Structural Breaks, Regime Change and Asymmetric Adjustment: A Short and Long Run Global Approach to the Output/Unemployment Dynamics

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Abstract: Even though the output and unemployment relation has always been a key theme in applied macroeconometrics research, the global hypothesis of modular short and long run dynamics assuming classic macroeconomic assumptions, is still to become a widely discussed subject in the field, and, therefore entails a large scope for further improvement, discussion and experimentation. Following recent advances in non linear bivariate estimation techniques this paper evaluates the joint hypotheses of endogenous growth, the natural rate hypothesis and asymmetric short run error correction. To tackle this global proposal a three step methodology, based on numeric grid search procedures is employed on data from nineteen OCDE countries. First, a numerical grid search is used to estimate linear trend output regimes with structural breaks and long run natural unemployment rate regimes are endogenously obtained from these estimates. Finally, different grid search procedures, based on the original two step procedure for estimating linear cointegration models, are used to estimate the short run adjustment process assuming threshold vector error correction dynamics, following recent proposals on asymmetric Okun adjustment.

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1. Introduction

In 1962 Arthur Okun defined one of the most famous and resilient relations in macroeconomic theory, the Okun Law, describing the solid pattern in the output and unemployment relation, when a long run regime was considered. In a short empirical paper[2], Arthur Okun defined the existence of stable relation for the U.S. economy between deviations from potential output, or output gaps, and its relation with the natural rate of unemployment. Using a regression analysis on output gap measures, obtained from both potential and trend linear assumptions, and considering an unemployment natural rate hypothesis of 4%, Arthur Okun defined the output/unemployment relation to be one to three. We follow the same basic assumptions as Arthur Okun, when defining linear trend structural regimes for output, but we assume regime changes that endogenously determine the natural rate of unemployment. This global endogenous long run proposal was first forward by Weber (1995). It consists on the estimation of Additive Outlier (A-0) specifications for the definition of different trend regimes (A-O Crash/Change models) for output. Then using this regime change information, unemployment regimes are endogenously given by an A-0 Crash specification. Additionally, we redefine the Okun Law as a dynamic and asymmetric relation of short to medium run transitions, using recent developments and techniques on the evaluation and estimation of threshold vector error correction models (T-VECM). The original proposal for this short run dynamics follows Harris and Silverstone (2001), and it stands on the assumptions that the Okun relation should be correctly considered as a dynamic asymmetric relationship. Harris and Silverstone (2001) propose to model the output/unemployment adjusted to regime relation using a T-VECM model, based on the threshold autoregressive (TAR) adjustment process, where threshold non-linearity may be endogenously estimated or defined exogenously. Their proposal also allows for the endogenous estimation of the Okun coefficient based on recent theoretical proposals for T-VECM estimation.

Having described our initial research hypotheses, we define bellow the set of goals that will guide our theoretical and applied estimation proposal:

1- Define a long and short run modular global bivariate specification for the output and unemployment dynamics, which is both consistent with the long run

[2] Okun (1962).

hypothesis by Weber (1995), and the short run proposal by Harris and Silverstone (2001). Show how both step choices are modular, and discuss the implications for the estimation of global specifications in applied macroeconomics, using advanced grid search procedures;

2- Review the relevant literature on estimation and testing of A-O models, bivariate specifications of output/unemployment dynamics and T-VECM bivariate systems;

3- Estimate and test these global specifications using a three step estimation procedure on data from nineteen OCDE countries, and define reliable criteria for short and long run model adequacy in a macroeconomic context. For this purpose, we shall use 4 estimation methods, which range from simplified assumptions to grid search techniques, and a simple score criteria for overall model adequacy;

4- Last, extend this field of non-linear applied time series theory from financial economics to applied macroeconomics, as it bears the potential to be extend to other meaningful hypotheses, other than ours. For this purpose we add to our specific results links to all our files, which include, straightforward routines in Eviews software that may be easily applied and extended to this or other theoretical scenarios and software systems. All these routines were also designed to be efficient in a context of limited computational power. This was achieved by jointly limiting the step size and extension of numerical grid searches and using Eviews programming specificities. However, this can be easily extended to allow for greater accuracy.

In the next sections, we will try to fulfil all these goals and present both the advantages and downfalls of our proposals for applied macroeconomic theory, and to the estimation of output/unemployment dynamics relations. We will not follow our set of goals religiously, as some of these subjects are interdependent and, therefore, a more interconnected and contextualized approach is advisable. In the appendix, a wide set of the data obtained from the estimated long and short run systems, can be found for this panel of OCDE economies. Links to all our results, and to the routines used, along with straightforward examples for experimenting, can also be found in the appendix. The statistical tables necessary for threshold cointegration tests, as originally proposed in Enders and Syklos (2001), may also be found in one of the sections of the appendix.

2. Structural Change and Additive Outlier Models

The original seminal work of Perron (1989) on structural change models vs. the unit root hypothesis, paved the way to both, the introduction of Additive Outlier Models (A-O) on macroeconomic time series modelling ,and to a multitude of statistical methods for unit root testing against different DGP hypotheses. This development led to two different outcomes on both theoretical and applied time series econometrics. The unit root hypothesis popularized by the Dickey-Fuller procedure for testing stationarity revealed a limited power to tackle with the structural change phenomena, when determinist trends specifications were considered. This has also happened with the extensions and alternative proposals ever since, and worsened with the increasing additional linear and non-linear DGP hypotheses for macroeconomic time series. To summarize this issue, we take a quote from Favero (2001): "Maddala and Kim[3] conclude their book on unit roots, cointegration and structural change with a chapter on 'Future Directions'; the last section of this chapter, entitled 'What is not needed', contains the following statement: '*… what we do not need is more unit root test (each of which uses the Nelson-Plosser data as a Guinea Peg)…*'". On the other hand, structural change models evolved from exogenously chosen date breaks, to endogenously estimated structural change models. A methodology for this purpose was defined in Vogelsang and Perron (1998) for A-O models. We will follow closely one of their estimation methods for A-O Crash/Change specifications, with the purpose of defining the long run relation between output and unemployment, as suggested in Weber (1995) proposal. For a further discussion on the subject of structural change specifications for time series refer to Rappoport and Reichlin (1989), Zivot and Andrews (1992), Bai and Perron (1998, 2003), Hansen (2001) and Kim and Perron (2007).

This short introduction to the theme of structural change and unit root testing served the purpose of introducing the A-O modelling approach to scaling macroeconomic time series. One interesting feature of the Crash/Change specification is that it can be used to estimate discontinuous structural changes for log output. This hypothesis follows the endogenous growth hypothesis for the degenerate case of deterministic dynamic general equilibrium models with a

[3] Maddala, G.S., Kim, I.M. "Unit Roots, Cointegration and Structural Change", *Cambridge University* Press, 1998.

constant growth rate. In this long run specification, although adjusting continuously for the long run outcome, these adjustments are given instantaneously, which mimics the discontinuous adjustment of simple endogenous growth models. Other interesting specifications include the *Innovation-Outlier* (I-O) family of models. This class of models just assumes that structural adjustment is not instantaneous, as in the A-O case, but instead is given by a slower adjustment process. The adjustment path DGP is then left at the choice of the researcher. Although, grid search procedures may be also used to tackle this issue.

Equation (1) defines the long run Crash/Change A-O specification for log output:

$$Y_t = \beta_0 + \gamma T_t + \sum_{i=1}^{n} \beta_i DU_{i,t} + \sum_{i=1}^{n} \rho_i DT_{i,t} + \phi_{1,t} \qquad (1)$$

Where the adjustment variable or regression error, $\phi_{1,t}$, refers to the transitions within the regimes, and $DU_{i,t}$, $DT_{i,t}$ refer to the shifts in the intercept and slope, respectively.

We estimate the structural changes model described in equation (1) using one of the methods for global optimization suggested in Vogelsang and Perron (1998). This method consists on choosing break dates that maximize the F-statistic between the trend linear model and the specific A-O structural change model[4]. Vogelsang and Perron (1998) also propose additional methods based on t-statistics from augmented ADF tests with a detailed methodology for structural change estimation and testing when the direction of the break is known. One of the problems with global optimization procedures is the exponential growth of computational time, when multiple structural changes are considered[5]. Bai and Perron (1998, 2003) tackle this problem and propose a number of local estimators for structural change, based on data with one or more global structural changes. However, in the presence of multiple breaks, local estimations based on global estimated segments may be inaccurate, due to model misspecification. Bai and Perron (1998, 2003) discuss these issues thoroughly and propose different approaches, according to various statistical methods. We dismiss such procedures

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[4] This method is identical to performing a grid search for minimizing the sum of squared residuals of the specific A-O model.

[5] The reasonable limit of computable global breaks in sample sizes similar to ours is four. When the sample size is greater than 200 then average computations may take about 48 hours to conclude in a modern Pentium processor.

due to the magnitude of our overall data and rely on the asymptotic properties of the global optimizer in adjusting to the data. Other relevant problems of this methodology are similar to univariate time series filters used on output gap measurement and short run forecasting. These issues are related to the biased estimates obtained near the endpoints of the sample[6]. However, as the number of estimated breaks increases, the probability of detecting breaks in endpoints improves, at the cost of over-specification and loss of relevant transitions information on the error term. The main advantage of this methodology is that it can be matched to straightforward theoretical assumptions, while bearing on grid search numerical procedures following objective functions suggested by asymptotic theory, instead of the usual statistical and mathematical assumptions that support time series filtering methodology. These set of procedures can also be extended to the class of I-O models discussed previously, where grid searches could be employed to choose of the adjustment process and relevant parameters values.

2.1. Defining the Long Run Output/Unemployment Relation: Endogenous Growth and the Natural Rate Hypothesis

In this section, we define the natural rate of unemployment as being given endogenously by long run structural output regimes. Whenever a structural innovation occurs, a switch to a new long run stationary equilibrium for natural unemployment takes place. This process is similar to Weber (1995) hypothesis for Okun estimation using A-O models for output and unemployment adjustment. The choice for a specification under these conditions is straightforward. As already described, an A-O Crash model for the natural rate hypothesis, assuming constant parameter changes endogenously defined by output regimes, was chosen:

$$U_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i DU_{i,t} + \phi_{2,t} \tag{2}$$

Long run adjustments are still defined by long run growth regime changes, but mean reverting equilibrium transitions for scaled unemployment, $\phi_{2,t}$, are obtained from simple OLS estimates obtained from regression (2).

One interesting feature of this proposal is the modularity of the dynamic system described by equations (1) and (2) that renders unemployment to be endogenous in

[6] For a recent discussion on the problems of univariate filters and a proposal to tackle them based on a multivariate framework refer to Valle e Azevedo (2008).

the long run, while still related to endogenously estimated output regimes. This proposal features two important innovations. First, it stands on the existence of a modular transformation, as previously discussed. This does not mean that our proposal and subsequent estimation is entirely correct. However, as we have estimated all structural significant changes against unemployment, following equation (2), it is straightforward to obtain a global measure for this modular adjustment. Considering only the matching unemployment/output samples[7] the modular specification adjusts significantly at a 74,2% rate, considering a 5% probability value, for all estimated regime parameters[8]. This global adjustment rate thus suggests that unless we have stumbled onto a statistical fortunate accident, our modular system seems to have a satisfactory outcome in describing the natural rate hypothesis against unemployment data. Second, it is possible to produce forecasts with long run regimes and still maintain modularity in our system. Consider that an innovation term, $\phi_{lr,t}$, for estimating the probability that a structural change may occur exists in equation (1). As the information contained in the estimated error term, $\phi_{1,t}$, is insufficient to describe this probability, this additional term must be composed by an information matrix of advanced indicators for output structural change. This matrix is a binary indicator that takes only the value 1 at period $t+n$, when the probability of a structural change has occurred at $t+n-1$ is greater that a specific benchmark threshold value. Then at period $t+n$ an additional set of crash/change variables are considered in (1) and a new crash variable in (2). This process might not be contemporary, as we suggest, it might only define the existence of a past structural shift that needs to be estimated, or long run regimes might differ from our A-O proposal. However, our modularity assumptions guarantee that the long run estimation and forecasting

[7] Four equations for unemployment were considered, with a total of ten parameters estimated per country, for a total of 190 estimated parameters in 19 countries. The sample used for the U.S. was the restricted one, starting in 1965.

[8] It was excluded from this global adjustment evaluation the initial intercept term that is significant in the vast majority of the specifications. Statistical significance depends largely on the specific Crash model estimated, even when the same shifts occur, so this is just a rough measure of global adjustment. For all the regressions estimated only a total of seven models were rejected. Five of them were specifications with just one Crash change. The remainder rejections were the two breaks Crash model for Spain and the three breaks Crash model for Portugal. Adjustment is sluggish for Spain unless we consider four regime changes, then adjustment becomes very good. Adjustment is always sluggish for Portugal, which suggests additional regimes or a different hypothesis for the output and unemployment long run dynamics.

outcomes for the natural rate of unemployment are both an endogenous outcome from the estimation and forecasting of long run output dynamics.

3. Short Run Dynamics: The Okun Law as a Dynamic Short Run Relation

We have exempted from putting forward any specific suggestion on the transition variables so far, because we wanted to discuss first the implications of our choice of model for long run regime estimation. On the other hand, our initial assumptions on long run regimes restrict our options for choosing the data available for short run model building. Again, the issue of modularity arises. The choice for a short run specification must be consistent with the available data and the long run adjustment process. Tradeoffs between short run vs. long run specifications might arise, suggesting that our modular system assumptions might not hold. Nonetheless, introducing modularity assumptions to macroeconometric modelling may prove to be an interesting tool towards better model selection and adequacy criteria, as it bears the potential for global estimation and testing.

Our choice for modelling the short run adjustment process for output and unemployment builds on the Harris and Silverstone (2001) proposal of bivariate asymmetric dynamic adjustment based on a T-VECM. This option involves choosing and estimating a nonlinear T-VECM specification, where asymmetric adjustment arises through a threshold autoregressive (TAR) adjustment process. Although, not following the same standard estimation and testing assumptions for linear bivariate error correction models, the methodology employed follows closely the seminal proposal by Engle and Granger (1985). The essential literature for T-VECM modelling, estimation and testing can be found in the articles by Balke and Fomby (1997), Tsay (1998), Enders and Granger (1998), Enders and Syklos (2001) and Hansen and Seo (2002). In this framework, as widely suggested in the literature, linear cointegration estimation and testing methods take a deep blow when facing nonlinearity assumptions. These issues are extended later in the text. In the quest for Okun's Law model adequacy, the first task is always to define the adjusted regime cyclical behaviour of the variables. Of course, these choices are always dependent on the choice of long run regime models. This might be just simple linear trend specifications, regimes obtained from statistical filtering processes, or in our case A-O regime based models. Similar extrapolations for the natural rate of unemployment must be considered also, in order to obtain its cyclical behaviour, as suggested by the unemployment modular modelling assumption, described in equation (2). Each of these specific options defines the information that will be used later on, when estimating short-run specifications. Therefore it also partially defines the outcomes of estimations and specific testing methodology employed.

When dealing with non-linear specifications, such as our T-VECM choice, where uncertainty arises from different existent estimation and testing procedures, the choice of regime modelling is crucial to the results obtained and their economic interpretation. This is where our modularity assumption proves useful, as it able us to restrict possible results obtained to be a feasible set of economic interpretations, within a specific choice of modular long run adjustment between output and unemployment.

Imagine that the science of output obtaining regime has reached an interesting peak and has reduced model adequacy, in a certain point in time, to just three hypotheses. However, the advanced techniques for estimation of non-linear specifications, including the natural rate of unemployment models, were still in a momentum of definition, bearing some ten's of different proposals altogether. In this context, the amount of possible bivariate time series specifications for the output and unemployment cyclical relation will be at least hundreds of possible hypothesis. Research in time would produce insight in more uncertain subjects that in time would produce increased uncertainty on the set of feasible models. This dynamics would at least maintain a relevant number of potential models on the existing set of possibilities for output and unemployment over time, as exponential growth on model adequacy research arises during uncertainty periods and acts on stylized procedures on the other end of research. If you additionally consider the scientific evolution of nonlinear stochastic mathematics and change in society, then the odds for correct model adequacy would be immense. To overcome this problem one must consider that in the presence of specific short and long run dynamics, the class of possible modular systems is certainly limited in respect to individual approaches. This is due to two rules. The first rule relates the existence of modularity, within the possible set of individual approaches, has a limited field of possibilities. The second rule relates to the original hypothesis for tackling the problem. If we consider that there is a relationship in the short/long run, then the resulting paradigm must entail some intuition about the long/short run outcomes.

If this is the case, then only a limited set of possible modular approaches is available following the first rule[9].

Bearing in mind the modelling paradigm discussed, we extend our modular assumptions for the short run dynamics by assuming the following T-VECM specification. Assuming $\phi_{2,t} = U_{adj,t}$ and $\phi_{1,t} = 100 \cdot Y_{adj,t}$ [10], to simplify we will just assume that $\phi_{1,t} = Y_{adj,t}$, our candidate for the short to medium run asymmetric adjustment process is given by the following T-VECM model, following one of the Enders and Granger (1998) specification proposals is given by the system described in equations (3) and (4):

$$\begin{aligned}\Delta U_{adj,t} &= \sigma_{u,1}\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right) I_t + \sigma_{u,2}\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right)\left(1 - I_t\right) + \\ &\quad + \sum_{i=1}^{n} \psi_i \Delta U_{adj,t-i} + \sum_{i=1}^{n} \pi_i \Delta Y_{adj,t-i} + \varepsilon_{u,t}\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta Y_{adj,t} &= \lambda_{y,1}\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right) I_t + \lambda_{y,2}\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right)\left(1 - I_t\right) + \\ &\quad + \sum_{i=1}^{n} \eta_i \Delta U_{adj,t-i} + \sum_{i=1}^{n} \theta_i \Delta Y_{adj,t-i} + \varepsilon_{y,t}\end{aligned} \tag{4}$$

Where the asymmetric adjustment process is defined by the following Heaviside function, following a threshold[11] determined by ξ_{t-1}, the error correction term, obtained, as usual, when estimating equation (5):

$$I_t = \begin{cases} 1 \;\; if \;\; \xi_{t-1} \geq 0 \\ 0 \;\; if \;\; \xi_{t-1} < 0 \end{cases}$$

Alternatively, the threshold value can be estimated through a grid search procedure and the Heaviside function comes:

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[9] In this specific research field, formal proposals could follow, for example, the seminal proposal by Blanchard and Quah (1989). For a formal discussion on the Blanchard and Quah (1989) proposal of a VMA representation for output/unemployment dynamics vs. a VECM approach refer to Lippi and Reichlin (1993), Blanchard and Quah (1993) and Quah (1995).

[10] This scaling assumption has no implications on none of our estimation and testing procedures, as it just imposes a linear homogeneous transformation on the data. Since we are dealing with absolute values of the GDP obtained from linear detrending the data, this transformation implies that now the adjusted output scale is given by percentual deviation points from the estimated regime. This is also the adjusted unemployment scale originally obtained following Weber (1995) approach with a crash A-O specification.

[11] The threshold choice is based on the original proposals by Enders and Granger (1998) and Enders and Syklos (2001). Original proposals for T-VECM models suggested the estimation of the threshold value employing a grid search procedure on equation (6), as discussed in Harris and Silverstone (2001) Okun estimation proposal. This methodology was originally suggested by Chan (1993) for threshold super consistent OLS estimation, when the sum of squared residuals objective is minimized.

$$I_t = \begin{cases} 1 \ if \ \xi_{t-1} \geq \tau \\ 0 \ if \ \xi_{t-1} < \tau \end{cases}$$

In this experiment the error correction mechanism is given by the following TAR error adjustment process, which is described in equations (5) and (6):

$$U_{adj,t} = \mu Y_{adj,t} + \xi_t \tag{5}$$

$$\Delta\xi_t = \omega_1 I_1 \xi_{t-1} + \omega_2 \left(1 - I_1\right)\xi_{t-1} + \nu_t \tag{6}$$

Where $\mu = \delta$ is the static symmetric Okun coefficient and our error correction terms, $\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right) I_t$ and $\left(U_{adj,t-1} - \delta Y_{adj,t-1}\right)\left(1 - I_t\right)$, are given by $\xi_{t-1} I_t$ and $\xi_{t-1}\left(1 - I_t\right)$, respectively, following the original two step procedure for linear cointegration.

Other meaningful specifications for the error correction mechanism include the momentum threshold autoregressive model (M-TAR), which assumes a threshold defined by the first difference of the estimated error correction series. This specification should be employed when the ξ_t series exhibits more momentum in one of the two possible directions. It is an appropriate specification to model situations, where adjustment differs in accordance with the size of the error term deviations. One interesting hypothesis suggested in Enders and Syklos (2001), relates the threshold momentum dynamics to policy interventions for smoothening large changes in the series in only one of the directions. On the other hand, adjustment is faster on the other direction. This specification can be also applied to our proposal, since policy makers try to smoother large increases on unemployment, while deviations that decrease unemployment are usually left unchecked. Last, in this family of models, the Band-TAR adjustment process, originally suggested by Balke and Fomby (1997), extends the above T-VECM specifications by including a neutral adjustment band, where there are no threshold effects. This methodology is usually encountered in financial economics for testing different market hypothesis, such as the *Law of One Price*, among others. Some other examples on T-VECM applied research include Peel and Davidson (1998), who discuss the applicability and adequacy of bivariate threshold specifications, when non-linearities might not be well captured by univariate methods. Martens, Kofman and Vorst (1998) use the T-VECM approach to estimate arbitrage conditions in markets of future contracts. Grasso and Manera (2005) apply threshold and asymmetric error correction to the oil and gasoline price relationship. Poghosyan and De Hann (2007) study interest rate linkages in the European Monetary Union countries. Wu and Chen (2006) investigate non-linear adjustments of the real interest rate toward purchasing power parity, and discuss the hypothesis of threshold cointegration. Baum and Karasulu (1998) introduce the application of threshold cointegration for modelling the discount rate policy problem by the Federal Reserve System. Sollis and Wohar (2006) discuss the relation between the real exchange rate and the real interest rate using threshold cointegration. Park, Mjeld and Bessler (2007) estimate a theoretical model for the law of one price based on Band-TAR vector error correction class of models.

To conclude this section, we still lack a formal discussion on the issue of Okun innovations based on a dynamic framework. The absence of non linear impulse response functions leaves little room to speculation on the overall qualitative behaviour of the estimated T-VECM specifications that are found in the appendix. The existence of a threshold for short run adjustment implies that shifts during the adjustment process are likely to arise, when a single temporary output innovation occurs. These regime transitions might impose qualitative changes to unemployment and output short run dynamics. There is no reason not to consider impulse response dynamics with multiple qualitative regime changes as well, although, the probability of such scenario is theoretically smaller. Having said this, we conclude this section with a proposal for analysing Okun dynamics for a future impulse response analysis. The temporary innovations proposed are given by the following vector, $\left[\varepsilon_{u,t}, \varepsilon_{y,t}\right]' = \left[0,1\right]'$, which is just the modern dynamic equivalent of the original Okun approach for measuring cyclical unemployment response to one base point innovation of cyclical output.

3.1. Estimation and testing T-VECM systems

As we referred in the previous section, T-VECM model estimation and testing is a rather complex issue, which is difficult to extend fully in an applied framework. Such a scenario implies defining a limited number of procedures for testing and estimation. To remain loyal to our initial proposed goals, we took the option of giving a larger relevance to estimation procedures, rather than testing procedures.

We opted to describe and estimate only the testing methodology for threshold cointegration proposed in Enders and Syklos (2001). However, in the end of this section we shall briefly refer other proposed testing procedures for threshold cointegration and model adequacy. On the other hand, four different estimation procedures for T-VECM estimation were employed in our data, which allows for a comparison of the different numerical procedures employed, and to test each method accuracy and reliability, in this specific dynamic Okun framework. The adjusted series used to estimate the T-VECM specifications are the ones obtained from regime estimation A-O models, where the output and unemployment samples matched. The exception is the Belgium data, where output regime changes were always within the unemployment sample. For the US data a restricted sample starting in the first quarter of 1965 was considered, as the larger sample showed evidence of more than four regime changes. All the estimation and test results may be found in the countries section tables of the appendix.

To simplify data presentation in the remainder of the document a number was given to define each of the four different methods employed for T-VECM estimation. A description of each of these methods follows bellow:

1- The first method consists on the estimation of the error correction mechanism following the Engle and Granger (1987) two step procedure for linear cointegration estimation. This procedure is based on the Enders and Granger (1998) and Enders and Slykos (2001) proposals and implies assuming that the threshold value, τ, is equal to zero;

2- The second method consists on employing a grid search procedure to estimate the threshold values by minimizing the sum of square residuals (SSR) of equation (6). According to Chan (1993), a super consistent estimate of the threshold value can be obtained following this procedure. We limit the grid search to avoid threshold regions that account for less than 5% of the total number of periods. When assuming a threshold adjustment process we have already defined that the probability distribution region for our threshold to be given by:

$$0 \prec P\left(\xi_{t-1} \prec \tau\right) \prec 1$$

By imposing a trimming parameter, $\pi = 0,05$, our constraint is now given by:

$$\pi \prec P\left(\xi_{t-1} \prec \tau\right) \prec 1-\pi$$

The choice of a trimming parameter is usually defined in the region $0,5 \leq \pi \leq 0,15$ and serves the purpose of guaranteeing meaningful threshold regimes;

3- This method is an extension of the previous grid search procedure to include the Okun parameter, μ. In this estimation procedure, we introduce the issue of sequential grid search on both equations (5) and (6) and maintain the previous objective of minimizing the sum of square residuals of equation (6). This specific approach is not tackled in theoretical literature, but serves the purpose of introducing sequential numerical grid search procedures based on Chan (1993) super consistency estimation theorem. Additionally, this method may be used to compare with the double grid search procedure proposed by Hansen and Seo (2002), which is described in the next paragraph. In all the first three methods, the lag length of our final VAR specification is chosen using the modified AIC criterion for bivariate systems. This is possible because the VAR estimation step is always independent from the grid search procedures, since the objective function is only related to equation (6);

4- The fourth and last procedure is the Hansen and Seo (2002) quasi-maximum likelihood (MLE) estimator for T-VECM models. To tackle the differentiation problems of the MLE function and the inadequacy of optimization techniques in this context, as discussed in Rapsomanikis and Panayiotes (2007), Hansen and Seo (2002) propose a consistent estimator based on the original MLE function for the T-VECM bivariate system. The Hansen and Seo (2002) quasi-MLE estimator is obtained by following a grid search procedure on the error correction parameter and the threshold value, similar to the grid search procedure described for the third method. However, the objective now is to minimize the log of the determinant residual covariance for the estimated VAR system. Provided the residuals of the estimated T-VECM follow a multivariate normal distribution then, theoretically, this estimator should be consistent. Still, the differentiation problems of the MLE function imply that the MLE function has specific non-linear features that might get the numerical optimizer stuck in a local maximum of the likelihood function that does not represent a consistent estimator. Hansen and Seo (2002) also suggest a set of procedures to choose the grids where to search. They suggest calibrating an even grid from a consistent OLS estimate of the error correction parameter from the linear model, and define the region for the search as an extended confidence interval. We follow this approach partially, in all the previous described methods, by selecting an even grid based on the sample size, but define different intervals for $\mu \approx [`-0,9;0,1]$ and $\tau \approx [`-0,5;0,5]$. These regions are just large confident intervals for expected outcomes of the Okun coefficient and reflect our expectations on an initial threshold close to the origin, based on a correct regime estimation of output and unemployment. The reason for using such large confidence intervals is justified by the need to test the accuracy of these different methods in this context. Under such non-linear scenario the use of new numerical procedures should be taken cautiously, until a set of contextualized rules and procedures arises. We show in the next section, how the non-linear problems previously discussed damage the T-VECM estimation by attracting the numerical routine to extreme values of μ and τ. This problem may be due to the large intervals used in the estimation of methods 3 and 4, but also serves the purpose of exposing the problems arising with the existence of local maxima in T-VECM estimation. To conclude the review on the Hansen and Seo (2002) procedure, we still have to discuss the issue of lag length. Because the objective function is now a function of the VAR estimation step, the usual AIC criterion can only be considered after the main grid search procedure is finished. However, this estimator is not in accordance with the Hansen and Seo (2002) methodology. To tackle this issue and still maintain the usual parsimony rule of time series econometrics, a decision was taken to split method 4 in two methods. The first one is just the Hansen and Seo (2002) theoretical estimator, and the second one, is an extension that chooses the lag length using the AIC criterion after the application of Hansen and Seo (2002) method. This decision was based on the large number of estimated lags following the Hansen and Seo (2002) method, compared to the previous described estimation procedures. However, the estimated VAR might not hold has a global maximum of the likelihood function, under the full set of possible models with the same lag length. Therefore, this method should only be regarded as a simple extension of the original Hansen and Seo (2002) procedure to allow for a more parsimonious comparison with the other meaningful estimated models.

The Enders and Syklos (2001) approach to threshold cointegration testing is based on the original Engle and Granger (1987) approach to linear cointegration testing. Enders and Syklos (2001) extend the usual cointegration procedures to include three more tests for both threshold cointegration and asymmetric adjustment. The test values for threshold cointegration are the estimates for the *F* and *t* statistics of the threshold autoregressive error equation (6). The *t* statistic used for inference purposes is the one that has a higher determinant value, thus Enders and Syklos (2002) named it as the *t*-Max statistic. The test for asymmetric adjustment is just the *Wald* estimate for the null hypothesis of symmetric adjustment, $\omega_1 = \omega_2$ [12]. Although rather simple to compute, these test statists show little power when compared to the original linear cointegration testing methods under specific conditions, such as nearly symmetric adjustment. Other tricky issues include the unknown threshold value assumption, as the properties for asymptotic multivariate normality in this framework are not yet established, and therefore, inference tests on equation (6) estimates may be misleading. To tackle these issues, Enders and Syklos (2001) propose the use of different bootstrap methods to define confidence intervals for each threshold value hypothesis. We discard these procedures and use just the usual OLS estimates to obtain our test statistics, as our main goal is to produce some insight in numerical methods for model estimation, and define a set of reasonable statistical criteria for model adequacy. We also discard the use of linear cointegration methods based on unit-root tests, for the reasons already described. This specific issue is also discussed in Enders and Syklos (2001), who also concur on the low power of unit-root tests, and use these testing procedures to establish also the low power of the *F* and *t*-Max tests. At this point the reader must be questioning the use of such flawed procedures. What is the point of insisting on non reliable testing procedures? Well, one of the justifications for this option lies on the need to limit the extension of research proposals. However, the best answer to this question lies on the pressure put on contemporary econometric inference theory resulting from the recent advances on non-linear time series modelling [13]. The challenges introduced by non-linear

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[12]The country tables for T-VECM estimation contain all the test results obtained for each inference method. Critical values for the *F* and *t-Max* are also reproduced in the appendix from the original tables by Enders and Syklos (2001). These values are for both threshold assumptions and no lagged changes considered in equation (6).

[13]A number of tests was proposed in the initial literature for T-VECM estimation and were based on the existent hypotheses for testing linear cointegration. Other applications include the Wane, Gilbert and Dibooglu (2004) threshold and momentum threshold cointegration *F*-

modelling in econometrics are too wide to be tackled by the classical methods that were tailored to fit inference theory in linear modelling scenarios. The introduction of numerical methods for both estimation and bootstrap confidence interval construction are a reaction to this outcome. However, these procedures have also specific problems, as we already referred. Estimation results and inference analysis in a T-VECM framework should, therefore, be taken as a continuous process of improvement, rather than a stylized outcome from a set of specific estimation and testing options. Bearing this in mind, we advise the reader to look at the results from the next section and the appendix, as an outcome based on this perspective. As the results in the appendix show, the model estimates obtained reveal patterns, specific to each methodology, which will help to improve the proposed T-VECM estimation procedures in the future.

3.2. Model adequacy and Okun coefficient results

The endogenous unemployment regimes assumption, following Weber (1995), poses an interesting problem for making a choice on the number of regimes for the long run specifications. There is no straightforward statistic available that may be used, under these set of assumptions, for regime choice and model adequacy criteria. The joint hypothesis of endogenous unemployment regimes and global adjustment, also invalidates the use of tests, such as those proposed in Bai and Perron (1998, 2003), to tackle the issue of model adequacy. In order to determine what model fits best the global proposal for output and unemployment, a battery of model adequacy criteria was used. These set of criteria included the usual F statistics for no structural change and the AIC. Following the suggestions in Bai and Perron (2003), we also used the Bayesian Information Criterion (BIC) and LZW criterion, following Yao (1988) and Liu, Wu and Zidek (1997), respectively, for the m regimes structural change model:

$$BIC\left(m\right) = \ln\left(T^{-1}\sum_{t=1}^{T}\phi_t\left(m\right)^2\right) + \left(\left(m+1\right)q + m + p\right)\ln\left(T\right)/T \qquad (7)$$

tests. Decision maps for evaluating the presence of potential threshold cointegration by Kunst (2002). Breitung (2001) discusses the use of rank tests in nonlinear cointegration. Gonzalo and Pitarikis (2006) propose testing procedures for threshold cointegration versus linear cointegration. Finally, Hansen and Seo (2002) propose numerical procedures to perform *LM* tests based on their quasi-MLE estimation method.

$$LZW(m) = \ln\left(\sum_{t=1}^{T}\phi_t(m)^2 \Big/ \left(T - \left((m+1)q + m + p\right)\right)\right) + \left(\left((m+1)q + m + p\right)\Big/T\right)c_0\left(\ln(T)\right)^{2+\delta_0} \quad (8)$$

Where $m = i$ is the number of regime changes considered, $\phi_t(m)$ are the residuals obtained for each i regime, q is the total of variables used for estimating the change points and p is the number of unchangeable or standard regime variables. The parameters c_0 and δ_0 take the values of 0,299 and 0,1 , respectively, as originally suggested by Liu, Wu and Zidek (1997).

To obtain a score for each model that is representative of global adequacy, each of the output and unemployment specifications was ranked according to their relative performance. The final score was given by the average of all ranking positions achieved by each structural model. To put on some bias towards better adjustment in unemployment regressions, the SSR outcomes were also considered as a criterion. In the final criteria decision the AIC criterion for long run output adjustment was dropped, because it is always biased towards choosing more regime changes. This problem with the AIC performance for grid search estimation of linear trend regime models is discussed in Bai and Perron (2003). Additionally, they report problems with the accuracy of the BIC and LZW criteria, when serial correlation in the errors is considered. Taking all these issues into account, the best fitting regimes were divided into two categories. The first one including series with an overall average rank equal or smaller than 2. When no specification was eligible under this first rule, the number of regimes was chosen between the second best fitting models. Table 1 bellow summarizes the estimated breaks and Okun coefficients for the best ranked long run regime specifications. The full results for all possible specifications are reported in the appendix.

Country	Average overall score no AIC- GDP	Number of A-O regimes	Okun coefficient estimates by method		
			$\mu_{1,2}$	μ_3	μ_4
Australia	1,375	3	-0,323	-0,188	-0,538
Austria	1,5	3	-0,099	-0,045	-0,929
Belgium	1,5	2	-0,618	-0,291	-0,9
Canada	1,75	1	-0,399	-0,204	-0,532
Denmark	2	2	-0,307	-0,102	-0,827
Finland 1	2,375	1	-0,571	-0,246	-0,915
Finland 2	2,375	2	-0,515	-0,054	-0,638
France	1,75	3	-0,467	-0,367	-0,878
Italy	1,875	2	0,002	-0,327	-0,891
Japan	1,375	3	-0,118	-0,036	-0,664
Netherlands	2	1	-0,268	-0,194	0,102
New Zealand 1	2,125	1	-0,033	-0,007	-0,927
New Zealand 2	2,25	3	-0,045	0	-0,707
Norway	2	3	-0,237	0,051	-0,898
Portugal	1,875	1	-0,256	-0,06	-0,457
Spain	1,875	4	-0,379	-0,218	-0,9
Sweden 1	2,375	1	-0,469	-0,357	-0,888
Sweden 2	2,375	2	-0,413	-0,122	0,102
Switzerland	1,375	1	-0,188	-0,217	-0,028
UK 1	1,75	2	-0,386	-0,089	-0,788
UK 2*	2,25	4	-0,449	-0,288	-0,62
USA	1,875	2	-0,429	-0,212	-0,767
Former FRG	1,75	2	-0,275	-0,193	0,067

Table 1- Estimated Okun coefficients for selected specifications
*Overall average score of 2 when the AIC- GDP is considered

A quick inspection to the estimated Okun coefficients reveals a clear pattern for each of the T-VECM estimation methods employed. OLS estimates yield expected results for the vast majority of the countries considered. The SSR minimization double grid method also performed reasonably, but showed a clear bias in relation to the OLS estimate, choosing in the majority of the cases a smaller Okun coefficient. This result comes in line with recent views of a smaller Okun coefficient than the one obtained following standard scaling and regression analysis. Finally, the quasi-MLE estimator shows both a bias towards a larger Okun relation and to choose coefficients that are on the edge of the grid search interval. The results obtained by the quasi-MLE are largely poor compared to other estimation techniques. This is a result of the non-linear form of the quasi-MLE objective function considered for numerical optimization, which attracts the numerical estimator to unfeasible local maxima near or outside the grid search interval limits. This pattern extends to the other possible specifications estimated using the quasi-MLE, with few exceptions, and suggesting that our grid search intervals might be too wide. Another consequence of this option is the estimated threshold values, which are systematically estimated as an extreme value near the limits of the grid search interval.

The T-VECM testing procedures also uncovered another obvious pattern in the data, when grid search procedures for estimation purposes were employed. This pattern relates the problem of extreme threshold and Okun parameter estimation with the outcomes of T-VECM and Wald asymmetry hypotheses tests. There is a clear bias towards rejecting the null of no cointegration and symmetric adjustment for the extreme quasi-MLE estimates, compared to the other estimation methods. Particularly, in the case of the Wald test for the null of symmetric adjustment, only the third T-VECM estimation method performs satisfactorily. This is an evidence of the low power of the Enders and Syklos (2001) F and t-Max tests, and of the inadequacy of the Wald symmetry test for inference in the T-VECM framework.

As expected the choice of long run and short run models failed to produce a consistent choice for all the countries considered. This expected outcome is a consequence of the wide number of possibilities that exist for output and unemployment bivariate dynamics. Even within our specific theoretical assumptions, a different set of long run and short run specifications could be considered, such as the I-O and M-TAR proposals described previously. On the other hand, the score method employed to choose long run regime adjustment proved to be a useful tool to global model choice, when compared to T-VECM estimates under different long run specifications, which consistently showed a worst performance. This result has to be considered in a context of low power T-VECM test statistics. Still, there is evidence that the use of scoring methods, with a variety of statistical indicators, may provide useful tools for evaluating global adjustment hypotheses, such as the one here proposed.

4. Conclusions

To avoid repeating the same arguments, proposals and results already thoroughly discussed, we shall use this final section to point out the most relevant directions for future research on this specific research field. First, an improvement of test quality and estimation accuracy/reliability must be achieved for this specific data set, with the purpose of accomplishing a full estimation methodology that may be broaden to other global modular hypotheses. Secondly, alternative DGP processes must be considered for both long run and short run dynamics, within the same standard global modular assumptions that were previously defined. Some specific options were already forwarded in this paper, however, the full scope of their potential implications in this framework is still to be fully tackled. Once this set of goals is achieved, it will be possible to compare results within this limited paradigm of bivariate modelling approach and, therefore, extend this methodology to tackle a wide set of possible policy implications.

Appendix

1.Tables by Country

Australia

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1974:2									
Two Breaks	+	-	1969:4	-	+	1991:2						
Three Breaks	+	-	1969:4	-	+	1982:4	-	-	1990:4			
Four Breaks	-	+	1961:2	+	-	1970:1	-	+	1982:4	-	-	1990:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	na	na						
Two Breaks	na	na	0,078	0,255				
Three Breaks	na	na	1,676	3,632	-0,477	-1,418		
Four Breaks	na	na	na	na	1,676	3,632	-0,477	-1,418

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1991:1									
Two Breaks	-	+	1982:4	-	-	1990:4						
Three Breaks	-	+	1982:3	-	0	1991:1	+	-	1998:3			
Four Breaks	-	+	1982:4	0	-	1990:1	0	+	1992:1	-	-	2000:4

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0,116	0,378						
Two Breaks	1,676	3,632	-0,477	-1,418				
Three Breaks	1,702	5,700	1,280	5,084	-3,175	-12,774		
Four Breaks	1,830	5,363	-0,031	-0,069	0,529	1,188	-2,883	-9,900

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	5	-0,034	-0,012	0,022	0,164	-0,418	1,696	-1,330	1,929
	2	-0,167	5	-0,034	-0,011	0,019	0,167	-0,418	1,922	-1,389	2,156
	3	-0,491	5	-0,049	-0,008	0,077	0,184	-0,128	3,301	-1,408	3,819†
	4.1	0,423	12	-0,033	-0,035	0,070	0,278	0,085	0,647	-0,910	0,623
	4.2	0,423	5	-0,043	-0,019	0,071	0,216	0,085	0,647	-0,910	0,623

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	4	-0,037	-0,012	0,073	0,116	-0,224	0,010	-0,764	0,612
	2	-0,491	4	-0,039	-0,011	0,071	0,119	-0,224	0,059	-0,785	0,661
	3	-0,363	4	-0,048	-0,0003	0,040	0,204	-0,034	2,385	-1,345	3,397†
	4.1	-0,491	4	-0,047	-0,0002	0,057	0,210	0,068	1,461	-1,155	2,308
	4.2	-0,491	4	-0,047	-0,0002	0,057	0,210	0,068	1,461	-1,155	2,308
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	3	-0,164	-0,113	0,095	0,027	-0,323	5,162*	-1,696	0,019
	2	0,474	3	-0,165	-0,114	0,145	-0,012	-0,323	5,216	-1,837*	0,070
	3	-0,406	3	-0,238	-0,032	0,073	0,140	-0,188	11,142***	-3,323***	6,846†††
	4.1	-0,491	5	-0,217	-0,081	-0,126	0,181	-0,538	24,850***	-4,950***	14,132†††
	4.2	-0,491	3	-0,194	-0,057	-0,198	0,164	-0,538	24,850***	-4,950***	14,132†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	4	-0,103	-0,148	0,095	-0,017	-0,146	3,740	-1,803	0,601
	2	-0,244	4	-0,102	-0,149	0,104	-0,027	-0,146	3,890	-1,866**	0,747
	3	-0,406	4	-0,208	-0,020	0,096	-0,012	-0,068	12,636***	-3,371***	9,414†††
	4.1	-0,466	4	-0,211	-0,021	0,124	-0,009	0,060	12,392***	-3,352***	8,998†††
	4.2	-0,466	4	-0,211	-0,021	0,124	-0,009	0,060	12,392***	-3,352***	8,998†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Austria

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1972:3									
Two Breaks	+	-	1972:3	+	-	1989:4						
Three Breaks	-	+	1974:4	-	-	1981:1	+	-	1989:4			
Four Breaks	-	+	1967:3	-	-	1974:4	-	-	1981:1	+	-	1989:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	1,850	6,331						
Two Breaks	1,118	4,879	1,442	10,914				
Three Breaks	0,503	3,625	1,606	12,759	0,562	5,662		
Four Breaks	na	na	0,503	3,625	1,608	12,759	0,562	5,662

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1974:2									
Two Breaks	-	-	1974:2	+	-	1989:4						
Three Breaks	-	-	1974:4	-	-	1981:1	+	-	1989:4			
Four Breaks	-	-	1974:4	-	-	1980:2	0	+	1986:1	-	-	1992:3

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	2,071	9,505						
Two Breaks	1,388	7,715	1,280	10,336				
Three Breaks	0,503	3,625	1,606	12,759	0,562	5,662		
Four Breaks	0,493	3,367	1,454	9,930	0,103	0,738	0,736	6,383

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,051	-0,039	0,020	0,040	-0,057	4,912	-1,741	0,287
	2	0,442	1	-0,074	-0,028	0,016	0,042	-0,057	6,232*	-2,288**	1,569
	3	0,455	1	0,013	-0,070	0,069	0,033	-0,039	6,839*	-2,615***	2,172
	4.1	0,494	11	0,004	-0,010	-0,044	-0,137	-0,916	14,655***	-3,740***	4,157††
	4.2	0,494	1	-2,141*e^{-5}	-0,014	-0,034	-0,158	-0,916	14,655***	-3,740***	4,157††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,087	-0,085	0,103	-0,083	-0,111	9,041***	-2,227**	0,039
	2	0,481	1	-0,062	-0,110	0,098	-0,069	-0,111	9,777***	-2,749***	0,734
	3	0,481	1	-0,020	-0,133	0,096	0,121	-0,026	12,575***	-3,514***	4,193††
	4.1	0,474	12	-0,020	-0,007	-0,053	-0,456	-0,929	41,479***	-6,439***	12,828†††
	4.2	0,474	1	-0,053	-0,020	0,055	-0,433	-0,929	41,479***	-6,439***	12,828†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,153	-0,200	0,274	-0,318	-0,099	20,096***	-3,576***	0,829
	2	0,318	1	-0,121	-0,236	0,310	-0,330	-0,099	22,454***	-4,257***	2,921†
	3	0,481	1	2,738*e^{-5}	-0,296	0,356	0,012	-0,045	32,865***	-5,735***	12,981†††
	4.1	0,474	11	-0,088	-0,029	-0,460	-1,124	-0,929	67,492***	-8,116***	14,622†††
	4.2	0,474	1	-0,061	0,004	-0,071	-0,707	-0,929	67,492***	-8,116***	14,622†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	3	-0,203	-0,266	0,577	0,269	-0,098	20,625***	-3,626***	0,512
	2	0,377	3	-0,166	-0,295	0,573	0,295	-0,098	22,384***	-4,274***	2,065
	3	0,500	3	0,027	-0,318	0,724	0,398	-0,039	34,826***	-5,861***	13,913†††
	4.1	0,481	12	-0,077	-0,143	-0,462	-0,803	-0,929	79,467***	-8,752***	14,285†††
	4.2	0,481	1	-0,051	-0,080	-0,136	-0,675	-0,929	79,467***	-8,752***	14,285†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Belgium

	Log Real GDP all sample											
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	0	1995:1									
Two Breaks	+	+	1987:4	+	+	1995:1						
Three Breaks	0	+	1984:4	-	0	1992:4	+	0	1995:1			
Four Breaks	0	+	1984:4	-	0	1992:4	+	0	1995:1	-	-	2001:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-0,492	-1,850						
Two Breaks	-2,469	-8,314	0,485	2,067				
Three Breaks	-2,415	-4,876	0,604	1,349	-0,630	-1,467		
Four Breaks	-2,415	-4,949	0,604	1,369	-0,319	-0,706	-0,648	-1,958

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,075	-0,137	-0,099	-0,074	-0,702	8,919***	-2,598***	0,091
	2	-0,409	1	-0,058	-0,152	-0,090	-0,078	-0,702	9,241**	-2,755***	0,385
	3	-0,373	1	-0,076	-0,029	0,022	0,110	-0,145	2,718	-1,692*	0,830
	4.1	0,500	6	-0,001	-0,147	0,076	0,010	-0,391	5,544	-2,394***	1,868
	4.2	0,500	1	0,003	-0,125	-0,026	0,080	-0,391	5,544	-2,394***	1,868

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,046	-0,247	-0,128	-0,004	-0,618	11,467***	-2,939***	1,074
	2	-0,491	1	-0,035	-0,307	-0,125	0,014	-0,618	12,869***	-3,222***	2,339
	3	0,482	1	-0,061	-0,178	0,080	0,146	-0,291	5,976*	-2,387***	1,776
	4.1	0,427	1	-0,143	-0,059	0,077	-0,480	-0,900	26,451***	-5,113***	7,371†††
	4.2	0,427	1	-0,143	-0,059	0,077	-0,480	-0,900	26,451***	-5,113***	7,371†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	7	-0,085	-0,132	0,029	0,094	-0,477	5,599*	-2,018**	0,473
	2	-0,309	7	-0,083	-0,135	0,037	0,081	-0,477	6,026*	-2,206**	0,877
	3	-0,491	7	-0,117	-0,100	0,066	0,121	-0,136	3,965	-1,947**	1,056
	4.1	-0,045	8	-0,126	-0,109	0,068	0,177	0,091	2,587	-1,406	0,266
	4.2	-0,045	7	-0,111	-0,084	0,053	0,126	0,091	2,587	-1,406	0,266
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	7	-0,129	-0,113	-0,103	-0,054	-0,420	4,093	-1,605	0,134
	2	0,445	7	-0,122	-0,119	-0,112	-0,047	-0,420	4,610	-1,914**	0,631
	3	-0,491	7	-0,143	-0,101	-0,079	-0,001	-0,091	3,924	-1,912**	1,180
	4.1	-0,491	8	-0,175	-0,092	-0,072	0,012	-0,282	6,911*	-2,633***	3,556†
	4.2	-0,491	7	-0,166	-0,075	-0,093	-0,026	-0,282	6,911*	-2,633***	3,556†

***, **, * indicates the rejection of the null hypothesis of no cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Canada

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	0	-	1974:3									
Two Breaks	0	-	1973:4	-	+	1991:1						
Three Breaks	+	-	1966:1	-	-	1981:4	-	-	1990:4			
Four Breaks	+	-	1966:1	-	-	1981:4	-	-	1990:4	+	0	1999:1

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	3,442	13,664						
Two Breaks	3,397	11,384	-0,032	-0,116				
Three Breaks	0,706	1,735	3,545	10,695	-1,151	-3,512		
Four Breaks	0,706	2,071	3,545	12,767	0,307	0,959	-2,875	-8,851

VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,059	-0,058	0,046	-0,072	-0,399	5,484*	-1,981*	0,288
	2	-0,495	1	-0,055	-0,063	0,053	-0,084	-0,399	5,871	-2,171**	0,664
	3	0,478	1	-0,047	-0,077	0,107	-0,027	-0,204	4,367	-2,015**	0,815
	4.1	0,489	12	-0,024	-0,023	0,013	-0,249	-0,532	10,203***	-3,178***	3,667†
	4.2	0,489	1	-0,048	-0,043	0,069	-0,167	-0,532	10,203***	-3,178***	3,667†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,052	-0,046	-0,036	-0,017	-0,497	4,595	-1,841	0,207
	2	0,156	1	-0,053	-0,045	-0,036	-0,016	-0,497	4,617	-1,857	0,228
	3	-0,495	1	-0,054	-0,049	0,035	0,092	-0,156	2,948	-1,849	0,727
	4.1	-0,495	12	0,000	-0,004	-0,272	0,023	-0,935	26,630***	-5,155***	14,618†††
	4.2	-0,495	1	-0,018	-0,022	-0,267	0,038	-0,935	26,630***	-5,155***	14,618†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,053	-0,037	-0,022	-0,005	-0,240	2,638	-1,441	0,063
	2	-0,360	1	-0,056	-0,033	-0,021	-0,006	-0,240	2,680	-1,494	0,104
	3	-0,495	1	-0,069	-0,025	-0,090	0,146	-0,097	5,976*	-2,572***	3,699†
	4.1	-0,495	1	-0,018	-0,009	-0,292	0,040	-0,941	32,715***	-5,720***	17,548†††
	4.2	-0,495	1	-0,018	-0,009	-0,292	0,040	-0,941	32,715***	-5,720***	17,548†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,079	-0,053	0,031	0,006	-0,251	4,960	-1,729	0,062
	2	-0,360	1	-0,082	-0,051	0,031	0,005	-0,251	4,992	-1,774*	0,092
	3	-0,473	1	-0,122	-0,016	-0,040	0,104	-0,204	14,393***	-3,806***	9,298†††
	4.1	-0,495	6	-0,011	-0,044	-0,306	0,054	-0,941	36,454***	-6,041***	17,231†††
	4.2	-0,495	1	0,007	-0,025	-0,337	0,042	-0,941	36,454***	-6,041***	17,231†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.

†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Denmark

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	+	1994:4									
Two Breaks	+	-	1985:3	+	+	1994:2						
Three Breaks	-	0	1980:3	+	-	1985:3	+	+	1994:2			
Four Breaks	-	0	1980:3	+	-	1985:3	+	+	1994:1	-	0	2002:2

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-2,083	-8,723						
Two Breaks	-0,995	-2,299	-1,744	-6,635				
Three Breaks	na	na	-0,995	-2,299	-1,744	-6,635		
Four Breaks	na	na	-1,036	-2,378	-1,334	-4,506	-0,796	-2,353

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	0	1989:2									
Two Breaks	+	-	1985:4	+	+	1994:2						
Three Breaks	+	-	1985:4	+	+	1994:1	-	0	2002:2			
Four Breaks	+	-	1985:4	+	+	1994:1	+	-	2002:2	-	+	2003:2

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-0,438	-1,205						
Two Breaks	-0,836	-1,983	1,761	-6,595				
Three Breaks	-0,878	-2,068	-1,350	-4,495	-0,796	-2,337		
Four Breaks	-0,878	-2,175	-0,967	-3,144	-1,457	-3,576	0,286	0,653

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,033	-0,014	-0,053	0,047	-0,455	1,536	-1,398	0,536
	2	0,051	1	-0,034	-0,014	-0,055	0,049	-0,455	1,580	-1,419	0,581
	3	-0,490	1	-0,038	-0,006	0,017	0,215	-0,061	0,618	-1,391	2,272
	4.1	0,439	3	-0,033	-0,035	-0,003	0,228	0,102	-0,664	-0,863	0,053
	4.2	0,439	1	-0,026	-0,022	0,025	0,236	0,102	-0,664	-0,863	0,053

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,020	-0,034	-0,037	-0,064	-0,307	1,506	-1,133	0,147
	2	-0,439	1	-0,015	-0,041	-0,010	-0,102	-0,307	2,054	-1,465	0,687
	3	-0,490	1	-0,046	-0,011	0,012	0,057	-0,102	1,100	-1,237	0,834
	4.1	-0,490	3	-0,017	-0,018	-0,222	0,012	-0,827	12,328***	-3,381***	1,847
	4.2	-0,490	1	-0,004	-0,006	-0,291	-0,067	-0,827	12,328***	-3,381***	1,847
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,026	-0,046	-0,030	-0,063	-0,207	1,706	-1,221	0,234
	2	-0,490	1	-0,021	-0,053	-0,030	-0,063	-0,207	1,903	-1,344	0,428
	3	-0,459	1	-0,053	-0,010	-0,055	0,096	-0,031	1,965	-1,484	1,067
	4.1	0,490	8	-0,049	-0,144	0,057	-0,009	-0,439	7,124**	-2,672***	2,927†
	4.2	0,490	1	0,002	-0,071	-0,045	-0,191	-0,439	7,124**	-2,672***	2,927†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	3	-0,058	-0,073	0,004	0,021	-0,070	0,792	-0,777	0,0002
	2	0,316	3	-0,055	-0,076	0,010	0,014	-0,070	0,809	-0,802	0,017
	3	-0,408	3	-0,073	-0,054	0,007	0,027	-0,041	1,928	-1,483	1,104
	4.1	0,388	8	-0,090	-0,138	0,096	-0,025	-0,888	13,564***	-3,433***	2,256
	4.2	0,388	3	-0,034	-0,079	-0,065	-0,138	-0,888	13,564***	-3,433***	2,256

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Finland

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1991:3									
Two Breaks	+	-	1989:3	0	+	1992:4						
Three Breaks	+	-	1989:2	-	+	1993:2	-	-	2001:3			
Four Breaks	+	+	1978:4	+	-	1989:3	0	-	1993:2	-	-	2001:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	5,779	13,872						
Two Breaks	0,441	0,571	5,213	6,761				
Three Breaks	1,210	1,926	6,213	9,185	-4,536	-7,615		
Four Breaks	0,372	0,562	1,407	2,122	5,964	8,662	-4,536	-7,648

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,042	0,039	-0,050	-0,116	-0,571	2,731	-1,522	0,334
	2	0,338	1	-0,043	0,040	-0,060	-0,107	-0,571	3,016	-1,673*	0,614
	3	-0,492	1	-0,043	-0,005	0,027	0,052	-0,246	2,196	-1,310	2,210
	4.1	-0,492	3	0,103	-0,041	-0,580	0,108	-0,915	43,677***	-6,550***	29,742†††
	4.2	-0,492	1	0,119	-0,031	-0,592	0,104	-0,915	43,677***	-6,550***	29,742†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,063	0,006	-0,012	-0,018	-0,515	3,115	-1,801	1,074
	2	-0,492	1	-0,064	0,007	-0,013	-0,016	-0,515	3,280	-1,853**	1,237
	3	-0,492	1	-0,055	0,009	0,028	0,048	-0,054	2,879	-1,677*	1,658
	4.1	0,485	3	-0,075	0,021	0,033	-0,080	-0,638	2,929	-1,336	0,014
	4.2	0,485	1	-0,069	0,009	0,021	-0,081	-0,638	2,929	-1,336	0,014
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,080	-0,094	-0,002	-0,053	-0,515	7,704**	-2,207**	0,327
	2	0,485	1	-0,080	-0,093	0,003	-0,059	-0,515	7,740**	-2,237***	0,361
	3	-0,385	1	-0,126	-0,001	0,036	0,051	0,023	8,779**	-2,970***	3,538†
	4.1	0,500	3	-0,145	-0,006	0,013	-0,106	-0,677	9,357***	-2,457***	0,031
	4.2	0,500	1	-0,140	-0,007	0,003	-0,119	-0,677	9,357***	-2,457***	0,031
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	2	-0,086	-0,087	-0,017	-0,046	-0,291	6,047**	-1,854	0,100
	2	0,360	2	-0,086	-0,088	-0,013	-0,051	-0,291	6,060*	-1,872**	0,113
	3	-0,384	2	-0,139	-0,005	-0,004	-0,003	0,078	8,623**	-2,937***	4,112††
	4.1	0,500	4	-0,160	-0,030	-0,008	-0,156	-0,783	11,148***	-2,406***	0,120
	4.2	0,500	2	-0,138	-0,009	-0,009	-0,148	-0,783	11,148***	-2,406***	0,120

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.

†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

France

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	0	1988:1									
Two Breaks	+	-	1988:3	+	+	1998:2						
Three Breaks	+	+	1988:1	-	0	1992:4	+	-	1999:3			
Four Breaks	0	+	1987:1	0	-	1990:2	0	+	1996:4	-	-	2001:2

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0.626	2.370						
Two Breaks	1,027	3,903	-0,857	-3,783				
Three Breaks	-0,195	-1,074	2,179	12,825	-2,015	-13,591		
Four Breaks	0,260	0,767	1,047	3,398	0,667	0,239	-1,253	-4,471

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1992:4									
Two Breaks	+	-	1989:1	+	+	1998:2						
Three Breaks	+	-	1988:3	-	+	1993:1	+	-	1999:4			
Four Breaks	0	+	1987:1	0	-	1990:2	0	+	1996:4	-	-	2001:2

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0,986	4,931						
Two Breaks	1,080	4,224	-0,911	-4,018				
Three Breaks	-0,210	1,174	2,173	12,683	-2,054	-13,859		
Four Breaks	0,260	0,767	1,047	3,398	0,667	0,239	-1,253	-4,471

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,042	-0,042	0,045	0,162	-0,493	1,067	-1,083	1,119
	2	-0,296	1	-0,036	-0,048	0,007	0,201	-0,493	2,253	-1,412	2,306
	3	-0,367	1	-0,053	-0,050	0,090	0,257	-0,224	1,984	-1,351	1,591
	4.1	0,500	4	-0,016	-0,045	0,020	0,338	0,102	4,927	-2,240**	2,289
	4.2	0,500	1	-0,020	-0,067	0,018	0,295	0,102	4,927	-2,240**	2,289

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,045	-0,091	-0,154	-0,053	-0,585	6,952**	-2,129**	0,202
	2	0,480	1	-0,040	-0,094	-0,180	-0,032	-0,585	7,164**	-2,236**	0,399
	3	0,490	1	-0,038	-0,073	0,099	0,051	-0,082	5,310	-2,345***	1,803
	4.1	0,469	4	-0,051	-0,048	0,243	-0,462	-0,888	38,248***	-6,040***	23,946†††
	4.2	0,469	1	-0,054	-0,057	0,191	-0,485	-0,888	38,248***	-6,040***	23,946†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,206	-0,321	-0,087	0,170	-0,467	14,778***	-2,839***	0,027
	2	0,449	1	-0,110	-0,338	-0,434	0,265	-0,467	15,776***	-2,875***	0,891
	3	0,418	1	-0,045	-0,372	0,292	0,088	-0,367	29,024***	-5,322***	12,544†††
	4.1	0,490	1	-0,218	-0,100	0,522	-0,469	-0,878	43,919***	-6,378***	19,870†††
	4.2	0,490	1	-0,218	-0,100	0,522	-0,469	-0,878	43,919***	-6,378***	19,870†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,027	-0,108	0,003	-0,010	-0,445	5,707*	-2,332**	0,967
	2	-0,439	1	-0,030	-0,107	0,034	-0,034	-0,445	5,830	-2,360***	1,084
	3	0,418	1	-0,019	-0,093	0,067	0,024	0,000	5,736	-2,442***	1,713
	4.1	0,500	10	-0,081	-0,180	0,046	-0,110	-0,622	8,828***	-2,992***	3,333†
	4.2	0,500	1	-0,010	-0,112	0,031	-0,057	-0,622	8,828***	-2,992***	3,333†

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Italy

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1990:3									
Two Breaks	-	-	1982:1	+	-	1988:2						
Three Breaks	-	-	1982:1	-	-	1992:2	+	-	2000:1			
Four Breaks	-	-	1974:4	-	-	1982:1	-	-	1992:2	+	-	2000:1

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0,840	2,833						
Two Breaks	na	na	1,154	3,674				
Three Breaks	na	na	2,135	9,035	-2,471	-9,771		
Four Breaks	na	na	na	na	2,135	9,035	-2,471	-9,771

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1988:4									
Two Breaks	-	-	1992:2	+	-	2000:1						
Three Breaks	+	-	1988:4	-	0	1992:4	+	-	2000:1			
Four Breaks*	0	+	1983:1	+	-	1989:4	-	0	1992:4	+	-	2000:1

*trend is not significant

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	1,099	3,527						
Two Breaks	2,135	9,035	-2,471	-9,771				
Three Breaks	0,716	2,437	1,810	6,283	-2,601	-10,800		
Four Breaks	2,195	4,096	0,047	0,155	2,062	6,824	-2,601	-11,344

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	4	-0,033	0,029	0,081	0,097	-0,034	2,118	-1,419	2,312
	2	-0,391	4	-0,036	0,033	0,083	0,094	-0,034	2,566	-1,523	2,761†
	3	-0,470	4	-0,038	0,039	0,089	0,091	-0,010	3,989	-1,780*	4,194††
	4.1	-0,490	10	-0,054	0,048	0,028	0,144	-0,465	7,034**	-2,001**	7,660†††
	4.2	-0,490	4	-0,053	0,044	0,040	0,054	-0,465	7,034**	-2,001**	7,660†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,107	-0,070	0,115	0,125	0,002	4,319	-1,623	0,130
	2	-0,351	1	-0,115	-0,062	0,115	0,125	0,002	4,513	-1,784*	0,317
	3	-0,351	1	-0,086	-0,049	0,010	0,059	-0,327	2,757	-1,614*	0,713
	4.1	0,391	11	-0,135	-0,062	0,023	-0,252	-0,891	4,714	-2,063**	1,017
	4.2	0,391	1	-0,050	-0,023	-0,002	-0,123	-0,891	4,714	-2,063**	1,017
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,104	-0,059	0,052	0,047	-0,130	3,408	-1,615	0,254
	2	0,431	1	-0,116	-0,050	0,044	0,055	-0,130	3,743	-1,780*	0,578
	3	-0,490	1	-0,110	-0,026	-0,029	0,064	-0,297	4,876	-2,214**	2,144
	4.1	0,480	4	-0,083	-0,036	0,133	-0,229	-0,792	10,261***	-3,205***	5,119††
	4.2	0,480	4	-0,083	-0,036	0,133	-0,229	-0,792	10,261***	-3,205***	5,119††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	4	-0,116	-0,022	0,111	-0,097	0,006	4,009	-1,864	0,562
	2	-0,490	4	-0,132	0,007	0,113	-0,119	0,006	4,849	-2,187**	1,374
	3	0,500	4	-0,097	-0,042	0,162	-0,160	-0,317	3,412	-1,828*	0,571
	4.1	0,500	5	-0,094	-0,021	0,076	-0,188	-0,624	5,701	-2,397***	1,671
	4.2	0,500	4	-0,094	-0,034	0,122	-0,175	-0,624	5,701	-2,397***	1,671

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Japan

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1990:2									
Two Breaks	0	+	1983:4	0	-	1991:2						
Three Breaks	0	+	1983:4	0	-	1991:2	-	0	1998:1			
Four Breaks	0	+	1983:3	0	-	1991:2	-	0	1998:1	-	0	2001:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	1,306	7,461						
Two Breaks	0,233	0,893	1,368	7,504				
Three Breaks	0,233	1,768	0,281	2,543	1,858	17,699		
Four Breaks	0,233	1,776	0,281	2,554	1,735	12,684	0,195	1,401

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,026	-0,037	-0,015	-0,125	-0,160	3,308	-1,639	0,170
	2	0,473	1	-0,029	-0,035	0,060	-0,168	-0,160	3,687	-1,855**	0,539
	3	0,500	1	0,000	-0,037	0,016	0,067	0,036	2,599	-1,650*	1,326
	4.1	-0,491	7	-0,011	-0,057	-0,413	-0,116	-0,591	15,358***	-3,253***	0,860
	4.2	-0,491	1	-0,009	-0,049	-0,352	-0,155	-0,591	15,358***	-3,253***	0,860

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,034	-0,021	-0,095	-0,122	-0,232	4,569	-1,612	0,173
	2	0,291	1	-0,045	-0,015	-0,120	-0,108	-0,232	4,921	-1,841*	0,511
	3	0,400	1	0,0004	-0,048	0,030	0,0003	0,000	2,780	-1,674*	1,235
	4.1	0,500	9	-0,075	-0,031	0,322	-0,340	-0,464	14,932***	-3,873***	3,454†
	4.2	0,500	1	-0,043	-0,010	0,309	-0,384	-0,464	14,932***	-3,873***	3,454†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,147	-0,049	-0,132	-0,246	-0,118	9,168***	-2,621***	0,552
	2	-0,327	1	-0,158	-0,023	-0,172	-0,203	-0,118	9,848***	-2,920***	1,182
	3	0,245	1	0,047	-0,212	-0,079	0,056	-0,036	14,650***	-3,794***	8,056†††
	4.1	0,500	3	-0,005	-0,085	-0,050	-0,667	-0,664	50,614***	-7,054***	11,191†††
	4.2	0,500	1	0,027	-0,060	-0,190	-0,809	-0,664	50,614***	-7,054***	11,191†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,134	-0,047	-0,205	-0,228	-0,147	9,905***	-2,702***	0,533
	2	0,191	1	-0,145	-0,039	-0,268	-0,162	-0,147	10,576***	-2,925***	1,150
	3	0,182	1	0,050	-0,184	-0,066	0,100	-0,036	12,070***	-3,446***	6,6150††
	4.1	0,400	3	-0,072	-0,054	-0,067	-0,606	-0,882	56,651***	-7,379***	4,506††
	4.2	0,400	1	-0,043	-0,020	-0,191	-0,690	-0,882	56,651***	-7,379***	4,506††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Netherlands

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1982:2									
Two Breaks	-	+	1982:2	+	-	1999:1						
Three Breaks	-	+	1982:2	-	+	1993:4	-	-	2001:4			
Four Breaks	+	-	1979:3	+	+	1983:2	-	+	1993:4	-	-	2001:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	na	na						
Two Breaks	na	na	-3,153	-11.908				
Three Breaks	na	na	-2,435	-7,781	-0,873	-2,383		
Four Breaks	na	na	-1,811	-1,341	-2,393	-7,640	-0,873	-2,393

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1999:1									
Two Breaks	-	+	1993:4	-	-	2001:4						
Three Breaks	-	+	1993:4	0	-	2001:1	0	+	2003:4			
Four Breaks	-	+	1988:1	0	-	1991:1	-	+	1993:4	-	-	2001:4

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-3,153	-11,908						
Two Breaks	-2,435	-7,781	-0,873	-2,383				
Three Breaks	-2,180	-7,324	-2,138	-4,874	1,434	2,916		
Four Breaks	-1,763	-4,365	-0,923	-2,001	-0,927	-2,399	-0,873	-2,888

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,053	-0,104	-0,048	0,172	-0,268	3,060	-1,356	0,014
	2	-0,490	1	-0,045	-0,119	-0,065	0,208	-0,268	3,118	-1,334	0,070
	3	-0,490	1	-0,143	0,050	0,086	0,009	-0,194	12,242***	-3,333***	8,843†††
	4.1	-0,316	12	-0,320	0,019	0,312	-0,081	0,102	20,180***	-4,350***	15,103†††
	4.2	-0,316	1	-0,173	0,053	0,216	-0,003	0,102	20,180***	-4,350***	15,103†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,065	-0,059	-0,040	-0,033	-0,247	3,092	-1,309	0,008
	2	0,418	1	-0,063	-0,061	-0,048	-0,024	-0,247	3,113	-1,370	0,028
	3	-0,490	1	-0,090	-0,016	0,005	0,019	0,082	3,801	-2,077**	1,642
	4.1	-0,490	4	-0,160	-0,009	-0,197	0,050	-0,878	15,830***	-3,978***	5,967††
	4.2	-0,490	1	-0,110	0,002	-0,192	0,003	-0,878	15,830***	-3,978***	5,967††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,077	-0,061	-0,057	-0,006	-0,129	2,724	-1,383	0,029
	2	-0,235	1	-0,079	-0,059	-0,059	-0,004	-0,129	2,741	-1,414	0,045
	3	-0,347	1	-0,108	-0,027	-0,034	0,024	0,061	3,979	-2,102**	1,362
	4.1	-0,490	11	-0,207	-0,044	-0,195	-0,090	-0,582	8,978**	-3,007***	3,465†
	4.2	-0,490	1	-0,123	0,018	-0,119	-0,047	-0,582	8,978**	-3,007***	3,465†

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,052	-0,074	-0,028	-0,080	-0,308	3,951	-1,756	0,352
	2	-0,408	1	-0,048	-0,078	-0,030	-0,080	-0,308	4,058	-1,808*	0,456
	3	-0,490	1	-0,095	-0,012	0,044	-0,049	0,051	3,927	-2,025**	1,955
	4.1	-0,469	6	-0,148	-0,047	-0,185	0,214	-0,735	24,550***	-4,837***	14,056†††
	4.2	-0,469	1	-0,105	0,010	-0,253	0,138	-0,735	24,550***	-4,837***	14,056†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

New Zealand

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1977:4									
Two Breaks	-	-	1974:4	-	+	1990:4						
Three Breaks	-	+	1967:3	-	-	1974:4	-	+	1990:4			
Four Breaks	-	+	1968:2	-	-	1969:2	-	-	1974:4	-	+	1990:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	4,283	9,828						
Two Breaks	2,284	4,426	3,122	9,044				
Three Breaks	na	na	2,284	4,426	3,122	9,044		
Four Breaks	na	na	na	na	2,284	4,426	3,122	9,044

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1991:1									
Two Breaks	-	-	1974:4	-	+	1990:4						
Three Breaks	-	-	1974:4	-	0	1984:1	-	+	1991:1			
Four Breaks	+	-	1972:2	+	+	1973:1	+	+	1983:3	-	+	1991:1

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	3,540	10,047						
Two Breaks	2,284	4,426	3,122	9,044				
Three Breaks	0,961	1,991	3,262	7,613	1,148	2.976		
Four Breaks	0,335	0,297	0,431	0,427	3,515	8,690	1,183	3,174

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	2	-0,024	-0,002	0,049	-0,047	-0,033	1,216	-1,094	0,264
	2	-0,493	2	-0,025	-0,001	0,047	-0,043	-0,033	1,301	-1,141	0,349
	3	-0,387	2	-0,026	0,002	0,052	0,002	-0,007	1,608	-1,266	0,805
	4.1	0,380	12	0,002	-0,019	-0,115	-0,241	-0,927	42,859***	-5,037***	0,020
	4.2	0,380	3	-0,005	-0,012	-0,241	-0,378	-0,927	42,859***	-5,037***	0,020
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	2	-0,027	-0,009	0,027	0,128	-0,046	0,917	-1,094	0,371
	2	-0,493	2	-0,027	-0,009	0,025	0,130	-0,046	1,021	-1,145	0,474
	3	-0,293	2	-0,030	-0,004	0,068	0,119	-0,013	1,044	-1,154	0,640
	4.1	-0,493	10	-0,010	-0,024	-0,265	0,308	-0,627	44,414***	-5,621***	1,136
	4.2	-0,493	10	-0,010	-0,024	-0,265	0,308	-0,627	44,414***	-5,621***	1,136
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	10	-0,066	-0,021	0,184	0,280	-0,045	1,985	-1,500	0,966
	2	-0,420	10	-0,067	-0,020	0,181	0,282	-0,045	2,239	-1,574	1,218
	3	-0,493	10	-0,068	-0,019	0,219	0,251	0,000	2,793	-1,659*	2,116
	4.1	-0,487	12	-0,059	-0,002	-0,198	0,195	-0,707	66,735***	-6,524***	0,555
	4.2	-0,487	10	-0,056	-0,004	-0,160	0,314	-0,707	66,735***	-6,524***	0,555
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	2	-0,051	0,007	-0,016	0,067	-0,046	2,622	-1,694	1,162
	2	-0,400	2	-0,053	0,010	-0,033	0,098	-0,046	2,880	-1,763*	1,418
	3	0,407	2	-0,001	-0,073	0,071	0,045	0,007	3,995	-2,053**	2,967†
	4.1	-0,493	11	-0,026	-0,081	-0,275	-0,062	-0,860	58,904***	-6,157***	0,694
	4.2	-0,493	2	0,002	-0,042	-0,508	-0,254	-0,860	58,904***	-6,157***	0,694

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.

†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Norway

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	0	1995:3									
Two Breaks	0	+	1993:3	-	-	1998:3						
Three Breaks	+	0	1984:3	0	+	1991:4	-	-	1998:3			
Four Breaks	-	+	1982:1	-	-	1987:3	+	+	1993:3	-	-	1998:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0,147	0,527						
Two Breaks	1,547	4,317	-1,246	-3,204				
Three Breaks	1,382	4,714	1,685	5,801	-1,644	-5,946		
Four Breaks	0,875	2,882	2,487	9,121	-0,202	-0,723	-1,246	-4,836

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	2	-0,018	-0,058	0,010	0,089	-0,242	3,937	-1,786	0,653
	2	0,364	2	-0,016	-0,061	0,014	0,082	-0,242	4,209	-1,905*	0,918
	3	0,466	2	-0,014	-0,045	0,050	0,150	-0,008	2,508	-1,544	0,817
	4.1	0,466	10	-0,002	-0,068	0,076	-0,146	-0,542	18,244***	-4,276***	9,822†††
	4.2	0,466	2	-0,011	-0,072	0,086	-0,194	-0,542	18,244***	-4,276***	9,822†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	2	-0,033	-0,072	0,016	0,089	-0,328	6,591**	-2,342**	1,319
	2	0,449	2	-0,031	-0,076	0,015	0,089	-0,328	7,113**	-2,508***	1,818
	3	0,458	2	-0,024	-0,064	0,067	0,142	-0,017	3,194	-1,704*	0,979
	4.1	-0,492	9	-0,061	-0,080	-0,066	0,326	-0,305	4,920	-1,928**	0,062
	4.2	-0,492	2	-0,042	-0,056	-0,050	0,253	-0,305	4,920	-1,928**	0,062
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	2	-0,072	-0,094	-0,002	0,001	-0,237	6,809**	-1,864	0,018
	2	0,381	2	-0,069	-0,098	0,013	-0,019	-0,237	6,911*	-1,988**	0,115
	3	-0,492	2	-0,071	-0,059	0,102	0,068	0,051	3,274	-1,748*	0,611
	4.1	0,076	12	-0,012	-0,167	-0,341	-0,403	-0,898	40,074***	-5,973***	6,772†††
	4.2	0,076	1	-0,015	-0,217	-0,145	-0,333	-0,898	40,074***	-5,973***	6,772†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,075	-0,126	-0,012	0,069	-0,198	6,270**	-2,052*	0,025
	2	0,441	1	-0,063	-0,132	0,010	0,053	-0,198	6,464*	-2,259**	0,210
	3	0,483	1	-0,031	-0,141	0,159	0,078	-0,051	6,322*	-2,509***	1,579
	4.1	0,500	9	-0,081	-0,217	0,251	-0,108	-0,364	15,186***	-3,897***	4,576††
	4.2	0,500	1	-0,017	-0,146	0,149	-0,133	-0,364	15,186***	-3,897***	4,576††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Portugal

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	0	1988:4									
Two Breaks	+	+	1988:4	+	-	2000:1						
Three Breaks	-	+	1984:1	-	-	1993:1	+	-	2000:3			
Four Breaks	0	-	1980:4	+	+	1986:2	-	-	1992:4	+	-	200:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-0,593	-2,994						
Two Breaks	-0,831	-3,872	0,620	2,559				
Three Breaks	0,335	1,209	-0,419	-1,608	0,582	2,061		
Four Breaks	0,836	2,204	-0,707	-2,377	-0,122	-0,448	0.630	2,305

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	2	-0,040	-0,050	-0,465	-0,463	-0,256	12,469***	-3,077***	0,219
	2	0,422	2	-0,034	-0,056	-0,417	-0,504	-0,256	12,692***	-3,240***	0,420
	3	0,466	2	-0,012	-0,077	0,103	0,028	-0,060	4,265	-2,160**	6,254††
	4.1	0,466	5	0,007	0,032	-0,004	-1,317	-0,457	35,048***	-5,920***	11,462†††
	4.2	0,466	2	-0,002	-0,003	0,048	-0,982	-0,457	35,048***	-5,920***	11,462†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	2	-0,018	-0,071	0,009	-0,111	-0,217	3,847	-2,349**	2,456
	2	0,431	2	-0,007	-0,077	0,043	-0,132	-0,217	4,603	-2,491***	3,203†
	3	0,457	2	-0,012	-0,080	0,246	0,058	-0,060	3,614	-1,991**	5,022††
	4.1	0,500	8	0,001	0,028	-0,089	-0,709	-0,716	30,641***	-5,577***	13,828†††
	4.2	0,500	2	-0,015	0,012	0,010	-0,607	-0,716	30,641***	-5,577***	13,828†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	2	-0,008	-0,071	-0,086	-0,113	-0,193	2,503	-1,817	1,552
	2	0,379	2	-0,005	-0,072	-0,080	-0,117	-0,193	2,743	-1,875**	1,790
	3	0,414	2	-0,016	-0,063	0,029	0,001	-0,017	1,714	-1,405	2,162
	4.1	-0,405	2	-0,014	-0,020	-0,563	0,116	-0,905	39,622***	-6,322***	15,510†††
	4.2	-0,405	1	-0,008	-0,006	-0,582	0,071	-0,905	39,622***	-6,322***	15,510†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	2	-0,028	-0,069	-0,002	-0,156	-0,265	3,226	-1,897	1,325
	2	0,353	2	-0,026	-0,070	0,000	-0,155	-0,265	3,461	-1,961**	1,556
	3	0,457	2	-0,020	-0,070	0,093	-0,043	-0,026	2,089	-1,495	2,238
	4.1	-0,491	12	-0,068	-0,113	-0,444	0,241	-0,888	45,958***	-6,775***	20,615†††
	4.2	-0,491	2	-0,029	-0,042	-0,631	0,098	-0,888	45,958***	-6,775***	20,615†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Spain

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1993:1									
Two Breaks	+	+	1987:1	-	0	1992:4						
Three Breaks	0	+	1985:2	+	-	1990:4	-	+	1993:1			
Four Breaks	0	+	1985:2	+	-	1990:4	-	+	1993:1	+	-	1999:3

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-1,014	-1,606						
Two Breaks	0,150	0,160	-1,018	-1,244				
Three Breaks	2,594	2,633	-2,073	-1,622	-0,347	-0,300		
Four Breaks	2,594	4,396	-2,703	-2,680	3,517	4,650	-7,005	-13,569

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,023	0,001	-0,022	0,046	-0,883	3,006	-1,715	2,537
	2	-0,491	1	-0,023	0,001	-0,027	0,051	-0,883	3,864	-1,881**	3,391†
	3	0,427	1	-0,019	-0,005	0,013	0,077	-0,064	0,987	-0,849	0,070
	4.1	-0,491	9	-0,021	-0,001	0,037	0,037	0,091	1,729	-1,117	0,092
	4.2	-0,491	1	-0,020	-0,003	0,020	0,074	0,091	1,729	-1,117	0,092
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,022	-0,016	-0,033	0,008	-0,818	2,334	-1,273	0,060
	2	0,391	1	-0,022	-0,015	-0,033	0,008	-0,818	2,339	-1,280	0,065
	3	0,073	1	-0,019	-0,008	-0,005	0,049	0,055	1,325	-1,045	0,169
	4.1	-0,418	2	-0,033	-0,002	-0,055	0,048	-0,900	5,410	-2,326***	2,721†
	4.2	-0,418	1	-0,032	-0,004	-0,068	0,044	-0,900	5,410	-2,326***	2,721†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,023	-0,010	-0,019	0,023	-0,655	1,187	-1,019	0,145
	2	0,464	1	-0,023	-0,010	-0,019	0,023	-0,655	1,247	-1,067	0,204
	3	-0,491	1	-0,025	-0,006	-0,007	0,036	0,091	0,730	-0,743	0,030
	4.1	-0,491	4	-0,054	0,003	-0,039	0,039	-0,900	4,462	-2,066**	2,940†
	4.2	-0,491	1	-0,037	0,009	-0,037	0,040	-0,900	4,462	-2,066**	2,940†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,067	-0,177	-0,0001	0,042	-0,379	10,053***	-2,989***	1,389
	2	0,500	1	-0,067	-0,176	0,009	0,033	-0,379	10,201***	-3,033***	1,526
	3	-0,327	1	-0,221	-0,025	0,045	0,012	-0,218	13,461***	-3,622***	4,394††
	4.1	-0,491	8	-0,288	0,046	-0,039	-0,108	-0,900	17,526***	-4,197***	7,637†††
	4.2	-0,491	1	-0,196	0,004	-0,030	0,037	-0,900	17,526***	-4,197***	7,637†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Sweden

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1992:2									
Two Breaks	0	-	1990:1	0	+	1993:3						
Three Breaks*	0	+	1982:1	0	-	1990:1	0	+	1993:3			
Four Breaks*	0	+	1982:1	0	-	1990:1	0	+	1993:1	-	+	2002:3

*trend is not significant

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	4,670	15,340						
Two Breaks	1,597	2,938	3,124	6,293				
Three Breaks	na	na	1,597	2,938	3,124	6,293		
Four Breaks	na	na	0,895	1,804	4,371	9,174	-1,473	-3,706

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1992:2									
Two Breaks	0	-	1990:1	0	+	1993:3						
Three Breaks	0	-	1990:1	-	+	1993:1	-	+	2002:3			
Four Breaks	0	-	1990:1	-	+	1993:2	-	0	1996:2	-	-	2001:2

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	4,670	15,340						
Two Breaks	1,597	2,938	3,124	6,293				
Three Breaks	0,895	1,804	4,371	9,174	-1,473	-3,706		
Four Breaks	1,221	2,829	5,384	10,457	-1,382	-2,944	-1,735	-4,498

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,045	-0,092	-0,008	0,120	-0,469	2,318	-1,089	0,001
	2	0,327	1	-0,040	-0,095	-0,025	0,135	-0,469	2,343	-1,172	0,025
	3	-0,439	1	-0,070	-0,076	-0,009	0,194	-0,357	3,351	-1,839*	1,373
	4.1	-0,490	6	-0,017	-0,123	-0,198	0,164	-0,888	13,823***	-3,719***	7,047†††
	4.2	-0,490	1	-0,001	-0,075	-0,251	0,108	-0,888	13,823***	-3,719***	7,047†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,061	-0,042	0,007	0,043	-0,413	2,279	-1,290	0,081
	2	-0,388	1	-0,060	-0,043	-0,002	0,053	-0,413	2,321	-1,337	0,123
	3	-0,286	1	-0,069	-0,017	0,016	0,069	-0,122	2,545	-1,639*	0,841
	4.1	-0,490	5	-0,097	-0,030	0,032	0,092	0,102	2,365	-1,590	0,638
	4.2	-0,490	1	-0,065	-0,009	0,031	0,074	0,102	2,365	-1,590	0,638
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,101	-0,046	-0,031	-0,018	-0,441	4,432	-1,794	0,382
	2	-0,469	1	-0,101	-0,046	-0,035	-0,015	-0,441	4,472	-1,819*	0,420
	3	0,459	1	0,011	-0,118	-0,022	0,032	-0,082	6,603*	-2,569***	3,265†
	4.1	-0,459	4	-0,142	-0,006	-0,169	0,067	-0,878	18,117***	-4,231***	10,617†††
	4.2	-0,459	1	-0,128	0,007	-0,167	0,048	-0,878	18,117***	-4,231***	10,617†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,171	-0,064	-0,001	-0,027	-0,279	7,481**	-2,512**	0,842
	2	-0,480	1	-0,181	-0,052	-0,013	-0,014	-0,279	8,174**	-2,730***	1,490
	3	0,398	1	0,052	-0,228	-0,019	0,053	0,071	16,801***	-4,020***	10,320†††
	4.1	-0,398	4	-0,275	-0,038	-0,141	0,080	-0,847	22,880***	-4,754***	10,780†††
	4.2	-0,398	1	-0,198	0,023	-0,149	0,056	-0,847	22,880***	-4,754***	10,780†††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

Switzerland

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1992:4									
Two Breaks	+	-	1989:2	+	+	1997:2						
Three Breaks*	-	+	1982:4	+	-	1989:4	+	+	1997:2			
Four Breaks*	-	+	1982:4	+	-	1989:4	+	+	1997:2	-	+	2002:4

*trend is not significant

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	2,641	21,858						
Two Breaks	1,986	9,388	0,810	4,029				
Three Breaks	0,475	1,421	2,045	9,848	0,666	3,508		
Four Breaks	0,475	1,541	2,045	10,675	0,206	1,010	0,991	4,341

T-VECM Estimation results

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,186	-0,046	0,281	-0,057	-0,188	5,680*	-2,258	0,691
	2	0,481	1	-0,206	-0,039	0,270	-0,004	-0,188	6,680*	-2,523***	1,646
	3	0,377	1	0,134	-0,307	-0,164	0,300	-0,217	25,112***	-4,687***	19,467†††
	4.1	0,500	1	0,146	-0,319	-0,142	0,579	-0,028	37,880***	-5,723***	29,290†††
	4.2	0,500	1	0,146	-0,319	-0,142	0,579	-0,028	37,880***	-5,723***	29,290†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,076	-0,083	-0,058	-0,148	-0,239	5,871*	-1,997*	0,014
	2	0,491	1	-0,053	-0,094	0,023	-0,182	-0,239	6,553*	-2,457***	0,659
	3	0,481	1	-0,020	-0,064	0,112	0,050	0,094	3,129	-1,764*	0,737
	4.1	0,491	10	-0,063	-0,153	0,181	-0,398	-0,858	28,767***	-5,349***	10,377†††
	4.2	0,491	1	-0,004	-0,091	0,003	-0,422	-0,858	28,767***	-5,349***	10,377†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,082	-0,123	-0,003	-0,053	-0,308	7,188**	-2,389**	0,239
	2	0,151	1	-0,068	-0,131	0,006	-0,058	-0,308	7,534**	-2,555***	0,563
	3	0,500	1	-0,018	-0,092	0,143	0,081	0,057	4,062	-2,008**	0,999
	4.1	0,472	7	-0,023	-0,130	0,236	-0,383	-0,764	35,468***	-5,785***	18,326†††
	4.2	0,472	1	-0,029	-0,139	0,238	-0,372	-0,764	35,468***	-5,785***	18,326†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,054	-0,131	-0,024	-0,061	-0,262	6,995**	-2,492**	0,705
	2	0,491	1	-0,047	-0,130	0,024	-0,085	-0,262	7,493**	-2,673***	1,174
	3	0,500	1	-0,009	-0,119	0,134	0,058	0,009	5,289	-2,307**	1,677
	4.1	-0,491	1	-0,012	-0,188	-0,444	-0,059	-0,896	22,697***	-4,004***	0,567
	4.2	-0,491	1	-0,012	-0,188	-0,444	-0,059	-0,896	22,697***	-4,004***	0,567

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.

†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

United Kingdom

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	-	1980:2									
Two Breaks	-	+	1980:2	-	-	1991:1						
Three Breaks	-	-	1974:4	-	+	1980:4	-	-	1990:4			
Four Breaks	+	+	1959:3	-	-	1974:4	-	+	1980:4	-	-	1990:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	3,279	8,229						
Two Breaks	5,043	13,273	-2,913	-8,773				
Three Breaks	1,402	2,623	4,612	10,998	-3,113	-9,594		
Four Breaks	na	na	1,402	2,623	4,612	10,998	-3,113	-9,594

Log Real GDP only unemployment sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	-	+	1980:3									
Two Breaks	-	+	1980:4	-	-	1990:4						
Three Breaks	-	-	1974:1	-	+	1980:4	-	-	1990:4			
Four Breaks	-	-	1974:1	-	+	1980:4	+	-	1988:1	+	+	1993:4

	Unemployment adjustment only unemployment sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	3,253	8,239						
Two Breaks	5,15	13,814	-3,113	-9,403				
Three Breaks	1,128	1,983	4,804	11,758	-3,113	-9,499		
Four Breaks	1,128	2,617	5,688	17,114	-2,245	-6,471	-2,327	-7,542

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	8	-0,020	-0,003	0,047	-0,018	-0,288	0,676	-0,788	0,122
	2	-0,425	8	-0,020	-0,002	0,048	-0,019	-0,288	0,827	-0,909	0,273
	3	-0,479	8	-0,018	-0,010	0,047	0,007	-0,171	0,364	-0,665	0,157
	4.1	0,493	12	-0,016	0,008	0,028	-0,082	-0,616	2,953	-1,453	0,222
	4.2	0,493	8	-0,014	0,008	0,039	-0,083	-0,616	2,953	-1,453	0,222

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,021	-0,087	-0,072	-0,069	-0,386	8,111***	-2,657***	1,314
	2	-0,377	1	-0,020	-0,087	-0,065	-0,076	-0,386	8,340**	-2,721***	1,533
	3	-0,493	1	-0,056	-0,048	-0,154	0,212	-0,089	4,339	-1,967**	0,653
	4.1	-0,493	9	-0,128	-0,044	-0,240	0,186	-0,788	30,775***	-5,550***	13,343†††
	4.2	-0,493	1	-0,067	-0,015	-0,335	0,050	-0,788	30,775***	-5,550***	13,343†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,008	-0,088	-0,111	-0,075	-0,482	8,029**	-2,571***	0,890
	2	0,219	1	-0,007	-0,089	-0,108	-0,077	-0,482	8,140**	-2,611***	0,996
	3	-0,356	1	-0,063	-0,037	-0,143	0,186	-0,089	4,645	-2,139**	1,408
	4.1	-0,493	8	-0,136	-0,040	-0,232	0,215	-0,705	33,073***	-5,688***	19,408†††
	4.2	-0,493	1	-0,077	-0,004	-0,350	0,103	-0,705	33,073***	-5,688***	19,408†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	8	-0,090	-0,147	-0,026	0,123	-0,449	4,884	-1,734	4,87*e^{-5}
	2	-0,295	8	-0,093	-0,141	-0,023	0,119	-0,449	4,972	-1,917**	0,085
	3	0,500	8	-0,064	-0,180	0,028	0,085	-0,288	9,106**	-3,019***	4,653††
	4.1	0,479	12	-0,060	-0,188	0,017	0,246	-0,062	11,480***	-3,375***	5,313††
	4.2	0,479	8	-0,060	-0,186	-0,014	0,207	-0,062	11,480***	-3,375***	5,313††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

United States of America

Log Real GDP all sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1965:3									
Two Breaks	-	0	1957:4	+	-	1965:4						
Three Breaks	-	0	1950:3	-	+	1958:1	+	-	1965:4			
Four Breaks	-	0	1957:4	+	-	1965:4	+	-	1978:2	+	+	1983:4

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	0,979	4,788						
Two Breaks	1,455	4,419	0,196	0,736				
Three Breaks	-1,138	-2,278	1,748	4,986	0,171	0,267		
Four Breaks	1,455	4,890	-0,297	1,051	2,286	7,162	-1,949	-6,601

Log Real GDP restricted 1965:1 2007:2 sample estimated structural breaks												
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1998:3									
Two Breaks	+	-	1978:2	+	+	1983:4						
Three Breaks	-	+	1981:4	-	-	1990:4	-	-	2001:3			
Four Breaks	+	-	1978:2	+	+	1983:3	-	0	1990:4	-	-	2001:3

	Unemployment adjustment restricted 1965:1 2007:2 sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	-1,190	-4,419						
Two Breaks	2,329	6,880	-1,949	-6,171				
Three Breaks	1,501	5,287	-1,569	-5,054	-0,242	-0,691		
Four Breaks	2,250	6,642	-1,103	-2,930	-0,957	-3,033	-0,242	-0,723

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	1	-0,045	-0,024	0,034	-0,079	-0,422	7,014**	-2,361**	0,120
	2	-0,229	1	-0,045	-0,024	0,036	-0,080	-0,422	7,049**	-2,389***	0,154
	3	0,494	1	-0,051	-0,034	0,130	-0,050	-0,271	4,783	-2,179**	0,806
	4.1	0,494	12	0,003	-0,028	-0,024	-0,204	-0,782	16,642***	-3,974***	2,777†
	4.2	0,494	1	0,004	-0,007	-0,079	-0,193	-0,782	16,642***	-3,974***	2,777†
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	1	-0,059	-0,058	-0,002	-0,058	-0,429	3,592	-1,726	0,042
	2	0,486	1	-0,073	-0,027	0,019	-0,104	-0,429	3,842	-1,900**	0,286
	3	0,418	1	-0,042	-0,120	0,098	-0,039	-0,212	4,910	-2,211**	2,468
	4.1	0,493	3	-0,040	0,023	0,077	-0,478	-0,767	22,602***	-4,762***	14,173†††
	4.2	0,493	1	-0,056	0,010	0,089	-0,426	-0,767	22,602***	-4,762***	14,173†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	1	-0,045	-0,054	0,019	-0,099	-0,372	7,131**	-2,455**	0,913
	2	0,441	1	-0,045	-0,054	0,025	-0,103	-0,372	7,217**	-2,490***	0,995
	3	-0,406	1	-0,084	-0,011	0,030	0,060	-0,118	7,209**	-2,664***	4,117††
	4.1	-0,494	1	-0,025	-0,020	-0,300	0,007	-0,918	32,426***	-5,694***	11,928†††
	4.2	-0,494	1	-0,025	-0,020	-0,300	0,007	-0,918	32,426***	-5,694***	11,928†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	1	-0,061	-0,070	-0,021	-0,123	-0,372	7,668**	-2,213**	0,277
	2	-0,494	1	-0,060	-0,071	-0,018	-0,129	-0,372	7,811**	-2,292**	0,414
	3	0,488	1	-0,054	-0,082	0,041	-0,001	-0,088	4,185	-1,755*	0,385
	4.1	-0,341	12	-0,056	-0,173	-0,363	-0,153	-0,935	25,523***	-4,671***	2,324
	4.2	-0,341	1	-0,019	-0,068	-0,268	-0,087	-0,935	25,523***	-4,671***	2,324

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

West Germany (former Federal Republic of Germany)

	Log Real GDP all sample estimated structural breaks											
	Signal		Period	Signal		Period	Signal		Period	Signal		Period
	DU1	DT1		DU2	DT2		DU3	DT3		DU4	DT4	
One break	+	-	1990:3									
Two Breaks	-	0	1982:2	+	-	1990:3						
Three Breaks	-	0	1982:2	+	-	1990:3	-	0	2003:1			
Four Breaks	-	-	1974:4	-	-	1981:4	+	-	1990:3	-	0	2003:1

	Unemployment adjustment all log GDP sample							
	DU1-coef.	DU1 t-stat	DU2-coef.	DU2 t-stat	DU3-coef.	DU3 t-stat	DU4-coef.	DU4 t-stat
One break	3,256	9,135						
Two Breaks	4,903	17,606	0,325	1,242				
Three Breaks	4,903	18,142	0,048	0,181	1,046	3,173		
Four Breaks	2,788	10,918	3,812	17,499	0,147	0,781	1,046	4,433

T-VECM Estimation results											
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
1	1	0	2	-0,044	-0,039	0,003	-0,066	-0,306	8,284***	-2,540**	0,142
	2	-0,473	2	-0,045	-0,038	0,007	-0,070	-0,306	8,314**	-2,560***	0,170
	3	0,440	2	-0,010	-0,064	0,061	-0,057	0,027	5,950*	-2,563***	2,922†
	4.1	0,433	9	0,004	-0,110	0,028	-0,318	-0,927	29,662***	-5,506***	8,042†††
	4.2	0,433	2	-5,413*e-5	-0,051	0,029	-0,152	-0,927	29,662***	-5,506***	8,042†††

Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
2	1	0	2	-0,162	-0,042	0,207	-0,080	-0,275	10,810***	-2,377**	0,175
	2	0,500	2	-0,166	-0,041	0,214	-0,081	-0,275	10,946***	-2,463***	0,303
	3	0,440	2	0,026	-0,160	0,087	0,047	-0,193	20,631***	-4,499***	10,996†††
	4.1	0,413	12	-0,006	-0,265	0,051	0,315	0,067	19,403***	-4,290***	11,759†††
	4.2	0,413	2	0,048	-0,173	0,035	0,171	0,067	19,403***	-4,290***	11,759†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
3	1	0	2	-0,144	-0,048	0,137	-0,110	-0,360	14,149***	-3,136***	0,100
	2	-0,467	2	-0,139	-0,050	0,151	-0,128	-0,360	14,415***	-3,286***	0,343
	3	0,413	2	0,032	-0,182	0,031	0,064	-0,213	22,915***	-4,743***	12,342†††
	4.1	0,060	12	-0,005	-0,286	0,055	0,283	0,067	17,390***	-4,119***	9,707†††
	4.2	0,060	2	0,033	-0,186	0,069	0,150	0,067	17,390***	-4,119***	9,707†††
Breaks	Method	τ	Lags	$\sigma_{u,1}$	$\sigma_{u,2}$	$\lambda_{y,1}$	$\lambda_{y,2}$	δ	F Stat	T-Max Stat	Wald Stat
4	1	0	2	-0,114	-0,150	0,040	0,069	-0,392	15,473***	-3,506***	1,047
	2	0,267	2	-0,084	-0,178	-0,018	0,121	-0,392	16,104***	-3,697***	1,621
	3	0,460	2	-0,028	-0,216	0,059	0,283	-0,193	12,911***	-3,592***	4,853††
	4.1	0,500	10	-0,031	-0,209	-0,065	-0,124	-0,920	55,746***	-7,205***	6,512††
	4.2	0,500	1	0,048	-0,091	-0,321	-0,514	-0,920	55,746***	-7,205***	6,512††

***, **, * indicates the rejection of the null hypothesis of no threshold cointegration at the 1%,5% and 10% level respectively.
†††, ††, † indicates the rejection of the null hypothesis of symmetry at the 1%,5% and 10% level respectively.

2. Statistical tables for long run model adequacy

Country	F-Stat GDP	AIC- GDP	BIC- GDP	LZW- GDP	SSR- UN	F-Stat UN	AIC- UN	BIC- UN	LZW- UN
Australia									
One break	47,059	-5,247	-7,868	-7,617	312,199	0,143	3,854	1,144	1,287
Two breaks	61,276	-5,772	-8,061	-7,482	279,751	6,691	3,761	1,238	1,561
Three breaks	94,434	-6,256	-8,196	-7,279	114,290	65,353	2,883	0,628	1,208
Four breaks	128,292	-6,660	-8,169	-6,828	144,856	32,422	3,137	1,231	2,148
Austria									
One break	153,609	-4,689	-7,350	-7,127	130,903	90,362	2,701	-0,032	0,095
Two breaks	202,129	-5,414	-7,807	-7,294	76,659	130,066	2,179	-0,403	-0,116
Three breaks	204,332	-5,763	-7,756	-6,817	34,695	250,796	1,399	-0,967	-0,454
Four breaks	228,764	-5,998	-7,612	-6,269	35,946	179,047	1,448	-0,637	0,170

Table 2- Model adequacy statistics for structural specifications

Country	F-Stat GDP	AIC- GDP	BIC- GDP	LZW- GDP	SSR- UN	F-Stat UN	AIC- UN	BIC- UN	LZW- UN
Belgium									
One break	232,320	-5,339	-8,017	-7,834	166,222	3,424	3,407	0,715	0,869
Two breaks	141,545	-5,993	-8,256	-7,661	96,206	37,496	2,881	0,403	0,750
Three breaks	128,294	-5,688	-7,891	-7,257	132,493	9,379	3,221	1,050	1,675
Four breaks	260,906	-6,727	-8,367	-7,187	127,246	8,205	3,201	1,431	2,423
Canada									
One break	840,436	-4,456	-7,186	-7,040	447,394	186,726	3,737	0,990	1,107
Two breaks	591,469	-5,093	-7,619	-7,239	478,024	81,043	3,814	1,197	1,460
Three breaks	453,704	-5,472	-7,581	-6,724	458,238	58,673	3,783	1,351	1,820
Four breaks	520,778	-5,743	-7,525	-6,305	319,807	82,293	3,434	1,244	1,981
Denmark									
One break	67,482	-5,216	-7,881	-7,689	236,538	1,454	3,760	1,068	1,222
Two breaks	49,596	-5,767	-7,979	-7,355	140,288	33,802	3,258	0,780	1,127
Three breaks	95,353	-6,428	-8,240	-7,247	139,960	22,423	3,276	1,105	1,730
Four breaks	83,752	-6,690	-7,580	-5,662	125,189	21,345	3,185	1,414	2,407
Finland									
One break	241,704	-4,624	-7,261	-7,021	721,908	192,459	4,583	1,864	2,001
Two breaks	286,120	-5,095	-7,523	-7,075	804,267	79,198	4,706	2,159	2,469
Three breaks	251,591	-5,579	-7,455	-6,437	621,286	80,181	4,464	2,163	2,717
Four breaks	364,485	-6,066	-7,507	-6,046	611,099	61,174	4,463	2,484	3,357
France									
One break	54,495	-5,917	-8,509	-8,240	90,116	24,319	2,795	0,103	0,257
Two breaks	61,401	-6,407	-8,619	-7,994	90,491	11,786	2,819	0,341	0,689
Three breaks	84,953	-6,963	-8,607	-7,447	29,805	87,404	1,729	-0,442	0,183
Four breaks	180,782	-7,478	-9,008	-7,763	76,540	11,058	2,693	0,922	1,915
Italy									
One break	192,263	-6,006	-8,603	-8,337	185,784	12,440	3,487	0,792	0,944
Two breaks	219,854	-6,692	-8,918	-8,301	95,571	58,222	2,842	0,356	0,699
Three breaks	265,514	-7,061	-8,895	-7,916	82,995	49,139	2,721	0,535	1,152
Four breaks	241,950	-7,144	-8,522	-7,124	74,451	43,414	2,632	0,837	1,816
Japan									
One break	1052,164	-5,236	-7,848	-7,590	85,216	55,668	2,619	-0,084	0,062
Two breaks	1990,167	-5,851	-8,354	-7,965	72,997	41,148	2,482	-0,025	0,306
Three breaks	2006,338	-6,247	-8,511	-7,816	18,454	211,920	1,125	-1,101	-0,506
Four breaks	1766,263	-6,396	-8,231	-7,250	18,115	160,878	1,125	-0,735	0,207
Netherlands									
One break	79,161	-5,826	-8,418	-8,148	149,453	141,816	3,301	0,609	0,762
Two breaks	93,800	-6,422	-8,634	-8,009	170,725	55,508	3,454	0,976	1,324
Three breaks	123,291	-6,647	-8,625	-7,798	144,305	49,056	3,306	1,136	1,760
Four breaks	104,675	-6,959	-8,062	-6,376	113,797	52,393	3,089	1,319	2,311
New Zealand									
One break	89,909	-3,514	-6,171	-5,946	679,387	100,953	4,375	1,644	1,773
Two breaks	83,562	-3,885	-6,268	-5,749	573,611	72,934	4,219	1,642	1,932
Three breaks	83,911	-4,041	-6,137	-5,320	427,341	81,479	3,938	1,581	2,100
Four breaks	59,406	-4,112	-5,546	-4,012	415,315	63,498	3,923	1,854	2,671

Table 2 (cont.)

Country	F-Stat GDP	AIC- GDP	BIC- GDP	LZW- GDP	SSR- UN	F-Stat UN	AIC- UN	BIC- UN	LZW- UN
Norway									
One break	120,209	-5,382	-8,068	-7,890	259,285	0,278	3,659	0,949	1,091
Two breaks	67,885	-5,663	-8,060	-7,592	223,531	9,357	3,528	1,003	1,325
Three breaks	99,436	-6,131	-8,221	-7,458	134,487	35,438	3,036	0,778	1,355
Four breaks	66,845	-6,331	-7,479	-5,743	96,462	47,866	2,721	0,809	1,722
Portugal									
One break	150,216	-4,124	-6,808	-6,629	121,337	8,968	2,917	0,209	0,352
Two breaks	86,383	-4,647	-6,933	-6,351	114,687	7,978	2,878	0,357	0,682
Three breaks	142,575	-5,380	-7,168	-6,094	124,527	1,905	2,978	0,727	1,308
Four breaks	231,696	-5,957	-7,270	-5,723	117,293	3,215	2,935	1,036	1,956
Spain									
One break	45,810	-4,970	-7,581	-7,324	1182,552	2,580	5,249	2,546	2,692
Two breaks	169,432	-6,093	-8,493	-7,985	1186,546	1,094	5,271	2,763	3,095
Three breaks	174,075	-6,538	-8,497	-7,493	1105,392	3,369	5,218	2,991	3,586
Four breaks	211,153	-7,005	-8,255	-6,666	401,433	52,925	4,223	2,363	3,305
Sweden									
One break	186,259	-5,611	-8,203	-7,934	204,918	235,343	3,616	0,925	1,078
Two breaks	464,913	-6,397	-8,849	-8,462	262,194	80,632	3,883	1,405	1,753
Three breaks	262,659	-6,684	-8,495	-7,503	194,644	82,522	3,606	1,435	2,059
Four breaks	359,895	-6,935	-8,463	-7,001	153,845	83,638	3,391	1,621	2,613
Switzerland									
One break	58,507	-5,473	-8,078	-7,817	39,733	477,804	1,894	-0,805	-0,657
Two breaks	57,653	-5,866	-8,114	-7,509	74,936	101,262	2,548	0,049	0,386
Three breaks	70,911	-6,314	-8,065	-6,987	63,755	84,540	2,405	0,196	0,800
Four breaks	92,760	-6,759	-7,809	-6,842	53,729	79,209	2,253	0,420	1,378
UK									
One break	95,100	-4,807	-7,461	-7,233	631,118	67,891	4,329	1,600	1,731
Two breaks	146,229	-5,575	-7,948	-7,423	392,743	97,566	3,869	1,297	1,591
Three breaks	142,860	-5,878	-7,836	-6,872	382,160	67,689	3,855	1,508	2,034
Four breaks	143,606	-6,121	-7,526	-5,970	217,770	115,071	3,306	1,253	2,081
USA									
One break	9,741	-4,947	-7,620	-7,407	345,738	19,529	3,571	0,831	0,952
Two breaks	24,412	-5,279	-7,704	-7,215	297,684	24,752	3,433	0,832	1,106
Three breaks	26,349	-5,470	-7,526	-6,630	313,510	12,781	3,497	1,095	1,585
Four breaks	37,724	-5,748	-7,453	-6,175	284,770	14,653	3,413	1,271	2,041
Former FRG									
One break	134,806	-5,095	-7,753	-7,527	698,993	83,450	4,404	1,673	1,801
Two breaks	171,828	-5,552	-8,022	-7,602	224,838	283,844	3,283	0,705	0,996
Three breaks	168,171	-5,731	-7,974	-7,290	210,330	204,262	3,229	0,873	1,392
Four breaks	129,241	-5,986	-7,575	-6,214	107,041	333,942	2,567	0,498	1,315

Table 2 (cont.)

Country	Overall Score	Overall Score no AIC-GDP	Score GDP only	Score GDP no AIC	Score UN only
Australia					
One break	3,444	3,375	3,250	3,000	3,600
Two breaks	2,889	2,875	2,750	2,667	3,000
Three breaks	1,444	1,375	2,000	2,000	1,000
Four breaks	2,222	2,375	2,000	2,333	2,400
Austria					
One break	3,667	3,625	3,500	3,333	3,800
Two breaks	2,444	2,375	2,000	1,667	2,800
Three breaks	1,556	1,500	2,250	2,333	1,000
Four breaks	2,333	2,500	2,250	2,667	2,400
Belgium					
One break	2,667	2,500	2,000	1,333	3,200
Two breaks	1,556	1,500	2,250	2,333	1,000
Three breaks	3,111	3,125	3,500	3,667	2,800
Four breaks	2,444	2,625	1,750	2,000	3,000
Canada					
One break	2,000	1,750	2,750	2,333	1,400
Two breaks	2,444	2,375	1,750	1,333	3,000
Three breaks	3,222	3,375	2,750	3,000	3,600
Four breaks	2,333	2,500	2,750	3,333	2,000
Denmark					
One break	3,000	2,875	2,750	2,333	3,200
Two breaks	2,111	2,000	2,750	2,667	1,600
Three breaks	2,333	2,375	1,750	1,667	2,800
Four breaks	2,556	2,750	2,750	3,333	2,400
Finland					
One break	2,556	2,375	3,500	3,333	1,800
Two breaks	2,444	2,375	1,750	1,333	3,000
Three breaks	2,556	2,625	2,750	3,000	2,400
Four breaks	2,444	2,625	2,000	2,333	2,800
France					
One break	2,778	2,625	3,250	3,000	2,400
Two breaks	3,000	3,000	2,500	2,333	3,400
Three breaks	1,778	1,750	2,750	3,000	1,000
Four breaks	2,444	2,625	1,500	1,667	3,200
Italy					
One break	3,222	3,125	3,000	2,667	3,400
Two breaks	2,000	1,875	2,250	2,000	1,800
Three breaks	2,111	2,125	2,000	2,000	2,200
Four breaks	2,667	2,875	2,750	3,333	2,600
Japan					
One break	3.444	3.375	3.750	3.667	3.200
Two breaks	2,889	2,875	2,000	1,667	3,600
Three breaks	1,444	1,375	1,500	1,333	1,400
Four breaks	2,222	2,375	2,750	3,333	1,800

Table 3- Average score rankings for structural specifications

Country	Overall Score	Overall Score no AIC-GDP	Score GDP only	Score GDP no AIC	Score UN only
Netherlands					
One break	2,222	2,000	3,000	2,667	1,600
Two breaks	2,556	2,500	2,250	2,000	2,800
Three breaks	2,556	2,625	2,000	2,000	3,000
Four breaks	2,667	2,875	2,750	3,333	2,600
New Zealand					
One break	2,333	2,125	2,000	1,333	2,600
Two breaks	2,444	2,375	2,250	2,000	2,600
Three breaks	2,222	2,250	2,500	2,667	2,000
Four breaks	3,000	3,250	3,250	4,000	2,800
Norway					
One break	2,667	2,500	2,000	1,333	3,200
Two breaks	2,889	2,875	2,750	2,667	3,000
Three breaks	2,000	2,000	2,000	2,000	2,000
Four breaks	2,444	2,625	3,250	4,000	1,800
Portugal					
One break	2,111	1,875	2,750	2,333	1,600
Two breaks	2,222	2,125	3,000	3,000	1,600
Three breaks	3,111	3,250	2,500	2,667	3,600
Four breaks	2,556	2,750	1,750	2,000	3,200
Spain					
One break	3,000	2,875	3,750	3,667	2,400
Two breaks	2,889	2,875	2,250	2,000	3,400
Three breaks	2,333	2,375	1,750	1,667	2,800
Four breaks	1,778	1,875	2,250	2,667	1,400
Sweden					
One break	2,556	2,375	3,500	3,333	1,800
Two breaks	2,444	2,375	1,500	1,000	3,200
Three breaks	2,556	2,625	2,500	2,667	2,600
Four breaks	2,444	2,625	2,500	3,000	2,400
Switzerland					
One break	1,667	1,375	2,500	2,000	1,000
Two breaks	2,667	2,625	2,500	2,333	2,800
Three breaks	2,778	2,875	2,500	2,667	3,000
Four breaks	2,889	3,125	2,500	3,000	3,200
UK					
One break	3.444	3.375	3.500	3.333	3.400
Two breaks	1,889	1,750	1,500	1,000	2,200
Three breaks	2,667	2,750	2,500	2,667	2,800
Four breaks	2,000	2,125	2,500	3,000	1,600
USA					
One break	2,556	2,375	2,750	2,333	2,400
Two breaks	2,000	1,875	2,250	2,000	1,800
Three breaks	2,889	3,000	2,500	2,667	3,200
Four breaks	2,556	2,750	2,500	3,000	2,600

Table 3 (cont.)

Country	Overall Score	Overall Score no AIC-GDP	Score GDP only	Score GDP no AIC	Score UN only
Former FRG					
One break	3,556	3,500	3,000	2,667	4,000
Two breaks	1,889	1,750	1,500	1,000	2,200
Three breaks	2,444	2,500	2,250	2,333	2,600
Four breaks	2,111	2,250	3,250	4,000	1,200

Table 3 (cont.)

3. Data and Eviews routines

The data in excel format, Eviews results and routines can be downloaded following this link. Alternatively, full web address follows bellow for readers in paper format: http://econpt.googlepages.com/Okun_T-VECM.rar

4. Statistical tables

The Ender and Syklos (2001) tables for the F and t-Max statistics used for testing asymmetric cointegration assuming a TAR specification follow bellow:

The distribution of the F Statistic with no lagged changes for known τ			
Obs.	90%	95%	99%
50	5,09	6.2	8,78
100	5,01	5,98	8,24
250	4,94	5,91	8,08
500	4,91	5,85	7,89

Table 4- Critical values for F stat when $\tau = 0$

The distribution of the t-Max Statistic with no lagged changes for known τ			
Obs.	90%	95%	99%
50	-1,89	-2,12	-2,58
100	-1,9	-2,11	-2,55
250	-1,9	-2,12	-2,53
500	-1,89	-2,11	-2,52

Table 5- Critical values for t-Max stat when $\tau = 0$

The distribution of the F Statistic with no lagged changes for unknown τ			
Obs.	90%	95%	99%
50	6,05	7,24	9,90
100	5,95	6,95	9,27
250	5,93	6,93	9,15

Table 6- Critical values for F stat when $\tau = \hat{\tau}$

The distribution of the t-Max Statistic with no lagged changes for unknown τ			
Obs.	90%	95%	99%
50	-1,62	-1,89	-2,43
100	-1,61	-1,85	-2,35
250	-1,59	-1,84	-2,31

Table 7- Critical values for t-Max stat when $\tau = \hat{\tau}$

5. Data

Country	Data	Source	Range	Specifications
Australia	Real GDP Quarterly	OECD.stat	1959:3 to 2007:2	Chained volume estimates, national reference year, quarterly levels, s.a.
	Unemployment Rate Monthly	Australian Bureau of Statistics	1978:2 to 2007:2	Quarter average rates, s.a.
Austria	Nominal GDP Quarterly	OECD.stat	1960:1 to 2007:2	Current prices, national currency, deflated using Austria index of consumer prices all items from OECD.stat, s.a.
	Unemployment Rate Quarterly	OECD.stat	1969:1 to 2007:2	Breaks in data at 1974:1, 1993:4, 2001:4 and 2003:4, s.a.
Belgium	Real GDP Quarterly	ECB	1980:1 to 2007:2	Chained 2004 Euros, s.a.
	Unemployment Rate Quarterly	ECB	1983:1 to 2007:2	Labour force survey (Eurostat), s.a.
Canada	Real GDP Quarterly	OECD.stat	1961:1 to 2007:2	Chained volume estimates, national reference year, quarterly levels, s.a.
	Unemployment Rate Quarterly	OECD.stat	1961:1 to 2007:2	Standardized, s.a.
Denmark	Real GDP Quarterly	ECB	1977:1 to 2007:2	Constant prices, national currency, s.a.
	Unemployment Rate Quarterly	ECB	1983:1 to 2007:2	Labour force survey (Eurostat), s.a.
Finland	Real GDP Quarterly	OECD.stat	1975:1 to 2007:2	Chained volume estimates, national reference year, quarterly levels, s.a
	Unemployment Rate Quarterly	OECD.stat	1975:1 to 2007:2	Estimated values from 1975:1 to 1987:4, break in data in 1987:4, s.a.
France	Real GDP Quarterly	ECB	1978:1 to 2007:2	Constant prices, national currency, s.a.
	Unemployment Rate Monthly	ECB	1983:1 to 2007:2	Labour force survey (Eurostat), quarter average rates, s.a.
Italy	Real GDP Quarterly	ECB	1970:1 to 2007:2	Constant prices, national currency, s.a. using Tramo-Seats routine in Eviews
	Unemployment Rate Monthly	ECB	1982:2 to 2007:2	Labour force survey (Eurostat), quarter average rates, s.a.

Table 8- Data sources

Japan	Nominal GDP Quarterly	OECD.stat	1980:1 to 2007:2	Current prices, national currency, s.a., deflated using Japan index of consumer prices all items from OECD.stat
	Unemployment Rate Quarterly	OECD.stat	1980:1 to 2007:2	Standardized, s.a.
Netherlands	Real GDP Quarterly	ECB	1977:1 to 2007:2	Constant prices, national currency, s.a.
	Unemployment Rate Monthly	ECB	1983:1 to 2007:2	Labour force survey (Eurostat), quarter average rates, s.a.
New Zealand	Real GDP Quarterly	OECD.stat	1960:1 to 2007:2	Current prices, national currency, s.a., deflated using New Zealand index of consumer prices all items from OECD.stat, values from 1960:1 to 1987:4 are estimated
	Unemployment Rate Quarterly	Statistics NZ	1970:1 to 2007:2	Unemployment rate, s.a.
Norway	Real GDP Quarterly	StatBank (Norway)	1978:1 to 2007:2	Constant prices, national currency, s.a.
	Unemployment Rate Quarterly	OECD.stat	1978:1 to 2007:2	Standardized, values from 1978:1 to 1988:4 are estimated,s.a.
Portugal	Real GDP Quarterly	Bank of Portugal	1978:1 to 2006:4	Chained volume estimates, reference year 2000, s.a.
	Unemployment Rate Quarterly	Bank of Portugal	1978:1 to 2006:4	Unemployment rate, s.a.
Spain	Real GDP Quarterly	ECB	1980:1 to 2007:2	Constant prices, national currency, s.a.
	Unemployment Rate Quarterly	OECD.stat	1980:1 to 2007:2	Standardized, values from 1980:1 to 1986:1 are estimated, break in 1986:1,s.a.
Sweden	Real GDP Quarterly	ECB	1980:1 to 2007:2	Constant prices, national currency, s.a. using Tramo-Seats routine in Eviews
	Unemployment Rate Quarterly	ECB	1983:1 to 2007:2	Labour force survey (Eurostat), s.a.
Switzerland	Real GDP Quarterly	OECD.stat	1981:1 to 2007:2	Chained volume estimates, national reference year, quarterly levels, s.a.
	Unemployment Rate Quarterly	OECD.stat	1981:1 to 2007:2	Unemployment rate, break in data in 1990:4, s.a.
United Kingdom	Real GDP Quarterly	National Statistics England	1955:1 to 2007:2	Chained volume measures at 2003 constant prices, s.a.
	Unemployment Rate Quarterly	National Statistics England	1971:1 to 2007:2	Unemployment rate, s.a.
United States of America	Real GDP Quarterly	FRED	1947:1 to 2007:2	Chained 2000 dollars, s.a.
	Unemployment Rate Monthly	FRED	1948:1 to 2007:2	Bureau of labor statistics unemployment rate, quarter averages, break in data in 2000:1,s.a.
West Germany (former Federal Republic of German)	Real GDP Quarterly	Deustche Bundesbank	1970:1 to 2007:2	Chained 2000 Laspeyres indices, s.a.
	Unemployment Rate Monthly	Deustche Bundesbank	1970:1 to 2007:2	Unemployment rate, quarter averages, s.a.

Table 8 (cont)

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