that the first row is a linear combination of the second one, the model may be rewritten in a reduced-rank form (now with five mean coefficients):

$$\begin{align*}
(\Delta U_t) &= (\beta_1 \theta_1 + \beta_2 \theta_2) \begin{pmatrix} \varepsilon_{t-1} \\ \varepsilon_{t-2} \end{pmatrix} + (\beta_3 \theta_3 + \beta_4 \theta_4) \\
&\times \begin{pmatrix} \varepsilon_{t-2} \\ \varepsilon_{t-3} \end{pmatrix} + \varepsilon_t
\end{align*}$$

One sees that the linear combination $\Delta U_t - \beta_3 \Delta Y_t = \varepsilon_{t-1} - \beta_2 \varepsilon_{t-2}$ is white noise. The normalized codependence vector $\beta = [1, -\beta_2]$ is, up to a scalar factor, the only one which yields this result. Notice also that the orthogonal complement $\beta$ of $\beta$, such that $\beta' \beta = 0_{(n-1)}$, gives the weights of the dynamic factors for each variable.

The problem can be rewritten as a pseudo-structural equation system (Vahid and Engle, 1997):

$$\begin{align*}
\Delta U_t &= \beta_3 \Delta Y_t + u_t \\
u_t &= \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \cdots + \beta_4 \varepsilon_{t-q}
\end{align*}$$

Imposing the correct codependence restrictions presents several advantages. From a statistical point of view, the existence of codependence means a decrease in the number of parameters that must be estimated. In general, this will induce an increase in efficiency and better accuracy of forecasts (see Issler and Vahid, 1999). Moreover, it emerges that two indicators summarize important features of the system: $\beta_1$ and $q - b$. Correctly normalized, the codependence vector or matrix gives the 'most stable elasticities', and provides an indication of the instantaneous reaction of the system after a shock; i.e. the famous Okun's coefficient $q - b$ represents an indicator of 'persistence' of a shock affecting this dynamic system. These indicators are of major importance in gauging the effect of a conjunctural economic policy. The economy of a country with efficient conjunctural stabilization mechanisms and/or employment policies should exhibit a high negative short-run output-unemployment elasticity $\beta_1$ and a low delay of adjustment necessary to absorb exogenous shocks.

**The recursive procedure**

A recursive codependence analysis is proposed to evaluate the temporal stability of the system. We first start with a sample of $r \leq T$ initial observations to get a first estimation. For this sample, we test the degree $b$ of codependence (or the value $q - b$) as well as the associated codependence vector. We use GMM (in other words instrumental variables) to estimate the codependence vector and a Hansen (1986) test for over-identifying restrictions for the codependence order (Engle and Kozicki, 1993; Vahid and Engle, 1993).

Then, we expand one by one the sample size until the end of the sample $T$ and we calculate for each point of that growing sample the same statistics. Therefore we obtain $q \times (T - r + 1)$ recursive coefficients and test statistics, we can represent graphically. In figures, the codependence order is $q - b$. We can then summarize this information by retaining, for each point of the growing sample, the minimum of the $q - b$ order for which we do not reject the null, as well as the associated codependence vector.
III. EMPIRICAL RESULTS

Data
In this section, the recursive codependence analysis for 11 OECD countries is performed. Quarterly seasonally adjusted data are extracted from the OECD BSDB database. They range from 1960:1 to 1994:2 for most countries and a little earlier for some others. The output series is the gross domestic product at factor cost, in volume and less government wages. The unemployment rate is the uniform rate. This period is considered because we want to analyse to what extend the interaction between activity and unemployment has been altered since the first oil shock. The unit root hypothesis cannot be rejected for all variables in levels. The level of output and the unemployment rate are not cointegrated for each country. Consequently the analysis can be carried out for first differences without the omission of useful information.

For recursive analyses, the first window, i.e. $r$, is set to 20 quarters. This choice allows us to have sufficient recursive points to analyse deformations of the activity–employment relationship. The basic model is chosen with $q = 6$ lags, which is enough to whiten residuals.

Results
Figure 1 presents graphically the recursive estimation: delay of adjustment and associated coefficients.

The whole period
First, it may be interesting to have a quick look to the value of $\beta_1$ for the whole period, i.e. the last point on the graphs. The highest coefficients are for France ($-0.255$), the UK ($-0.26$), Germany ($-0.4$), The Netherlands (0.45) and the USA ($-0.475$). It is possible to find for each of these economies, institutional or political factors that justify this classification. Kaufman (1988) explains that unemployment is more responsive in the USA because of the lack of job security pension and restrictions on layoffs. Employers are thus inhibited from reducing their workforce during recessions and hiring more people during expansions. Another reason is also proposed by Layard et al. (1991). For these authors, countries whose wage negotiations are decentralized at the firm level, exhibit less rigidities: a shock in activity modifies wages and thus labour demand immediately and fully.

For the other countries, the coefficient is negative but close to 0, indicating a tight relation between activity and unemployment. In Japan, this weak link between employment and real activity fluctuation finds its source in cultural habits. For Europe, the relation is also tighter than in the North American countries, mainly because of strict laws on firing, and powerful unions. These results are in accordance with those found by Moosa (1997).

The second tool provided by the methodology is the delay of adjustment. Its analysis for the whole period indicates two main types of countries: those, in which the speed of adjustment is high (say less than 2 quarters), and those, for which adjustment speed is very slow (more than 4 quarters for full adjustment). The UK, Germany, Belgium and Italy belong to this latter category. For these countries, it can be concluded that stabilization mechanisms or employment policies take more than one year to have full effect. This result can be understood for Italy, where it is generally admitted that rigidities in the labour market are important (public sector important, restrictive firing laws, . . .), and for Germany, where, the increase in the speed of adjustment finds its origins in reunification. For other countries, explanations remain uncertain.

The recursive emphasis
The previous partial conclusions on the whole period may be influenced by recent evolutions and do not give enough weight to periods of instability in the last 20 years. The recursive analysis provides some clues to analysing this.

It appears clearly that crises (oil crisis in the mid-1970s or the 1980s business cycle) have increased the delay of adjustment. For most countries (Austria, Norway, the USA, France and The Netherlands), oil shocks slowed down the adjustment mechanisms, a phenomenon which reached a maximum level of five lags (more than one year). This result is generally associated with an increase in $\beta_1$ (in absolute value). Economic grounds of such behaviour are linked to the rise of uncertainty induced by the severe recession phase of a cycle. This provokes higher wages rigidity, and consequently a disconnection between activity variations and change in unemployment. On the other hand, some countries do not seem to be particularly affected by these crises (Japan, Germany, the UK, Italy and Sweden). In these countries, variables (unemployment and output) seem to be more affected by specific shocks than by common ones caused by a single crisis. The best example is provided by Germany, where both indicators are stable before reunification, and then indicate a sharp increase in the degree of adjustment.

In the recent past, two countries (Norway and The Netherlands) exhibit simultaneously an increase in $\beta_1$ and in the speed of adjustment. A quick and efficient reduction in unemployment can be expected after a conjunctural policy. For France, Austria, Sweden and Japan, no particular modification of the joint activity/unemployment behaviour is noticed for the last ten years. They exhibit a low $\beta_1$ coefficient (except for France) and a high degree of adjustment during the whole period. For these countries, active

\footnote{The data is described in Appendix 1.}
Codependence Order: The USA

Recursive estimate of the elasticity: The USA

Codependence Order: France

Recursive estimate of the elasticity: France

Codependence Order: Germany

Recursive estimate of the elasticity: Germany

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Fig. 1. Recursive global estimates and codependence order
conjointural policies are expected to be rapidly efficient. The conclusion is less clear for Italy, the UK, the USA, Germany and Belgium, where the adjustment speed decreases, indicating a possible delay between the shock and full reaction of the system. In such countries, conjointural employment policies appear inefficient and have to be replaced with structural policies.

IV. CONCLUSION

In this paper, a recursive codendependence framework is proposed to investigate the stability of the activity–unemployment relationship. Besides some noticeable advantages from a statistical point of view, this new method gives rise to a multi-dimensional judgment about the efficiency of conjointural stabilization mechanisms and/or employment policies.

The recursive analysis shows that for Norway and The Netherlands the efficiency of conjointural policies has increased, whereas the opposite result is obtained for Italy, the UK, the USA, Germany and Belgium.

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REFERENCES


APPENDIX

Data description

<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>Outlier in $y$</th>
<th>Outlier in $U$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium (BEL)</td>
<td>60:1–92:4</td>
<td>63:1</td>
<td>—</td>
</tr>
<tr>
<td>France (FR)</td>
<td>60:1–94:2</td>
<td>68:2</td>
<td>—</td>
</tr>
<tr>
<td>The Netherlands (NL)</td>
<td>60:1–93:4</td>
<td>79:1</td>
<td>—</td>
</tr>
<tr>
<td>Germany (GE)</td>
<td>60:1–93:4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>The United Kingdom (UK)</td>
<td>60:1–94:1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Italy (ITA)</td>
<td>60:1–94:2</td>
<td>69:4, 70:1</td>
<td>73:2, 92:4, 93:1</td>
</tr>
<tr>
<td>Sweden (SWE)</td>
<td>60:1–90:4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Norway (NW)</td>
<td>60:1–94:1</td>
<td>70:1, 75:1, 75:2</td>
<td>—</td>
</tr>
<tr>
<td>Austria (AU)</td>
<td>60:1–93:4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>The United States (USA)</td>
<td>60:1–94:2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Japan (Jap)</td>
<td>60:1–94:2</td>
<td>68:4, 74:1</td>
<td>—</td>
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</tbody>
</table>

Source: The data are extracted from the OECD BDD database. They are the seasonally quarterly adjusted series for $y$: GDP in volume at factor cost less government wages (mnemonic: Q:x:GDPBV) and $U$: unemployment rate (mnemonic: Q:x:UNR). Each series is adjusted for outliers with an ARMA model. A dummy variable is introduced for the outliers that have been identified via a boxplot analysis on the data in first difference.