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“Asymmetry in Okun´s Law”

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Table of abbreviations:

e.g.for example

et al.and others

EU.....European Union

GDPgross domestic product

i.e.that is

OECDOrganisation for Economic Cooperation and Development

OLCOkun's law coefficient

Countries: AUSAustralia

CANCanada

FRAFrance

ITAItaly

JAPJapan

U.KUnited Kingdom

U.SUnited States of America

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1. Introduction

Scientific research on macroeconomics has always been one of special importance in respect to the practical implications for the real-world economy. Either by modelling the “real world”, or by analysing it, the findings and results of this research have often led (and surely will lead) to applicable and useful policies or rules of thumb which have proved successful in many areas of the macro economy at different times. One such rule of thumb that has stood the test of time is “Okun’s Law”, which describes the inverse long-run relationship between output growth and the unemployment rate. Since the seminal contribution of Okun (1962) a number of other scientific papers and studies have confirmed such a relationship between the unemployment rate and output growth for different time periods and different countries. Appropriately, Perman and Tavera (2007) put forward the term “sacrifice ratio”, which, indeed, describes the most obvious feature beneath Okun’s law. According to them, the OLC can be seen as a cost-benefit ratio, roughly measuring the cost of reducing unemployment.

While studies show that output and the unemployment rate are negatively related they tend to show that increases in the rate of growth of output do not lead to equal decreases in the unemployment rate. That is to say, a 1 percent increase in output growth leads to a less than 1 percent decrease in the unemployment rate. Blanchard (2003) puts forward a number of arguments to explain this result. Firstly, he argues that the concept of “labour hoarding” is important, according to which firms tend to have their staff work overtime rather than hiring new employees during upturns, and similarly rather than fire trained staff during a downturn firms would rather have them work fewer hours¹. Secondly, the potential work force seems to increase during upturns, as people who previously thought that they had little chance of finding a job find their possibilities increased. Due to this fact, vacancies are not only filled by unemployed persons being part of the “initial” labour force, but also by formerly discouraged workers who enter the work force when output increases. This implies that increases in employment do not lead to equivalent decreases in the number of registered unemployed. Hence, the effect of an expansion in the labour market appears to be reduced. Other possible explanations are provided by Okun, who lists five possible reasons for the muted response of the unemployment rate to changes in output growth. (Okun, 1962). Firstly, contractual commitment generally strengthens the position of workers and hence the number of

¹ Also, some workers are required regardless of the level of output (for example, accountants) and will thus not become unemployed when output falls.

employees is too high rather than too low. Secondly, Okun considers technological factors to be responsible for firms usually employing a higher number of workers than actually needed. Thirdly, fluctuations in a firm's employment levels are reduced due to transaction costs in the recruiting process. Fourthly, fluctuations are reduced due to firm-specific skills of the labour force that would have to constantly be regained in the case of fluctuations. Finally, Okun considers laying off workers as a generally undesired activity for firms. Thus, firms are likely to employ more workers than actually required. Overall, Okun's arguments support the claim that changes in output growth do not lead to firms changing employment levels correspondingly.

A further result found in existing studies is that the response of the unemployment rate to changes in output growth is asymmetric. According to Neftci (1984) asymmetry occurs when the (economic) correlation between time series differ over various phases of the business cycle. Being more specific to Okun's relationship, Silvapulle et al. (2004) discuss the notion that the unemployment rate might react differently to output growth, depending upon whether an economy is experiencing an expansion or contraction. According to these authors, studies that account for such asymmetry are a crucial step forward when compared with earlier research which assumes a symmetric response of the unemployment rate to changes in output growth. Considering asymmetry in the Okun's law relationship allows one to question whether economic downswings or upswings have a more influential effect on the unemployment rate in the long-run. This paper takes such an approach to considering the Okun's law relationship, thus contributing to the existing debate on the question of asymmetry.

Consistent with most previous research this paper does not question the general validity of Okun's law, though the Okun's law relationship is estimated for a sample of OECD countries. The main aim of this paper is not however a "classic" investigation of Okun's law², but instead the consideration of asymmetry in the Okun's law relationship across a sample of OECD countries. To test for such asymmetric behaviour the threshold regression model of Hansen (1996, 2000) is employed, which allows one to estimate both the point at which such asymmetric behaviour takes place (i.e. the threshold) as well as the OLC in the different regimes. As such, the main contribution of the paper will be to provide evidence of whether cyclical downturns or cyclical upturns in output (i.e., recessions or expansions) exert a stronger influence on the unemployment rate.

² By which is meant the search for the existence of a long-run relationship between the unemployment rate and output growth

2. Literature Review

Across the many studies investigating the Okun's Law relationship there are a remarkable variety of coefficient estimates for the Okun's law coefficient. According to Moosa (1999) there are a number of reasons for these differing estimates. Most importantly, Moosa (1999) argues that a crucial influence on the results is the methodological approach used. Moosa (1999) considers the distinction between static and dynamic specifications, which imply different interpretations regarding the mechanism behind Okun's law. Static models imply that the relationship between output and the unemployment rate captured by Okun's law reflects a contemporaneous relationship between the two variables, while a dynamic specification implies that the relationship may also be influenced by lags and thus changes in output can exhibit an influence on the unemployment rate in later periods. Attfield and Silverstone (1997) further distinguish between the first-difference approach, which expresses the change of both the output rate and the unemployment rate in percentage points (i.e., quarterly percentage changes in the unemployment rate are related to quarterly percentage changes in real output), and the gap modelling approach, which uses the change in the cyclical components of unemployment and output and therefore requires a detrending procedure³. According to Attfield and Silverstone the first-difference approach is inappropriate as it does not allow for co-integration between the unemployment rate and output growth (Attfield and Silverstone, 1998).

A further difference found across existing studies is that authors have taken different views concerning the inclusion of additional variables in their estimated model. Moosa (1999) discusses a number additional variables, including such factors as capacity utilization, hours per worker and labor force participation, as being potentially relevant variables to include in an analysis of the Okun's law relationship. One example of a study using such additional information is that of Prachowny (1993).

Moosa (1999) also points out the important role of the detrending method used. While there is little discussion in the literature about which of the available detrending methods available is the most reliable, and as such there is no a-priori reasoning to favour one detrending method over another, the different detrending methods can lead to different estimates of the OLC. Moreover, the use of different detrending methods leads to a certain lack of comparability

³ The gap model approach measures the change in the cyclical components of output and the unemployment rate as the difference between the the logged actual values and the estimated "potential" value of these variables.

across studies. One way round this is to use a number of alternative detrending methods to test the robustness of the results obtained, a suggestion followed by Crespo-Cuaresma (2003) for example.

Furthermore, the relationship between unemployment and output is influenced by both supply or demand shocks. Weber (1995) claims that Okun's law is – in the long run - generally supposed to be valid in the case of demand shocks, with supply shocks⁴ (either positive or negative) not necessarily having a significant impact on the Okun's relationship. The rationale for this is that supply shocks are most likely due to technological changes (e.g. innovation which can lead to more efficient labor force utilization), and so may lead to an increase in both output and unemployment. This would be in line with Aghion's and Howitt's arguments that in the long-run technological progress usually leads to job destruction (Aghion and Howitt, 1994). In the short run, both Weber and Aghion and Howitt do not find evidence that demand shocks automatically lead to an inverse relationship between output and the unemployment rate, but in the long run increased demand implicitly induces a decrease in the unemployment rate. According to Weber (1995) positive short-run shocks may however increase unemployment, e.g. technological inventions immediately reducing the need for employees although they are actually supposed to increase output. Further evidence on the effect of shocks is provided by Altissimo and Violante (2001).

3. Empirical findings

Following the seminal contribution of Okun (1962) a number of empirical papers have appeared estimating the OLC for different countries and time periods, using a variety of different methods. This section discusses a sample of these papers, with Table 4 in *Appendix B* summarizing the results of this literature.

Okun (1962) was the first researcher to seriously investigate whether the assumption that output growth and the unemployment rate were related. In his contribution, which has to be regarded as a milestone of economic policy research, the relationship between output and the unemployment rate is considered for U.S post-war data. Okun (1962) considers three

⁴ The term “supply shock” basically describes shocks (positive or negative) which are induced by producers or firms (reasons may relate to technological standards, the desire to expand etc.). In contrast, “demand shocks” are those driven by the goods market, which in turn, exert pressure on the supply side (firms) to adjust their production levels.

alternative estimation methods (i.e. first differences, trial gaps, fitted trend and elasticity⁵) in order to test the robustness of his findings. Using a weighted average of the OLC found using the three estimation methods Okun found that given an unemployment rate above 4% (a rate which he considered to be a reasonable and achievable rate of unemployment), each percentage point increase in output growth goes hand in hand with a decrease in the growth of unemployment rate of approximately 1/3 percent (Okun, 1962)⁶. Okun's result can therefore be represented by the following equation (Weber, 1995)

$$1) \quad U_t^c = \alpha \times y_t^c + \varepsilon_t$$

where U_t^c stands for the cyclical unemployment rate, y_t^c denotes cyclical output, and α represents the OLC (which, according to Okun is, -0.32).

For many years, the coefficient of -0.32 found by Okun was considered a valid rule of thumb for policy makers. Despite this studies continued to appear that tested either a variant of Okun's original empirical model on different countries or time periods, or extended the analysis to consider such things as asymmetry in the Okun's law relationship. Prachowny (1993) for example, strongly disagrees with Okun's point of view that changing unemployment rates exhibit *pari passu* characteristics (i.e. Okun takes for granted that factors related to the change of the unemployment rate always change to the same extent, regardless of the actual level of the unemployment rate). Prachowny's first-difference approach based on Okun's specification can be written as follows (Lee, 2000):

$$2) \quad \Delta y_t = \beta_0 - \beta_1 \Delta u_t + \varepsilon_t \quad t = 1, \dots, T$$

Where Δy_t and Δu_t denote actual percentage changes in output and the unemployment rate in period t (note: the difference terms are determined out of actual, not detrended data), β_0 is the intercept representing mean growth and β_1 is the OLC.

⁵ The first-difference and trial gap approaches will be explained later on. Explanation of the fitted trend and elasticity approach can be found in *Appendix A*.

⁶ Similarly, a 1% decrease in output growth leads to an increase in the unemployment rate of 0.33 %

Prachowny takes this basic approach and reformulates it as a production function specification including additional variables such as the contribution of workers (i.e hours per worker or labour supply) and the change in weekly hours. His revised specification is thus:

$$3) \ y - y^* = \alpha(c - c^*) + \beta\gamma(l - l^*) - \beta\gamma(u - u^*) + \beta\delta(h - h^*) + \varepsilon$$

with: $y - y^*$ is the output gap, $c - c^*$ is the capacity gap, $l - l^*$ is the labour supply gap, $u - u^*$ is the unemployment gap, $h - h^*$ is the gap in labour hours and $\alpha, \beta, \gamma, \delta$ as parameters to be estimated. y^* and u^* are taken from previous research, c^*, l^* and h^* denote equilibrium levels of the relevant variables respectively⁷.

Considering a relationship in first differences the final estimating equation of Prachowny (1993) is:

$$4) \ \Delta(y - y^*) = a_1\Delta(c - c^*) + a_2\Delta(l - l^*) - a_3\Delta(u - u^*) + a_4\Delta(h - h^*) + \varepsilon$$

where Δ indicates the percentage change in the respective gaps

Prachowny estimates equation (4) using quarterly U.S data, with all “gap terms” determined, preassumed or taken from actual data. In Prachowny’s model the coefficient a_3 provides an estimate of the OLC, while controlling for other factors that influence output. Prachowny finds an OLC of around -0.66 for the U.S, which is somewhat larger than that found by Okun (1962).

Lee (2000) also adopts the first-difference approach, but uses a more basic specification than Prachowny’s production function approach. Lee considers data on 16 OECD countries for a period covering the years from 1955 to 1996. Estimating the OLC for each country, Lee finds a cross-country mean OLC of -2.04⁸. Most relevant for a comparison with existing studies are estimates for individual countries such as the U.S (-1.84) and the U.K (-1.39). Additional use

⁷ An explanation concerning the derivation and calculation of Prachowny’s gap terms is provided in Prachowny (1993).

⁸ Lee’s OLC estimates represent a direct pay-off ratio between output growth and the change in the unemployment rate, and so their interpretation is comparable to Okun’s statement of a 3:1.

of an error correction model to account for short-run dynamics in the output-unemployment relationship leads to similar, but overall less significant results.

Using the same data as Prachowny (1993), Attfield and Silverstone (1998) find quite different results due to imposing the assumption of an existing cointegrating relationship between the additional factors introduced by Prachowny. Their approach is based on a gap-model and can generally be shown as:

$$5) \quad y_t - y_t^* = -\beta_1(u_t - u_t^*) + \varepsilon_t$$

Where y_t and u_t are the logs of observed output and unemployment, and y_t^* and u_t^* denote corresponding “potential” values for output and unemployment⁹. This equation can be rewritten as

$$6) \quad y_t^c = -\beta_1 u_t^c + \varepsilon_t$$

Where $y_t^c = y_t - y_t^*$ and $u_t^c = u_t - u_t^*$ (Weber, 1995) denote cyclical output and the cyclical unemployment rate. The cyclical components are obtained by detrending the original data series using the Beveridge-Nelson decomposition. Employing this approach Attfield and Silverstone (1999) find evidence that Prachowny’s version of the initial formula behind Okun’s Law exhibits a high level of collinearity among the additional right hand side variables included by Prachowny. Using their method, Attfield and Silverstone find an OLC of -2.25¹⁰ for the U.S.

Empirical evidence on the use of the gap-model can also be found, again, in Lee (2000), who uses three decomposition methods for extracting the cyclical component (the Hodrick-Prescott filter, the Beveridge-Nelson decomposition and the Kalman filter). Among the sample of 16 OECD countries, the cross country mean OLC (depending on the extracting method applied) is between -2.14 (Beveridge-Nelson) and -2.64 (Kalman filter). Once again concentrating on the countries most relevant for comparison, Lee finds values of the OLC for the U.S between -1.88 and -2.09 and for the U.K between -1.41 and -1.51. Thus, there is

⁹ Note: Compared to the first-difference approach, which considers the actual change in both output and the unemployment rate, in the gap-model the relevant changes in the variables are considered as the difference between the actual and potential (or equilibrium) values of both output and the unemployment rate.

¹⁰ Once again, this value can be directly compared to that of Okun.

evidence that his estimates for both the U.S and U.K are lower than the average values of the entire sample.

Further results obtained using the gap model can be found in Moosa (1997). According to his empirical contribution considering seven OECD countries with data from 1960 to 1995, the OLC is very low for JAP (-0.088) and relatively high for the U.S (-0.456) and CAN (-0.491). Moosa (1997) argues that the low value of the OLC for JAP can be explained by rigid labour markets in this country. A similar argument can be found in Candelon and Hecq (1998) who discuss the Japanese phenomenon of life work.

Weber (1995) determines the OLC for the U.S using quarterly data from 1948 to 1988 and six different estimation methods¹¹, with his approach also allowing for lags in the regression model (i.e. the relationship between output and unemployment is not necessarily contemporaneous, but can also include delayed effects). He obtains 18 different values for the OLC (due to six methods applied on each the entire sample and two shorter sub-samples), of which 14 are below Okun's estimate of -0.32. Weber concludes therefore that Okun's coefficient might be too large. Reassuringly however, all of Weber's coefficient estimates are in the vicinity of Okun's -0.32, with remaining differences most likely due to differences in the estimation methods applied.

4. Asymmetry

4.1 Why Consider the Importance of Asymmetries?

Following the finding of a relationship between output and the unemployment rate, the issue of whether Okun's law displays asymmetric behaviour has become an increasingly relevant question for economic researchers. In addition to finding evidence of such asymmetric behaviour however, it is important to understand and explain such behaviour. Neftci (1984) discusses several reasons in support of research on business cycle asymmetries more generally. One such reason is that by assigning existing probability functions to certain regularly occurring asymmetries, decision makers are enabled to generate appropriate prediction models allowing for such detected asymmetries. A further reason relates to the

¹¹ The methods employed are: static OLS, an autoregressive approach adapted from Blanchard (1989) with both two and four lags, a dynamic OLS method put forward by Gordon (1984) with both two and four lags, and a cointegrating regression approach.

importance of finding a way of predicting sharp turning points in business cycles, in order to regulate or remedy heavy and sudden regime switches. Overall, the objective behind research on asymmetries, according to Neftci, is to introduce linearity and predictability into the complex area of business cycle forecasting.

According to Harris and Silverstone (2001) there are at least four reasons for considering asymmetry in the Okun's law relationship. By providing more reliable research results such research would allow agents to choose more appropriate models and theories relating to the behaviour of both goods and labour markets. Secondly, finding significantly asymmetric behaviour would support former research claims that the Phillip's curve - which is directly connected to the Okun's law relationship - is asymmetric¹². Thirdly, an exact analysis and understanding of asymmetries should lead to an increased opportunity in adjusting structural policies and stabilization policies. Fourthly, and consistent with Neftci, they argue that evidence of asymmetry could help in reducing forecasting errors. A further important reason for allowing for asymmetric behaviour is that not allowing for it could lead to a rejection of the hypothesis of an existing long-run relationship between unemployment rates and output, when in fact one is present (Silvapulle et al., 2004).

For Virén (2001) finding significant asymmetries in the Okun's law relationship would have three main advantages. From a policy-based point of view, it could provide an explanation for varying effects resulting from specific political measures. Additionally, knowing about the presence of asymmetries in certain countries is helpful when interpreting results from country groups (e.g. the Euro area). And finally, due to its status as one of the most important relationships available in macroeconomics, the finding of asymmetries in the Okun's law relationship can have important implications for other economic relationships.

4.2 Why Should we Expect Asymmetries in Okun's Law?

The question of asymmetric behaviour in the Okun's law relationship cannot be answered directly, as its determining variables (i.e. the change in the unemployment rate and output growth) are themselves the result of a framework of cointegrated parameters or events.

¹² For more details on the derivation and specification of the Phillip's curve, see Laxton et al. (1999)

Therefore, any attempt at finding such asymmetries requires paying regard to the broader macroeconomic context.

As there is no proof that occurring asymmetries are necessarily due to spontaneous changes or reactions, the explanations of some researchers rely on general business cycle behaviour. Neftci (1984) finds empirical evidence that business cycles exhibit switching regimes (either recession or expansion) over time. Neftci argues further that these two regimes are likely to happen with different probabilities, and that recessions are, in general, more likely to occur. Bodman (1998) claims that expansions are more likely to occur (and easier to predict) during a recession, than recessions during an expansion. As a result, one could assume that such natural inequality of regimes is supposed to be balanced by general asymmetric behaviour in the Okun's law relationship.

Further evidence in respect of general business cycle behaviour is provided by Altissimo and Violante (2001) and Kim et al. (2005). Both papers claim that recessionary regimes cause strong bounce-back effects (i.e. long lasting recoveries which – in the long-run - lead to higher growth than a recession costs in the short-run). Both contributions point out that the positive effect on output growth exerted by recessions is stronger than the effect of expansions. Findings like these suggest the general inequality in the impact of either recessions or expansions is likely to be transmitted to the Okun's relationship.

The main variables of interest in the Okun's law relationship, namely the *growth* rate of output and the *change* in the unemployment rate, are time series. Although the existence of a relationship between these two variables has been shown in previous research it is clear that other factors are also important in explaining these two variables. In other words, the unemployment rate is not exclusively dependent on output, and vice versa. As such, both time series might evolve somewhat independently of each other. For instance, according to Pesaran and Potter (1997) and Koop and Potter (1997), U.S output growth exhibits structural breaks (i.e. non-linear behaviour) over time. As they go on to argue, both time series suffer from a wide range of exogenous influences (examples including rapid technical change, changes in monetary or fiscal policy, and so on), making the likelihood of a linear relationship between the two variables highly unlikely. They mention further that research on Okun's law that occurred during the 1950's can hardly be based on the same assumptions as research

nowadays. That is why they claim that the change of time requires new specifications, such as non-linear specifications. A similar argument is stressed by Bodman (1998) who criticises existing research that for a long time has been conducted under the assumption that the two time series were linear and stationary.

Empirical support for non-linearity in the output and unemployment series is found by Harris and Silverstone (2001) whose cross-country data is tested for stationarity. Overall, their investigation results in output and the unemployment rate both being non-stationary. Aswell, Laxton et al. (1999) assume unemployment to be generally a lagged (and therefore non-linear) time series.

Although it seems inevitable that these exogenous influences (general business cycle, fluctuations, time series non-linearity, technological or political change) can impose asymmetries on the Okun's relationship, this paper does not specifically intend to take account of them.

Besides possible influences which can be put down to phenomena that seem to occur regularly, a number of explanations have been put forward to explain possible asymmetries in the Okun's law relationship. Compared to the arguments stressed above, these arguments are based on more practical approaches and often provide more reliable information on the extent and direction that potential asymmetries may take.

Acemoglu and Scott (1994) in their paper considering the U.K labour market discuss three possible facts which may be responsible for causing asymmetric behaviour. Firstly, while shocks can spontaneously trigger off either expansions or recessions, there is usually no evidence as to which shocks (supply or demand) are more often responsible for which kind of regime. Secondly, propagation mechanisms may be likely to change over time (i.e., to what extent and how fast shocks affect the economy). And finally, they point out that shocks can lead to completely different reactions, depending on whether the shock is positive or negative. In other words, there is no evidence that a positive shock has the same influence on economy than a negative one would have in the opposite direction. Pesaran and Potter (1997) find some evidence for this latter statement, finding that there seems to be a high likelihood that shocks

to output will show different effects, depending on whether economy is rapidly growing or declining. Though, their contribution only results in empirical analysis and leaves open economic explanations.

According to Bodman (1998), asymmetry can result for two main reasons. On the one hand, the shocks that an economy experiences take different forms. Thus, reactions to these shocks can be rather different at various stages of the business cycle¹³. On the other hand, it is possible that, even if shocks were identical in extent (but heading for opposite directions), positive shocks would have completely different impacts to negative ones¹⁴. The work of Altissimo and Violante (1998) for example shows that positive shocks are more persistent than negative ones independently of the regime they are occurring in. Huang and Chang (2005) stress a number of other reasons for asymmetry, namely factor substitution during cycles, fluctuations in multi-factor productivity, and changes in the distribution sector growth rates.

Another reasonable argument questioning Okun's specification of linearity is put forward by Zagler (2000). According to him, there is no doubt that positive demand shocks will encourage firms to hire new workers, thus reducing the unemployment rate. Given the case that increased demand leads to a decline in unemployment before demand returns to its starting point, the question arises how Okun's approach can explain persistent unemployment (keep in mind, job destruction as a function of changes in demand usually does not happen simultaneously because of labour market regulations). According to Zagler's theory, expansions are likely to have a larger effect on unemployment, as the effects caused by an expansionary regime are more directly transmitted to the unemployment rate¹⁵.

In the case of an expansionary regime, Aghion and Howitt (1994) discuss the so-called *capitalization effect*. This comes into play when demand is rising and simply means that, due to an improved economic situation, founding a firm is more attractive than before. As a result of such start-ups the demand for labour rises and unemployment decreases.

¹³ For instance, the labour market will react far more enthusiastically to a positive shock occurring at the end of a persistent recession, rather than a more moderate shock when the economy has been growing for a longer period.

¹⁴ For instance, labour market laws do not allow firms to fire workers immediately when negative shocks occur, but positive shocks can lead to spontaneous hiring.

¹⁵ Overall, Zagler points out that jobs are created more quickly than they are destroyed. Hence, according to him the unemployment rate is supposed to decline in the long-run.

A further argument for there being a stronger relationship between output growth and the unemployment rate during upswings is proposed by Silvapulle et al. (2004). These authors claim that firms are – by law – usually more restrained in respect to firing workers than they are in respect of hiring new employees. Hence, firms who increase their staff during economic growth find it more difficult to shed workers when business declines. Similarly, employers tend to invest in staff training and are therefore reluctant to lose that investment by laying off workers during downswings.

Others argue that the Okun's law relationship may be stronger during recessions. Acemoglu and Scott (1994) for example argue that during recessions jobs are generally destroyed very rapidly and radically. They go on to argue that this level of job destruction is usually so intense that subsequent periods of expansion cannot offset the damage that economy suffered during the recession. As a reason for this phenomenon, Acemoglu and Scott suggest that phases of recessions are sharper than expansions which seem to evolve more gradually (see also Lee, 2000). To conclude their argument they further suggest that the high degree of cyclical job destruction while an economy contracts has a stronger impact on the unemployment rate than an expansion has in terms of job creation. Further evidence consistent with these arguments is presented by Burgess (1992). Silvapulle et al. (2004) also put forward a possible rationale for recessions invoking a stronger response on the unemployment rate. According to them, employers tend to be pessimistic when an economy contracts, with employees being laid off very quickly. Once the economy is set to recover, entering a period of expansion, however employers tend to be rather cautious thus limiting the extent of job creation.

Again in Aghion and Howitt (1994) arguments are proposed suggesting that increased demand can cause a movement in the opposite direction. This would be the case if the *creative destruction effect* occurs, whereby an increase in demand leads to a reduced duration of a job match. As a result, the equilibrium rate of unemployment will rise directly, due to a higher separation rate, and indirectly, due to a reduced willingness to create job vacancies. Overall, their argument may support the assumption of recessions being more influential on the Okun's law relationship, as, obviously, the expected effect of economic growth (i.e., that the unemployment rate will decline) need not necessarily occur.

Other (indirect) arguments supporting the view that recessions might have a stronger influence on the unemployment rate are presented by Zagler (2000). Given the case of increased demand, Zagler expects new firms to enter the market. The efforts required to make these firms successful combine with the natural increase in demand for workers to impact upon the Okun's law relationship. Zagler argues that not all of the firms will be successful immediately and as such will be forced to withdraw job offers. To offset such insecure job offers workers will negotiate a risk premium. The effect of this will be to decrease the profits gained by incumbent firms and negatively affect their supply functions, reducing their willingness and ability to invest. In consequence, precarious jobs will be reduced, and hence unemployment is supposed to increase. Zagler does not claim that recessions seem to have stronger influence than expansions, but argues that the influence of expansions must not be overestimated. In other words, the expected decrease in unemployment due to expansions may be weakened by market failures, which could result in recessions being more effectful on the Okun's law relationship.

4.3 Empirical Evidence on Asymmetry in the Okun's Law Relationship

As with the existing literature considering a linear Okun's law relationship, studies of an asymmetric Okun's law relationship also tend to use varying specifications and country samples. The literature on asymmetries however starts out from the basic assumption that a relationship between the unemployment rate and output does exist, that is, there is a presumption that Okun's law holds. Table 5 in *Appendix C* summarises the results from studies considering asymmetry in the Okun's law relationship.

Silvapulle et al. (2004) consider asymmetric behaviour for post-war U.S data (1947 – 1999), by using a gap model. They start with a basic distributed lag model approach, as seen in Weber (1995).

$$6) \quad u_t^c = \sum_{j=1}^p \alpha_j u_{t-j}^c + \sum_{j=1}^q \beta_j y_{t-j}^c + \varepsilon_t$$

where the cyclical components of the unemployment rate and output are obtained using Harvey's decomposition method.

Their next step is to distinguish between positive and negative cyclical components (i.e. expansions and recessions), which is done by formulating an indicator function with a cut-off threshold of 0. This is done in order to allow for detecting regime switches in the relationship:

$$I_t^+ = \begin{cases} 1 & \text{if } y_t^c \geq 0 \\ 0 & \text{if } y_t^c < 0 \end{cases}$$

$$I_t^- = \begin{cases} 1 & \text{if } y_t^c < 0 \\ 0 & \text{if } y_t^c \geq 0 \end{cases}$$

Where I is the indicator function.

After some further reformulating their estimating equation is,

$$7) \quad u_t^c = \alpha_0 + \sum_{j=1}^p \alpha_j u_{t-j}^c + \sum_{j=1}^q \theta_j I_t^+ y_{t-j}^c + \sum_{j=1}^q \delta_j I_t^- y_{t-j}^c + \varepsilon_t$$

This model thus allows them to estimate a different OLC depending upon whether a country's output is above or below its trend level. Silvapulle et al. find a long-run OLC of -0.42 . More precisely, Silvapulle et al. define this value of -0.42 as an “average” coefficient, which is derived from the two single coefficients determined for the regimes of expansion (-0.25) and recession (-0.61). Their results therefore support the conclusion that recessions exert significantly more influence on the unemployment rate than expansions do. While the arguments described above suggesting that legal circumstances prevent firms from a high number of spontaneous dismissals following an economic downturn do not appear to be valid for the U.S therefore - it may nevertheless be the case that for countries with more rigid labour market legislation (i.e., EU countries, JAP) such a hypothesis may hold.

A study across 16 OECD countries by Lee (2000) includes the two main methodological approaches (that is, both the first-difference and gap model), with the gap model being applied using three alternative methods of detrending (the HP filter, the Beveridge-Nelson decomposition, and the Kalman Filter). Formulations of the basic approaches behind both specifications can again be found in equations 2 and 5.

In order to allow for asymmetric behaviour, Lee introduces an indicator function enabling to distinguish between regimes¹⁶.

$$I_{1,t}^+ = \begin{cases} 1 & \text{if } \Delta u_t \geq 0 \\ 0 & \text{if } \Delta u_t < 0 \end{cases}$$

$$I_{1,t}^- = \begin{cases} 1 & \text{if } \Delta u_t < 0 \\ 0 & \text{if } \Delta u_t \geq 0 \end{cases}$$

while, that for the gap model is given by

$$I_{2,t}^+ = \begin{cases} 1 & \text{if } (u_t - u_t^*) \geq 0 \\ 0 & \text{if } (u_t - u_t^*) < 0 \end{cases}$$

$$I_{2,t}^- = \begin{cases} 1 & \text{if } (u_t - u_t^*) < 0 \\ 0 & \text{if } (u_t - u_t^*) \geq 0 \end{cases}$$

Lee's final estimating equations are then given by,

$$8) \quad \Delta y_t = \beta_0 - (\beta_1^+ I_{1,t}^+ \Delta u_t + \beta_1^- I_{1,t}^- \Delta u_t) + \varepsilon_t \quad (\text{first-differences})$$

$$9) \quad y_t - y_t^* = -[\beta_1^+ I_{2,t}^+ (u_t - u_t^*) + \beta_1^- I_{2,t}^- (u_t - u_t^*)] + \varepsilon_t \quad (\text{gap model})$$

The first-difference approach obtains mixed evidence in favour of asymmetric behaviour, with recessions found to lead to a stronger response of the unemployment rate for FIN, JAP and the U.S. Surprisingly, for CAN, FRA and NET the OLC is larger during expansions. The results from the gap-model suggest more clearly that recessions tend to be associated with a larger value of the OLC. Interestingly however, neither the U.S nor the U.K are found to be subject to significant asymmetries. Additionally, Lee shows that the OLC of European countries is in general lower than that in the U.S, and that there is a notable degree of cross-country heterogeneity in the estimated OLC. This heterogeneity may be due to structural differences in country-specific labour markets. In conclusion, Lee questions whether the common emphasis on U.S data is fully reliable and relevant for all countries.

¹⁶ The threshold is once again exogenously imposed and assumed to be equal to 0. Notably, in Lee's approach the unemployment rate is the independent variable. Hence, he uses the change in the unemployment rate as indicator for whether economy is in recession or in expansion. According to Lee (2000), the validity of the results reported does not depend upon which variable is chosen to be the explanatory one.

Huang and Chang (2005) use quarterly Canadian data (1960:1 – 2002:4) to consider the importance of structural breaks and regime-dependent differences in the OLC. Besides one structural break which is found to occur after 1992, they determine one threshold value for each detrending method applied. Only in the period prior to the structural break (i.e., 1960:1 – 1992:4) do the results support the hypothesis of a significant presence of a recessionary and an expansionary regime¹⁷. For this period, the OLC is highly significant in both regimes. The coefficients in the two regimes are much different however, with a short-run OLC of -0.19 for the recessionary regime and -0.10 for the expansionary regime. As such, the impact of output on the unemployment rate tends to be twice as strong during periods of recession. Interestingly, the reverse is true for the full sample, with a value of the OLC of -0.36 for recessions and -0.51 for expansions. Hence, expansions tend to affect the unemployment rate to a greater extent in the long-run.

Crespo-Cuaresma (2003) uses quarterly U.S data to consider the importance of asymmetry. A special feature of this work is that rather than impose a threshold on the data he allows the data to determine the presence and positioning of any threshold. The data is first detrended using either the HP filter or Harvey's decomposition. Using this data the results from a linear specification suggest an OLC of -0.17. The endogenous threshold approach adopted by Crespo-Cuaresma can be formulated as,

$$10) u_t^c = \alpha_0^i + \beta^i y_t^c + \sum_{j=1}^{p_i} \alpha_j^i u_{t-j}^c + \varepsilon_t^i$$

with $i = 1, 2$

The value for i depends on whether the country is above or below the estimated threshold. In particular, it is:

$$i = \begin{cases} 1 & \text{if } y_t^c > \gamma \\ 2 & \text{if } y_t^c < \gamma \end{cases}$$

Equation 10 can thus be rewritten as:

¹⁷ For the period after the structural break, no significant regime-dependent differences can be found. The basic Okun's law relationship is still present during this period however.

$$11) u_t^c = \left(\alpha_0^1 + \beta^1 y_t^c + \sum_{j=1}^{p_1} \alpha_j^1 u_{t-j}^c + \varepsilon_t^1 \right) + \left(\alpha_0^2 + \beta^2 y_t^c + \sum_{j=1}^{p_2} \alpha_j^2 u_{t-j}^c + \varepsilon_t^2 \right)$$

The value of the threshold, γ , is found by estimating the model for different values of cyclical output and choosing the value of γ as that which minimises the sum of squared errors. Existence of a threshold is tested by testing the above model against the linear model, which is achieved through a bootstrap procedure. Crespo-Cuaresma's finds evidence of a significant threshold (-0.389 and -0.143 for the HP and Harvey's detrending methods respectively)¹⁸ with the coefficient in the recessionary regime found to be -0.24 (-0.44) and that in the expansionary regime found to be -0.07 (-0.20) for the HP (Harvey's) detrending method. Hence, Crespo-Cuaresma finds clear evidence, in terms of absolute size and level of significance, that recessions have a larger impact on the unemployment rate than expansions¹⁹. In respect to unemployment shocks, Crespo Cuaresma finds that they appear to be more persistent during expansions than during recessions.

Holmes and Silverstone (2005) contribute to the issue of asymmetry by checking for cross-regime and for within-regime asymmetries²⁰. They find mixed evidence in favor of asymmetry. The strongest OLC is estimated for the case of upswings when the unemployment rate is below trend, the lowest OLC, in contrast, for upswings when unemployment is above trend. Lying somewhere between these two expansionary cases is found the OLC for downswings in respect of unemployment either above or below trend.

Harris and Silverstone (2001) obtain further evidence suggesting a high degree of country-specific behaviour. By applying an error correction model they obtain results on both long-run and short-run behaviour. In the long-run, they find that the OLC ranges between -0.39 and -0.50 for their sample of seven OECD countries, with the exception of Japan which has a coefficient of -0.09. Considering the possibility of asymmetric behaviour, Harris and Silverstone find some interesting results. Firstly, they find that Japan is much faster at

¹⁸ Interestingly, the confidence intervals of these estimates both contain the value of zero, suggesting that the imposition of zero in other studies may not be problematic.

¹⁹ Notably, Crespo-Cuaresma's results appear to be robust across the different detrending methods applied.

²⁰ By cross-regime asymmetry the authors question whether expansions or recessions have a stronger impact on the response of the unemployment rate, while within-regime asymmetry asks whether expansions or recessions evoke the same response in the unemployment rate, in respect of whether the unemployment rate is above or below trend level.

returning to equilibrium than other countries, which is a potential explanation for the low value of the OLC found for this country. They find further that expansions in JAP, AUS and the U.K have the ‘wrong’ impact on the unemployment rate, with the unemployment rate not decreasing. Moreover, in JAP and the U.K output is highly likely to decrease rapidly after an expansion has occurred. Overall, there is evidence that downturns increase the unemployment rate significantly, whilst the effect of upturns on the unemployment rate is, if anything, negative. Interestingly, the U.S is found to be the country with the highest likelihood of exhibiting “expected” behaviour. Either way, the results obtained by Harris and Silverstone (2001) support the claims put forward by Lee (2000) that OECD countries generally exhibit heterogeneous behaviour in the output-unemployment relationship.

5. Data and Detrending

Rather than consider a single country, this paper considers the Okun’s law relationship and asymmetry in the relationship for seven OECD countries²¹. The reason for this is, as noted above in section 4.3, that there are reasons to suppose that the size of the OLC and the extent and presence of asymmetry may differ across countries (see also Lee, 2000). The raw data comes from the OECD and is quarterly data on the logged value of GDP and the standardised unemployment rate (both seasonally adjusted). Information on the cyclical component of output and the unemployment rate is required in order to undertake the empirical analysis. In order to extract the cyclical components of the two series the Hodrick-Prescott Filter is used. The cyclical components for output and the unemployment rate are reported in figures 1–7 in *Appendix D*. A glance at these figures would tend to support the Okun’s law relationship with high levels of cyclical output tending to correspond with low levels of cyclical unemployment rates.

6. Methodology and Econometric Approach

The approach adopted in this paper consists of three main steps. Firstly, for each country the OLC is estimated using the linear model, in a manner equivalent to that common in traditional research on Okun’s law. The approach differs from some of the earlier literature on the Okun’s law relationship by accounting for dynamics in this relationship.

²¹ The countries being: AUS, CAN, FRA, ITA, JAP, U.K, U.S

The basic approach adopted to estimate the linear Okun's relationship can be written as follows:

$$12) u_t^c = \alpha_0 + \beta_0 y_t^c + \sum_{l=1}^L \alpha_l u_{t-l}^c + \varepsilon_t$$

where u_t^c denotes the cyclical unemployment rate, y_t^c is cyclical output and u_{t-l}^c are lags of the dependent variable to account for the dynamics in the Okun's law relationship. The OLC is given by β_0 .

Determining the number of lags of the dependent variable to include for each country is achieved by considering the AIC (Akaike Information Criterion) method with a maximum lag length of six. Support for this method can be found in Crespo Cuaresma (2003) or in Huang (2003)²².

Secondly - as a first step towards checking for asymmetric behaviour, an exogenous threshold is imposed at zero in order to distinguish between the state of either recession or expansion. – This follows the approach of Lee (2000) amongst others This model can be expressed as follows:

$$13) u_t^c = \alpha_{0,1} I(y_t^c \leq 0) + \alpha_{0,2} I(y_t^c > 0) + \beta_{0,1} y_t^c I(y_t^c \leq 0) + \beta_{0,2} y_t^c I(y_t^c > 0) + \sum_{l=1}^L \alpha_{l,1} u_{t-l}^c I(y_t^c \leq 0) + \sum_{l=1}^L \alpha_{l,2} u_{t-l}^c I(y_t^c > 0) + \varepsilon_t$$

Where I is the indicator function. This specification allows to estimate a separate OLC depending upon whether cyclical output is negative, $\beta_{0,1}$, or positive, $\beta_{0,2}$. As can also be seen from equation (13) this specification allows the constant and on the lags of the dependent variable to vary across regimes.

As a final step in the analysis, rather than impose a threshold on cyclical output at zero the threshold is estimated along with the remaining parameters of the model. The model for

²² According to the AIC, the chosen lag lengths are as follows: AUS: 4; CAN: 5; FRA: 2; ITA: 1; JAP: 4; U.K: 2; U.S: 3;

estimating a single threshold follows the approach of Crespo-Cuaresma (2003) and can be expressed as:

$$14) \quad u_t^c = \alpha_{0,1}I(y_t^c \leq \gamma) + \alpha_{0,2}I(y_t^c > \gamma) + \beta_{0,1}y_t^c I(y_t^c \leq \gamma) + \beta_{0,2}y_t^c I(y_t^c > \gamma) + \sum_{l=1}^L \alpha_{l,1}u_{t-l}^c I(y_t^c \leq \gamma) + \sum_{l=1}^L \alpha_{l,2}u_{t-l}^c I(y_t^c > \gamma) + \varepsilon_t$$

where γ is the threshold, which has to be estimated along with the other parameters. According to this specification, observations with a value of cyclical output below γ will be classified as downturns, while observations greater than γ will be considered upturns. Once again the OLC and the remaining parameters are allowed to vary across the two regimes. An initial problem in estimating this model is how to estimate the threshold γ . According to Chan (1993) and Hansen (2000), γ can be estimated by choosing the value of cyclical output that minimises the sum of squared errors. In practice, this method involves considering distinct value of cyclical output, estimating the above model for each value and saving the sum of squared residuals. The estimate for γ is that value of cyclical output for which the sum of squared residuals is smallest. In order to avoid too few observations being in one of the two regimes the restriction is imposed that the value of γ must lie between the 25% and the 75% quantile of the distribution of cyclical output. Once there is an estimate for γ it is straightforward to estimate the parameters of the model, in a similar manner to that used in equation (14).

After obtaining an estimate for the threshold it is important to test whether the threshold is significant, i.e. whether there are differences in the coefficients across the two regimes. This however has been shown not to be straightforward as the estimated threshold, $\hat{\gamma}$, is not identified under the null hypothesis. As such, standard, tabulated values cannot be used. Hence, a bootstrap procedure proposed by Hansen (1996) is used to simulate the asymptotic distribution of the likelihood ratio test. This method can be described briefly as follows: Firstly, estimate the model under the null (of linearity, i.e. no threshold) and alternative hypothesis (assuming a threshold at value $\hat{\gamma}$). The actual value of the likelihood ratio test (F_1) is then given by:

$$15) \quad F_1 = \frac{S_0 - S_1(\hat{\lambda}_1)}{\hat{\sigma}^2} \quad \text{where} \quad \hat{\sigma}^2 = \frac{1}{n(t-1)} S_1(\hat{\lambda}_1)$$

Where S_0 and S_1 are the sum of squared errors from the linear and threshold model respectively. According to Hansen (2000), the required bootstrap can be derived by drawing from the normally distributed residuals of the estimated threshold model. Then, as in Hansen (2000), repeated bootstrap samples with fixed regressors are created. By estimating the threshold model - again under the null and alternative - with this new sample, a new likelihood ratio test statistic (F_1) is computed. This procedure is repeated a large number of times (i.e. 1000). The obtained estimation of the p-value for F_1 under the null hypothesis is equal to the percentage of draws for which the simulated test statistic is above the actual statistic.

7. Empirical Results

Linear Model:

The results from the linear model are reported in Table 1. All countries have a negative OLC that is significant, suggesting that the Okun's law relationship holds for all countries in the sample. Among the sample, the long-run OLC values lie between -0.045 (JAP) and -0.19 (CAN). Hence, the range of estimates is lower than most existing estimate (*Appendix C*). Despite this the relative size of the coefficients is consistent with existing results, in that the U.S and CAN have larger negative OLC coefficients than European countries and JAP. These findings are consistent with the findings provided by Moosa (1997). According to him, the fact that the OLC is particularly high in CAN and U.S is mainly due to lacking job security restrictions. Therefore, employers can more easily fire workers (which then is the case mostly during recessions). Overall, this leads to a stronger response of the unemployment rate to output growth.

Other things to note from Table 1 are that the relevant number of lags in the model varies between 1 and 5 across the sample. The Q-statistics indicate that there is no evidence of serial correlation in the residuals, but there is some evidence suggesting that the residuals for AUS and ITA are not normally distributed.

Table 1: Linear specification

	α_0	β	Lags	Sample	Obs	Q(2)	Q(4)	JB	R^2
AUS	2.94E-5 (0.14)	-0.151 (-3.76)***	4	1980:1 – 2004:3	99	0.14	1.38	43.33***	0.94
CAN	6.82E-5 (0.27)	-0.19 (-5.65)***	5	1980:1 – 2004:3	99	0.67	1.03	2.50	0.92
FRA	1.59E-5 (0.16)	-0.10 (-5.62)***	2	1982:1 – 2004:3	91	1.55	5.05	3.68	0.97
ITA	1.22E-5 (-0.08)	-0.076 (-3.32)***	1	1982:1 – 2002:4	84	1.16	1.62	8.57**	0.88
JAP	-3.92E-6 (-0.04)	-0.045 (-5.73)***	4	1980:1 – 2004:3	99	0.60	1.60	0.95	0.77
U.K	4.87E-5 (0.41)	-0.10 (-6.88)***	2	1982:1 – 2004:2	90	2.14	2.28	2.39	0.97
U.S	-2.38E-5 (-0.16)	-0.18 (-5.97)***	3	1980:1 – 2004:3	99	3.27	4.86	4.46	0.93

Notes: *, ** and *** indicate significance at the 10,5 and 1 percent levels respectively. JB denotes the results for the Jarque-Bera test of the normality of the residuals. Q(2) and Q(4) report the Ljung-Box statistics for serial correlation at lags 2 and 4.

Exogenous threshold model:

The results for the exogenous threshold specification (where the threshold is set at a cut-off value of 0) are reported in Table 2 and give a first impression of regime-dependent variation in the OLC. In four countries (AUS, CAN, JAP, U.S), the OLC for the recessionary regime is higher than that for the expansionary case. For CAN the difference in the coefficients is large, with the coefficient twice as large in the recessionary regime (recession: -0.364; expansion -0.182). The other countries with higher OLC values for the recessionary case (AUS, JAP, U.S) exhibit much smaller differences in the OLC in the two regimes. Indeed, only in the case of CAN does the Wald test suggest that the coefficients in the two regimes are significantly different.

In the remaining countries (FRA, ITA, U.K) the results suggest that the OLC is larger in absolute value in the expansionary regime. While the differences tend to be relatively small and not significant, for ITA the coefficient in the expansionary regime is more than double that in the recessionary regime.

Table 2: Exogenous threshold specification

	α_1	α_2	β^1	β^2	Lags	Wald	Q(2)	Q(4)	JB	R ²
AUS	-9.83E-5 (-0.27)	5.51E-5 (0.11)	-0.16 (-2.74)***	-0.151 (-2.77)***	4	0.02	0.10	1.30	39.29***	0.94
CAN	-0.002 (-2.09)**	0.001 (1.28)	-0.364 (-4.04)***	-0.182 (-3.75)***	5	3.17*	0.15	0.93	0.47	0.93
FRA	0.0003 (1.22)	8.66E-5 (0.26)	-0.079 (-2.76)***	-0.084 (-2.96)***	2	0.02	1.73	4.58	2.25	0.97
ITA	-0.0003 (-0.83)	0.001 (2.74)***	-0.095 (-1.61)	-0.213 (-3.74)***	1	2.06	0.33	0.87	8.40**	0.90
JAP	0.0002 (0.91)	-0.0001 (-0.62)	-0.042 (-1.79)*	-0.027 (-1.93)*	4	0.30	1.00	2.53	0.51	0.79
U.K	0.0001 (0.32)	0.0003 (1.42)	-0.092 (-2.83)***	-0.116 (-4.34)***	2	0.31	2.37	2.77	2.37	0.97
U.S	1.03E-5 (0.02)	-0.0004 (-0.98)	-0.159 (-2.96)***	-0.153 (-4.23)***	3	0.01	2.47	4.93	5.47*	0.94

Notes: *, ** and *** indicate significance at the 10, 5 and 1 percent levels respectively. JB denotes the results for the Jarque-Bera test of the normality of the residuals. Q(2) and Q(4) report the Ljung-Box statistics for serial correlation at lags 2 and 4.

Endogenous threshold model:

The results in Table 3 show the estimates of the non-linear specification when the threshold is estimated rather than imposed at a value of zero. Thus, the estimated threshold determined for each country is responsible for defining the regime specification applicable to each country. Hence, if the actual output change is below this threshold, the country is considered to be in recession. Significant threshold values, that is, the coefficients in the two regimes are significantly different, are found for AUS, CAN, FRA and ITA. While all of the significant thresholds are found to be negative, their values are close to zero. *Appendix E* reports the confidence intervals for the estimated thresholds, and in all cases the confidence interval includes zero, suggesting that imposing a threshold at zero need not be problematic. The estimated thresholds generally result in a large number of periods under each regime, in the case of AUS for example the dataset consists of 30 recessionary periods and 69 periods of expansion.

In respect of the significant country-specific thresholds, there are some interesting findings. Recessions have a stronger influence on unemployment in four countries (AUS, CAN, JAP, U.S.)²³, though only in the case of AUS and CAN are the differences significant. For AUS and the U.S, the OLC in the recessionary case does not only exceed its expansionary counterpart in absolute magnitude, but also in terms of significance. The results for AUS and CAN suggest large differences in the OLC across regimes, with the coefficient much larger in the

²³ Comparing the results with those of the exogenous threshold model, the same countries tend to have a larger OLC in the recessionary regime. Only for JAP, there is no longer a significant OLC.

recessionary regime. The case of JAP is interesting in that the coefficient is larger in absolute magnitude in the recessionary regime, but the coefficients in both regimes are not significant. Similar to the above results, the unemployment rates of FRA, ITA and U.K react more strongly to changes in output in the expansionary regime. For these three countries, OLC values in expansions are both higher in absolute magnitude and more significant than OLC values in recessions. Only in the cases of FRA and ITA however are the coefficients in the two regimes significantly different. In the case of FRA only the expansionary case leads to a significant OLC.

Table 3: Endogenous threshold model

	α_1	α_2	β_1	β_2	Lags	λ	obs	Q(2)	Q(4)	JB	R ²
AUS	0.0004 (0.63)	-0.0001 (-0.36)	-0.205 (-4.17)***	-0.090 (-2.50)**	4	-0.0049 (0.063)*	30/69 (30 th)	0.46	0.97	11.13***	0.95
CAN	-0.002 (-2.95)***	0.001 (1.70)*	-0.386 (-5.98)***	-0.212 (-3.91)***	5	-0.0017 (0.011)**	47/52 (47 th)	0.001	0.81	0.63	0.93
FRA	0.001 (2.53)**	-9.04E-5 (-0.58)	-0.025 (-0.50)	-0.08 (-3.11)***	2	-0.004 (0.097)*	63/36 (64 th)	1.70	3.74	2.37	0.97
ITA	-0.0003 (-0.93)	0.001 (2.47)**	-0.095 (-2.27)**	-0.213 (-3.73)***	1	-0.0003 (0.027)**	44/48 (48 th)	0.33	0.89	8.40**	0.90
JAP	0.0003 (1.49)	-0.0003 (-1.31)	-0.03 (-1.41)	-0.016 (-0.84)	4	0.00048 (0.117)	52/47 (53 rd)	0.94	2.54	2.39	0.80
U.K	0.0004 (1.09)	0.0001 (0.60)	-0.07 (-2.17)**	-0.12 (-4.68)***	2	-0.002 (0.188)	43/56 (43 rd)	1.94	2.10	3.18	0.97
U.S	-2.42E-5 (-0.10)	-0.0002 (-0.16)	-0.163 (-5.24)***	-0.144 (-1.79)**	3	0.0064 (0.257)	67/33 (68 th)	2.22	4.74	7.57**	0.93

Notes: *, ** and *** indicate significance at the 10, 5 and 1 percent levels respectively. JB denotes the results for the Jarque-Bera test of the normality of the residuals. Q(2) and Q(4) report the Ljung-Box statistics for serial correlation at lags 2 and 4. λ reports the estimated threshold value, with the p-value in parenthesis; the p-value is the test for significance of the threshold, and is determined according to Hansen's (1996) bootstrap procedure with 1000 repetitions.

8. Conclusion

In 1962, Okun considered the relationship between the unemployment rate and output for the U.S and found an inverse relationship between the two. The resulting Okun's law relationship has evolved to become one of the most important rules-of-thumb in macroeconomics. Being empirically supported by various researchers, the validity of Okun's law is no longer questioned, though later researchers have questioned the presence of a linear relationship between output and unemployment. As such, this paper evaluates whether there are significant differences in the Okun's law relationship depending upon whether a country is in recession or expansion. In other words, this paper investigates Okun's law by examining whether economic upturns and downturns lead to a differential impact of output on unemployment.

This contribution investigates asymmetry in the Okun's relationship law by using a regime-switching dynamic estimation model with an endogenously estimated threshold, as suggested by Crespo-Cuaresma (2003). The model is estimated on a sample of seven OECD countries, which allows to consider differences in the Okun's law relationship and the direction and extent of asymmetry across countries. Existing studies on asymmetry in the Okun's law relationship, such as Lee (2000), Silvapulle et al. (2001) and Crespo-Cuaresma (2003) tend to find evidence of asymmetry, with a tendency for the OLC to be larger in absolute value in the recessionary regime. In line with the cross-country comparison conducted of Lee (2000)²⁴, the results in this paper support the generally asymmetric behaviour of the Okun's law relationship, but generates even more mixed evidence in respect of the direction of the influence. In three of the seven countries examined (AUS, CAN, U.S), the Okun's law relationship is stronger in recessions, while in three of the countries (FRA, ITA, U.K) the OLC is larger in expansions. For the seventh country (JAP), the endogenous threshold model shows that the OLC is insignificant in both regimes, though, if anything, the results point to the OLC being stronger in recessions²⁵. It should be noted that for the U.K and the U.S the hypothesis of the OLC being the same in the two regimes cannot be rejected, despite differences in the size of the coefficients. Concentrating on the results for the U.S the results reported here are consistent with those reported by Silvapulle et al. (2001) and Crespo-Cuaresma (2003) suggesting that the relationship is stronger in recessions, although as mentioned the hypothesis that the coefficients in the two regimes are equal cannot be rejected.

²⁴ Most relevant for the comparison are the results of Lee obtained using the gap-model (detrended by using the HP filter)

²⁵ According to Lee (2000) the OLC is larger for five countries (AUS, FRA, JAP, U.K, U.S) when cyclical output is negative. Interestingly, Lee finds that the OLC for CAN is larger when cyclical output is positive. For Italy no significant results are found.

For CAN the results are in line with Huang and Chang (2005) who also find that the Okun's law relationship is stronger in recessions, but are in contrast to Lee (2000). There are a number of reasons why the results presented here may be different to previous studies, and why in general less evidence for asymmetry is found than in other studies. The main reason being the time period considered. This paper concentrates on an (approximately) common sample across countries considering the period after 1980. As such, it ignores the 1970s where the oil crises may have altered the Okun's law relationship and which may be partially deriving previous results.

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10. Appendices

Appendix A

In addition to other approaches, Okun (1962) put forward the following method to determine the output-unemployment coefficient. The starting point is:

$$15) \frac{N}{N_F} = \left(\frac{A}{P} \right)^a$$

where: $N = 100 - U$ as the “employment rate”
 N_F as the potential level of the employment rate
 A as actual output
 P as potential output

In addition can be written:

$$16) P_t = P_0 e^{rt}$$

where: P_0 is the assumed starting level of potential output
 r is the constant growth rate of potential output

After substitution and some rearranging, the formula can be expressed as:

$$17) N_t = \frac{A_t^a N_F}{P_0^a e^{art}}$$

which can be expressed in logarithmic form as:

$$\log N_t = \log \frac{N_F}{P_0^a} + a \log A_t - a (rt)$$

where a depicts the output elasticity of the unemployment rate.

Appendix B

Table 4: Empirical results for OLC

	Country	Sample/Period	Approach	OLC
Lee (2000)	U.S	1955 - 1996	gap method	-2.09*
	U.K	1955 - 1996	- " -	-1.41*
	AUS	1955 - 1996	- " -	-1.81*
	ITA	1955 - 1996	- " -	-0.57*
	JAP	1955 - 1996	- " -	-6.55*
	CAN	1955 - 1996	- " -	-1.58*
	FRA	1955 - 1996	- " -	-2.20*
Lee (2000)	U.S	1955 - 1996	first-difference	-1.84*
	U.K	1955 - 1996	- " -	-1.39*
	AUS	1955 - 1996	- " -	-1.53*
	ITA	1955 - 1996	- " -	-1.09*
	JAP	1955 - 1996	- " -	-4.41*
	CAN	1955 - 1996	- " -	-1.68*
	FRA	1955 - 1996	- " -	-2.91*
Crespo-Cuaresma (2003)	U.S	1965:1 - 1999:1	gap method	-0.17
Silvapulle et al. (2004)	U.S	1947:1 - 1999:4	gap method	-0.42**
Huang/Chang (2005)	CAN	1960:1 - 2002:4	gap method	-0.08
Harris/Silverstone (2001)	U.S	1978:1 - 1998:4	gap method	-0.44
	U.K	1978:1 - 1998:3	- " -	-0.26
	AUS	1978:1 - 1998:3	- " -	-0.50
	JAP	1978:1 - 1998:3	- " -	-0.09
	CAN	1978:1 - 1998:4	- " -	-0.39
Freeman (2001)	U.S	1958 - 1998	gap method	-2.26*
	U.K	1958 - 1998	- " -	-1.30*
	AUS	1958 - 1998	- " -	-2.19*
	ITA	1958 - 1998	- " -	-1.05*
	JAP	1958 - 1998	- " -	-3.92*
	CAN	1958 - 1998	- " -	-1.85*
	FRA	1958 - 1998	- " -	-1.91*
Attfield/Silverstone (1998)	U.K	1959 - 1994	gap method	-1.45*
Moosa (1997)	U.S	1960 - 1995	gap method	-0.49
	U.K	1960 - 1995	- " -	-0.48
	ITA	1960 - 1995	- " -	-0.20
	JAP	1960 - 1995	- " -	-0.12
	CAN	1960 - 1995	- " -	-0.60
	FRA	1960 - 1995	- " -	-0.44
Prachowny (1993)	U.S	1975:1 - 1988:4	first-difference	-0.69*
Sögner/Stiasny (2002)	U.S	1960 - 1999	first-difference	-0.52
	U.K	1960 - 1999	- " -	-0.58
	ITA	1960 - 1989	- " -	-0.21
	JAP	1960 - 1999	- " -	-0.12
	CAN	1960 - 1999	- " -	-0.60

Notes: OLC values stressed by “*” express a direct pay-off ratio between output growth and change in the unemployment rate (i.e., their meaning is, apart from absolute magnitude, comparable to Okun’s statement of a present 3:1 ratio); OLC determined by Silvapulle et al. (2004), stressed by “**”, is not an actual result, but an assumed average value of their estimates for both the recessionary and expansionary OLC

Appendix C

Table 5: Empirical results for OLC (asymmetric effects)

	Country	Sample/Period	Approach	OLC (recession)	OLC (expansion)
Lee (2000)	U.S	1955 - 1996	gap method	-2.14*	-2.06*
	U.K	1955 - 1996	- " -	-1.59*	-1.29*
	AUS	1955 - 1996	- " -	-2.06*	-1.55*
	ITA	1955 - 1996	- " -	-	-
	JAP	1955 - 1996	- " -	-10.86*	-6.37*
	CAN	1955 - 1996	- " -	-1.52*	-1.64*
	FRA	1955 - 1996	- " -	-2.44*	-1.99*
Lee (2000)	U.S	1955 - 1996	first-difference	-2.04*	-1.72*
	U.K	1955 - 1996	- " -	-1.43*	-1.37*
	AUS	1955 - 1996	- " -	-	-1.74*
	ITA	1955 - 1996	- " -	-1.81*	-
	JAP	1955 - 1996	- " -	-6.47*	-4.34*
	CAN	1955 - 1996	- " -	-0.90*	-2.03*
	FRA	1955 - 1996	- " -	-	-3.76*
Crespo-Cuaresma (2003)	U.S	1965:1 - 1999:1	gap method	-0.24	-0.07
Silvapulle et al. (2001)	U.S	1947:1 - 1999:4	gap method	-0.61	-0.25
Huang/Chang (2005)	CAN	1960:1 - 2002:4	gap method	-0.19	-0.10

Notes: OLC values stressed by “ * ” express a direct pay-off ratio between output growth and change in the unemployment rate (i.e., their meaning is, apart from absolute magnitude, comparable to Okun’s statement of a present 3:1 ratio); OLC determined by Silvapulle et al. (2004), stressed by “***”, is not an actual result, but an assumed average value of their estimates for both the recessionary and expansionary OLC

Appendix D

Figures 1-7 below plot the cyclical levels of output and cyclical unemployment rates for the seven OECD countries. In general, each of figures 1-7 show (at least graphically) that peaks in the cyclical level of output are associated with troughs in the cyclical unemployment, thus providing some initial support for the Okun's law relationship.

Figure 1: Cyclical GDP and the cyclical unemployment rate for Australia

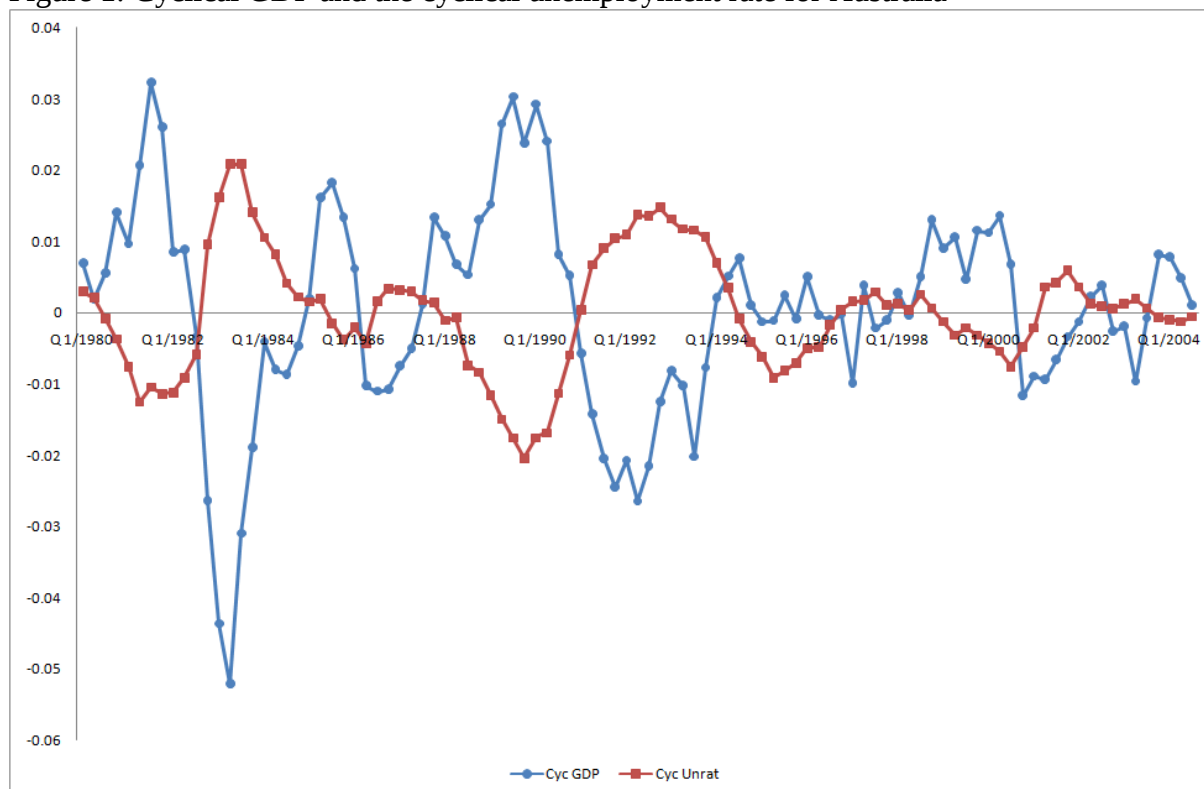


Figure 2: Cyclical GDP and the cyclical unemployment rate for Canada

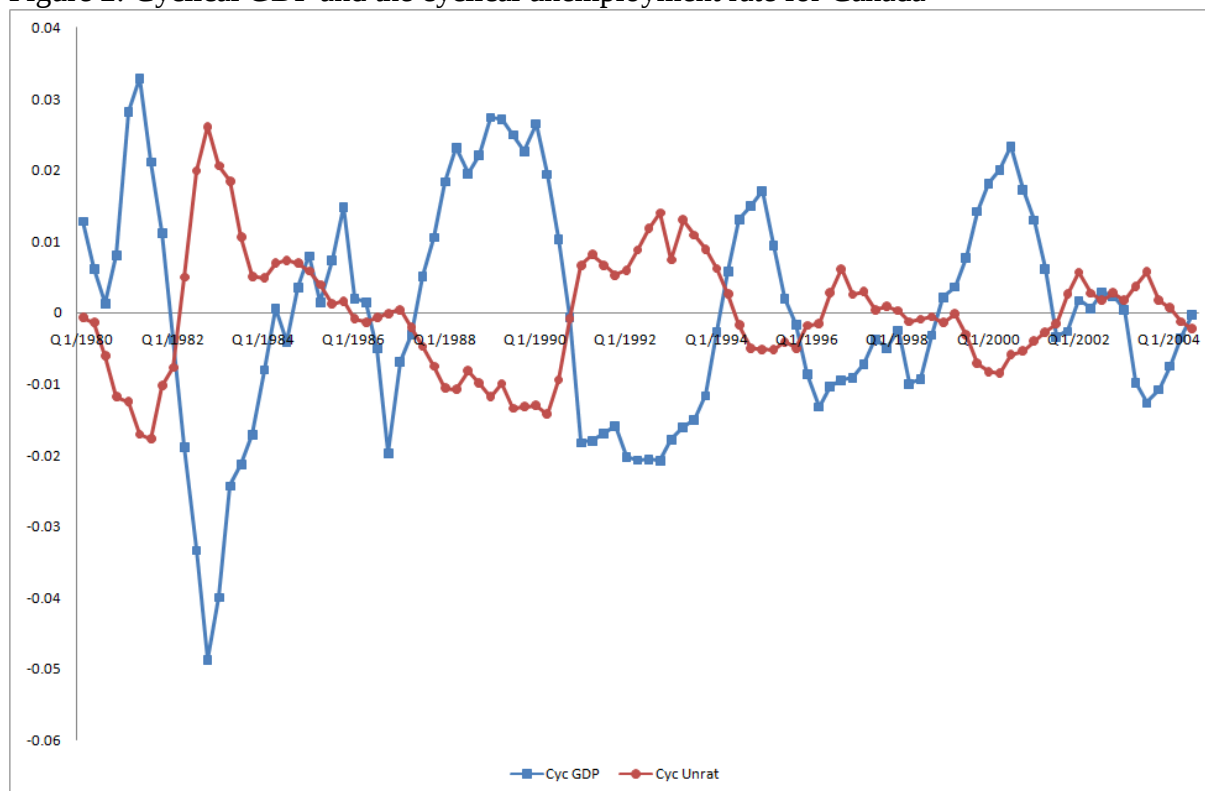


Figure 3: Cyclical GDP and the cyclical unemployment rate for France

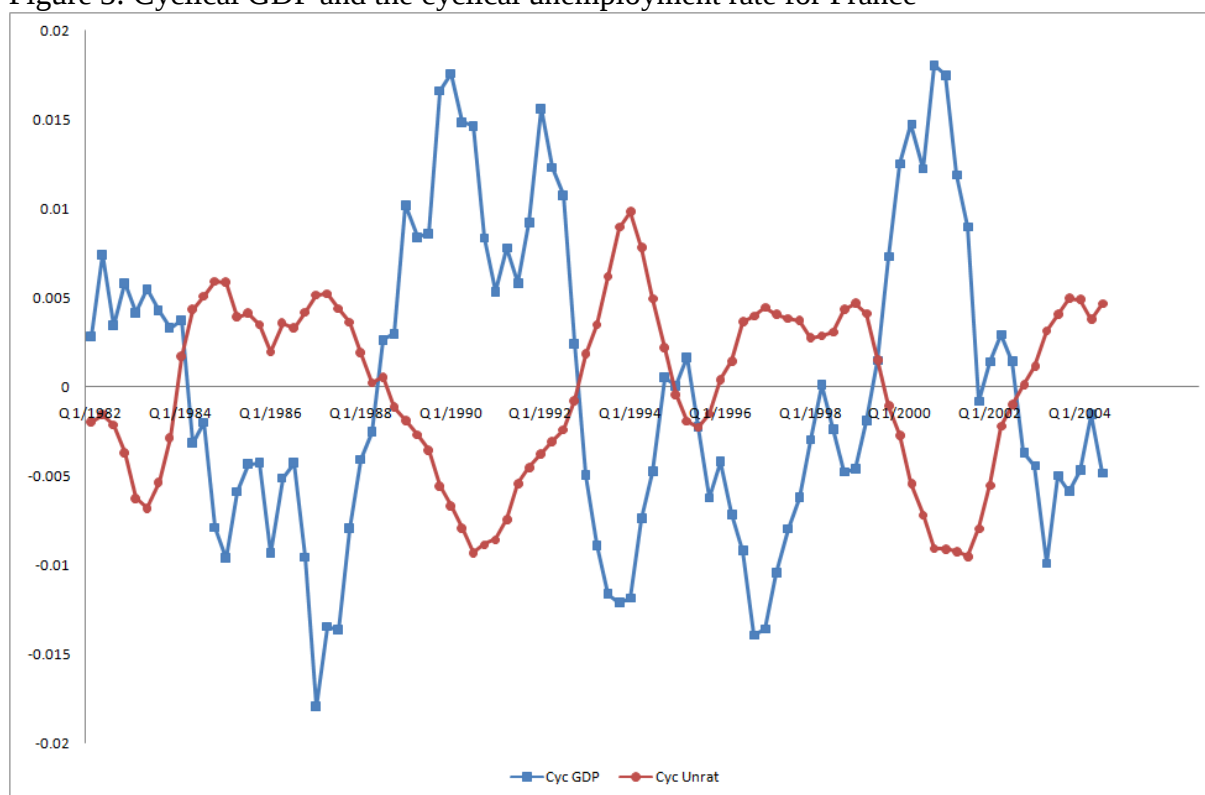


Figure 4: Cyclical GDP and the cyclical unemployment rate for Italy

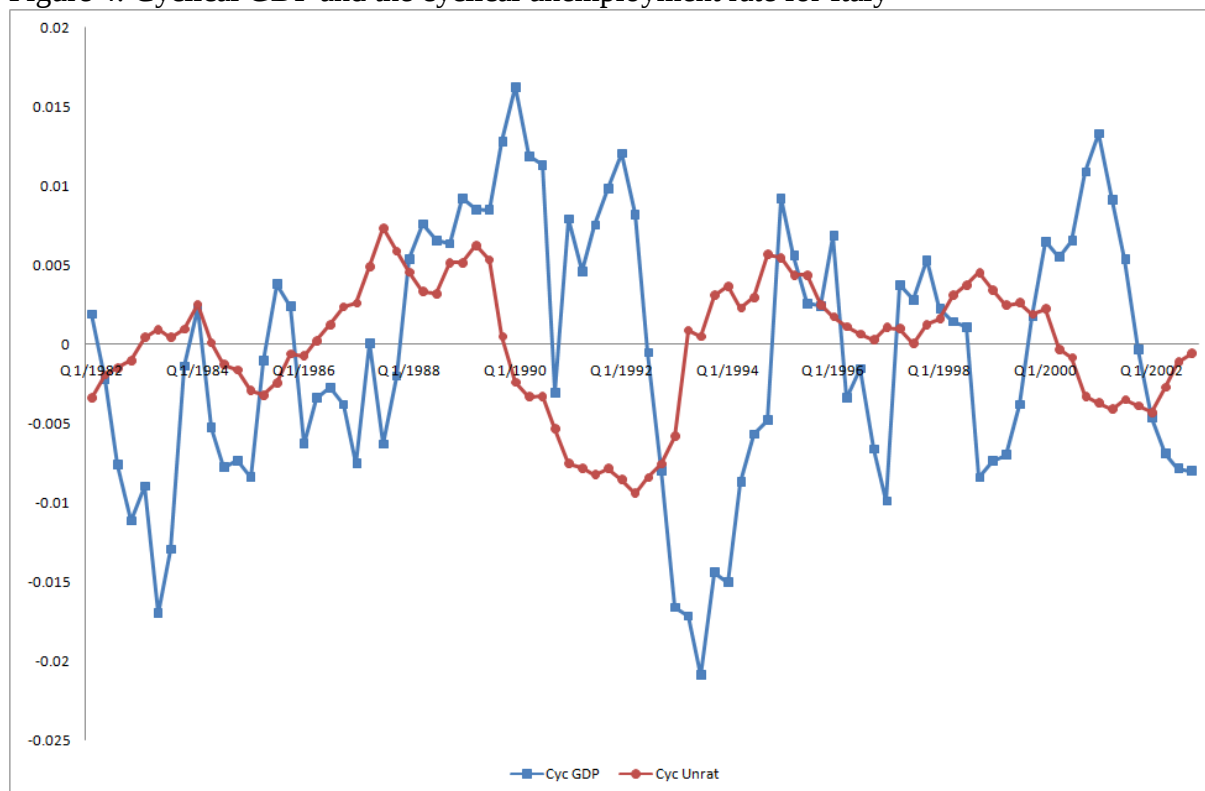


Figure 5: Cyclical GDP and the cyclical unemployment rate for Japan

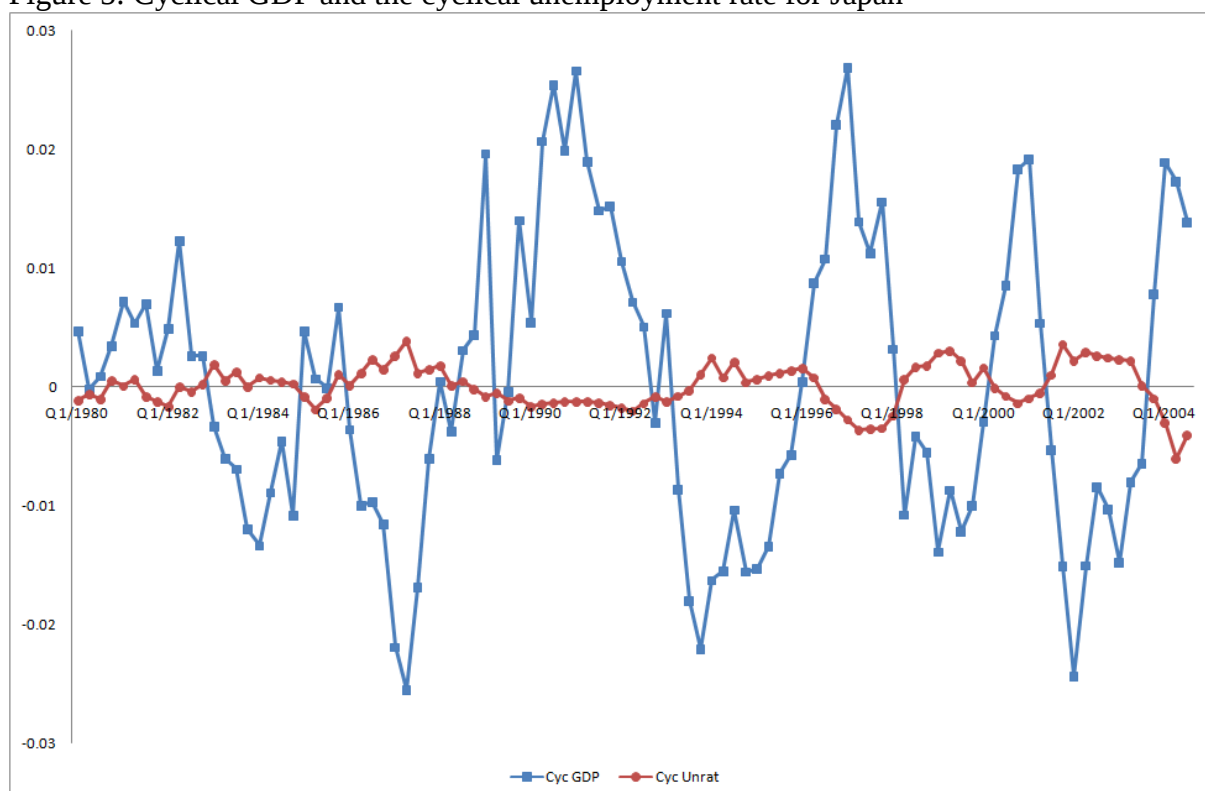


Figure 6: Cyclical GDP and the cyclical unemployment rate for the U.K

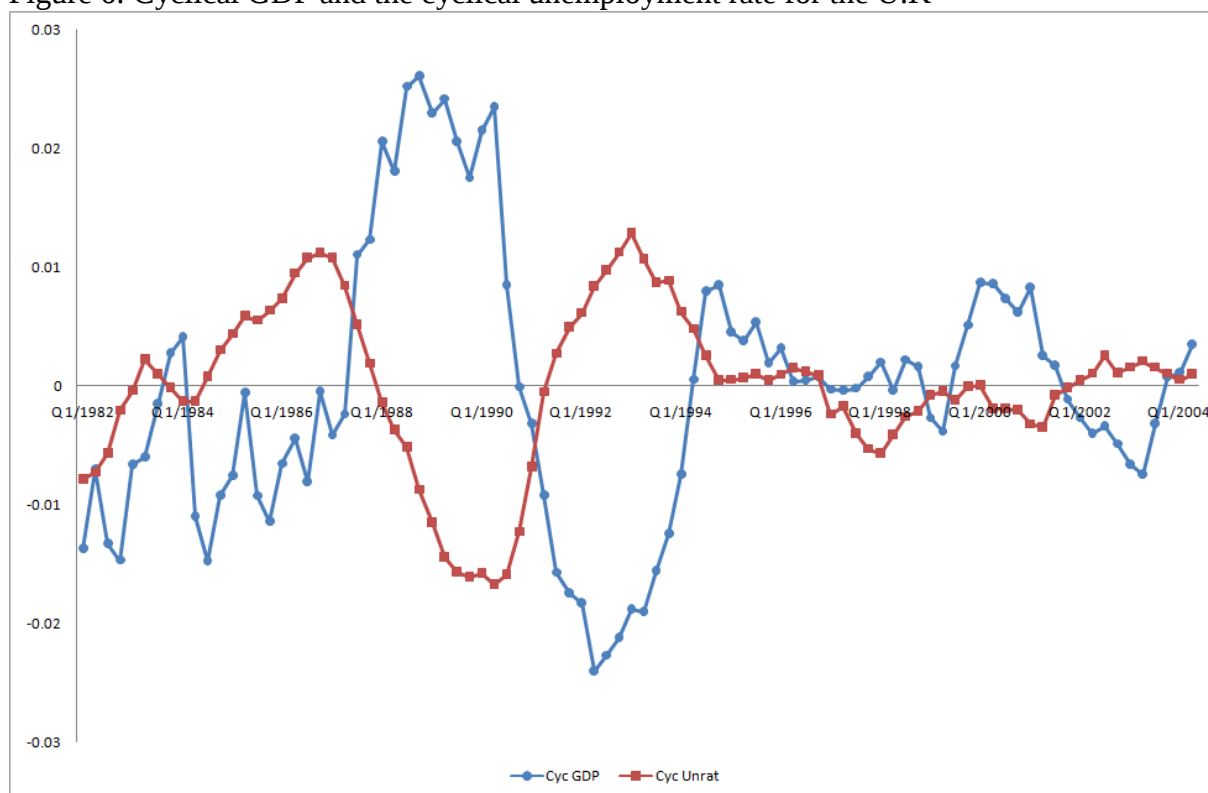
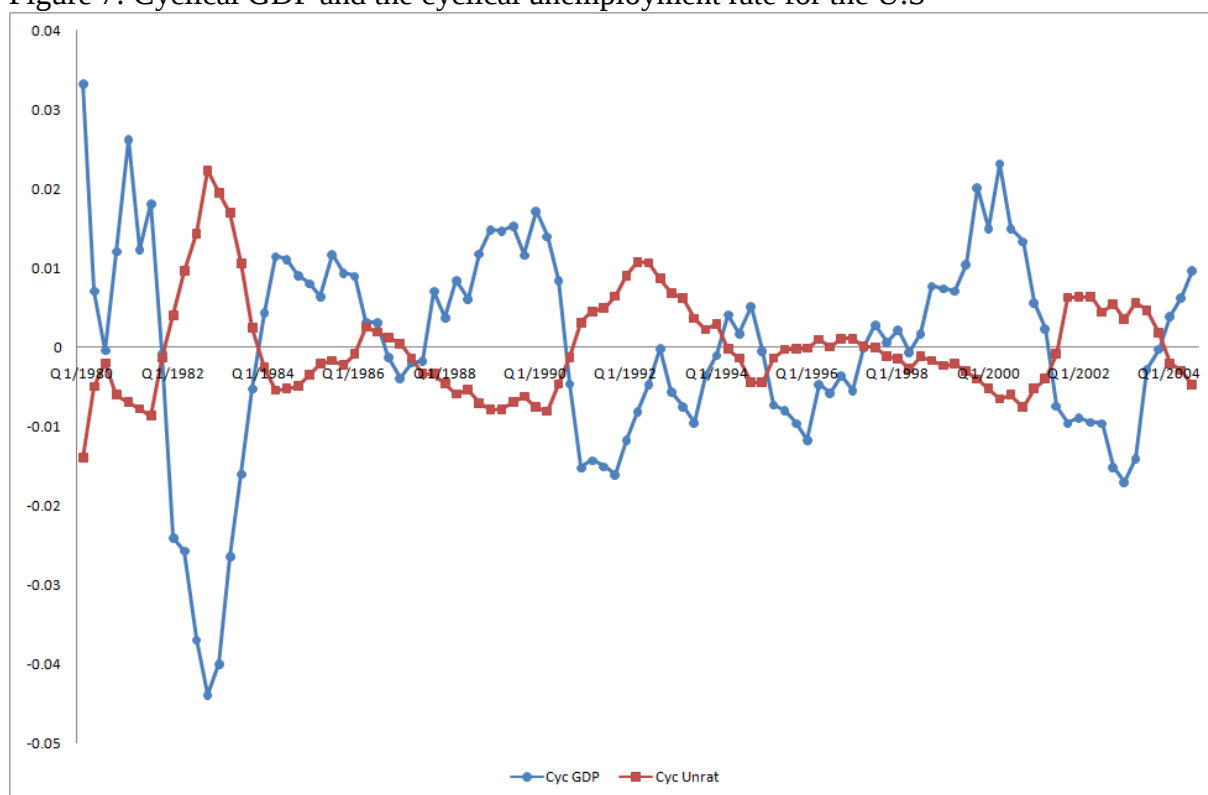


Figure 7: Cyclical GDP and the cyclical unemployment rate for the U.S



Appendix E

Confidence Intervals

Having found a significant threshold, it is important to be able to classify observations as being in a particular regime with a certain degree of certainty. Usually the confidence interval of a parameter can be determined by using the inverted form of the Wald statistics or t-statistics. In the case considered here however, where some of the parameters are not identified under the null hypothesis of no threshold, Wald statistics have been shown to produce poor results (Dufour, 1997). Hansen (2000) however has constructed the appropriate distribution for the likelihood ratio test given by:

$$18) LR_1 = T \frac{S(\gamma_0) - S(\hat{\gamma})}{S(\hat{\gamma})}$$

Where T is the number of observations, $S(\hat{\gamma})$ is the sum of squared residuals from the model with a threshold imposed at its estimated value and $S(\gamma_0)$ the sum of squared residuals when imposing a threshold at some hypothesized value. Varying the value γ_0 over all possible values of γ allows one to trace out the LR statistic for all possible values and allows one to construct the confidence interval. The critical values of the LR statistics are reported by Hansen (2000) to be 5.94, 7.35 and 10.59 at the 90, 95 and 99 percent significance level.

Figures 8 – 14 display the confidence intervals constructed using the above approach for the seven countries. The horizontal line in each figure shows the 90 percent critical value. The way to interpret the figures is as follows: the confidence interval ranges from the minimum to the maximum value of cyclical output for which the LR statistic is less than the critical value. In the case of AUS for example, the confidence interval ranges from -0.027 to 0.023. Hence there is reason to be confident at the 90 percent level therefore that the true threshold is not less than -0.027 or greater than 0.023. As this paper is only searching the data for thresholds within the central 50% of the distribution, other existing thresholds cannot be ruled out in advance and might be indicated by additional spikes in the graphs. However, due to the small number of observations this paper concentrates on only one single threshold. Similarly, negative values for the LR statistic can be obtained in the part of the distributions over which no search for a threshold takes place. Such an outcome is suggestive of the fact that a threshold exists outside the range considered that has a lower sum of squared residuals than the one found in the central 50 percent of the distribution. It is clear from the figures that with the exception of CAN (and to an extent JAP) the confidence intervals are all quite wide,

giving little confidence in having found the true threshold value. For all countries however the confidence interval contains the value zero, providing some support for the approach of imposing an exogenous threshold of zero that has been used elsewhere in the literature.

Figure 8: Confidence interval AUS

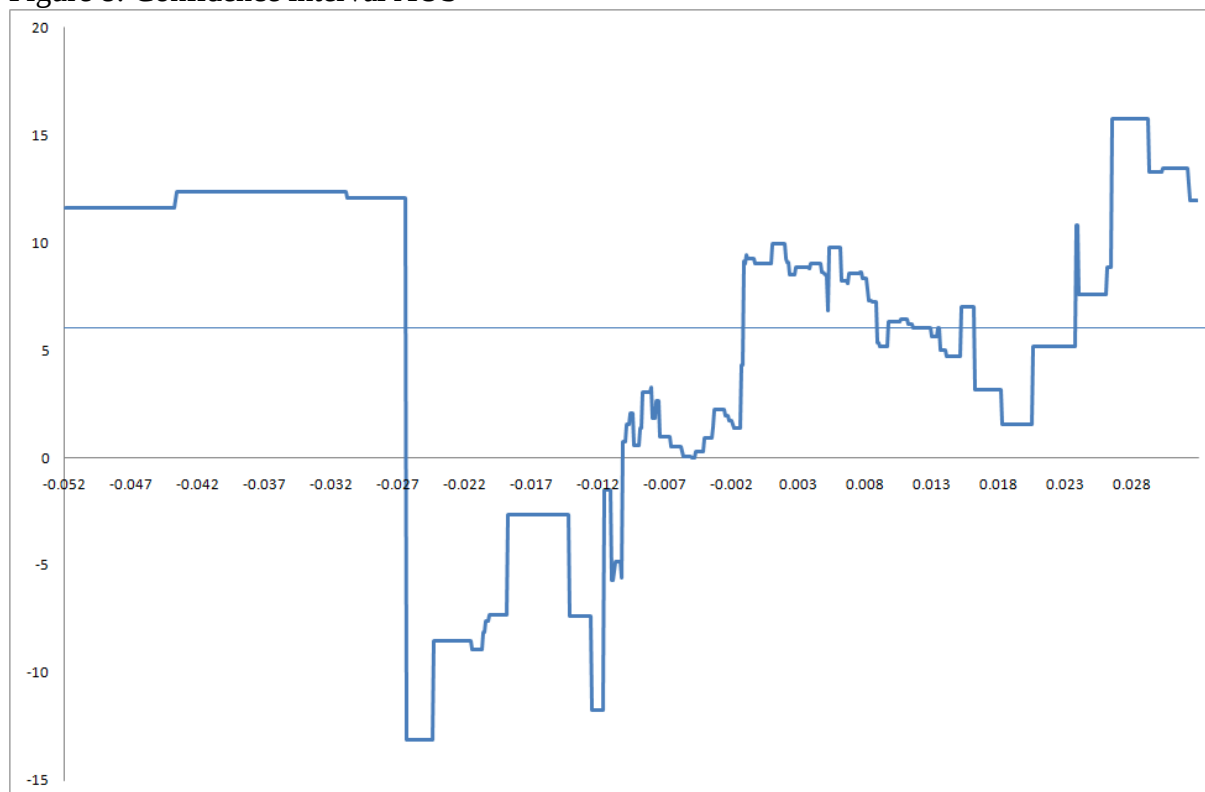


Figure 9: Confidence interval CAN

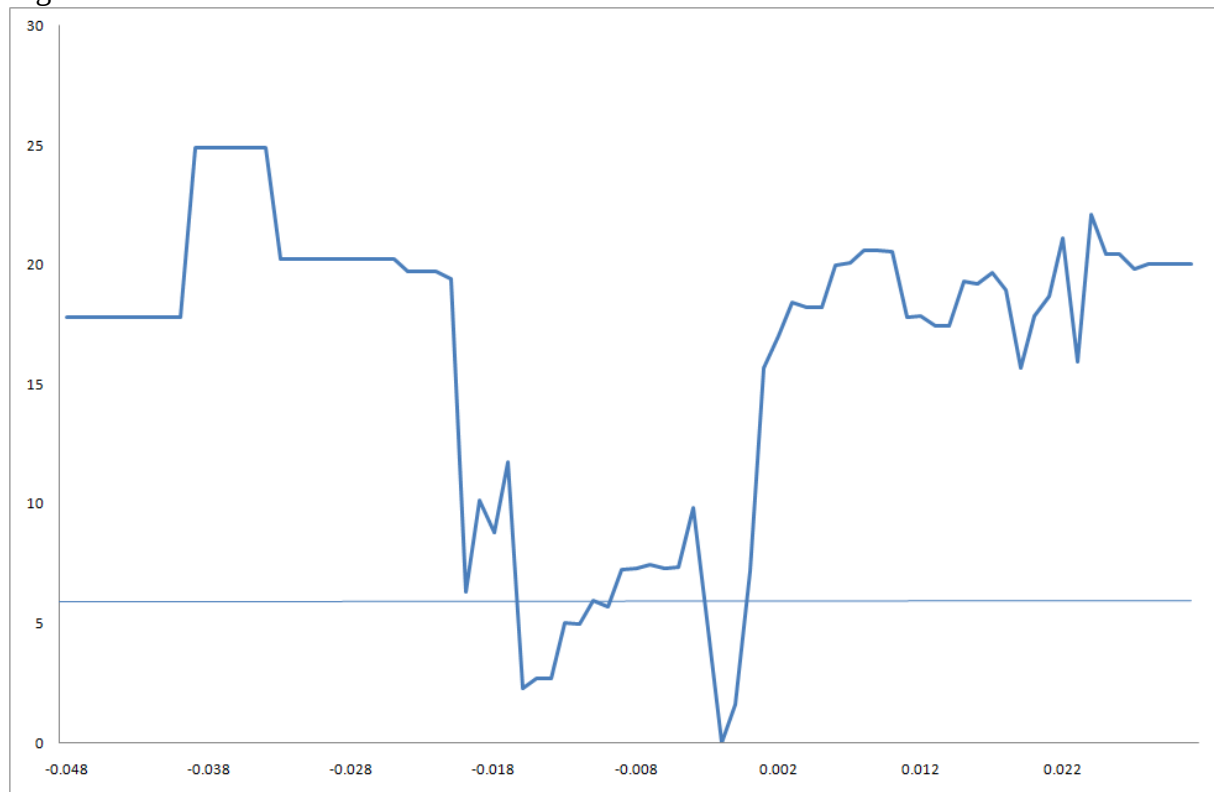


Figure 10: Confidence interval FRA

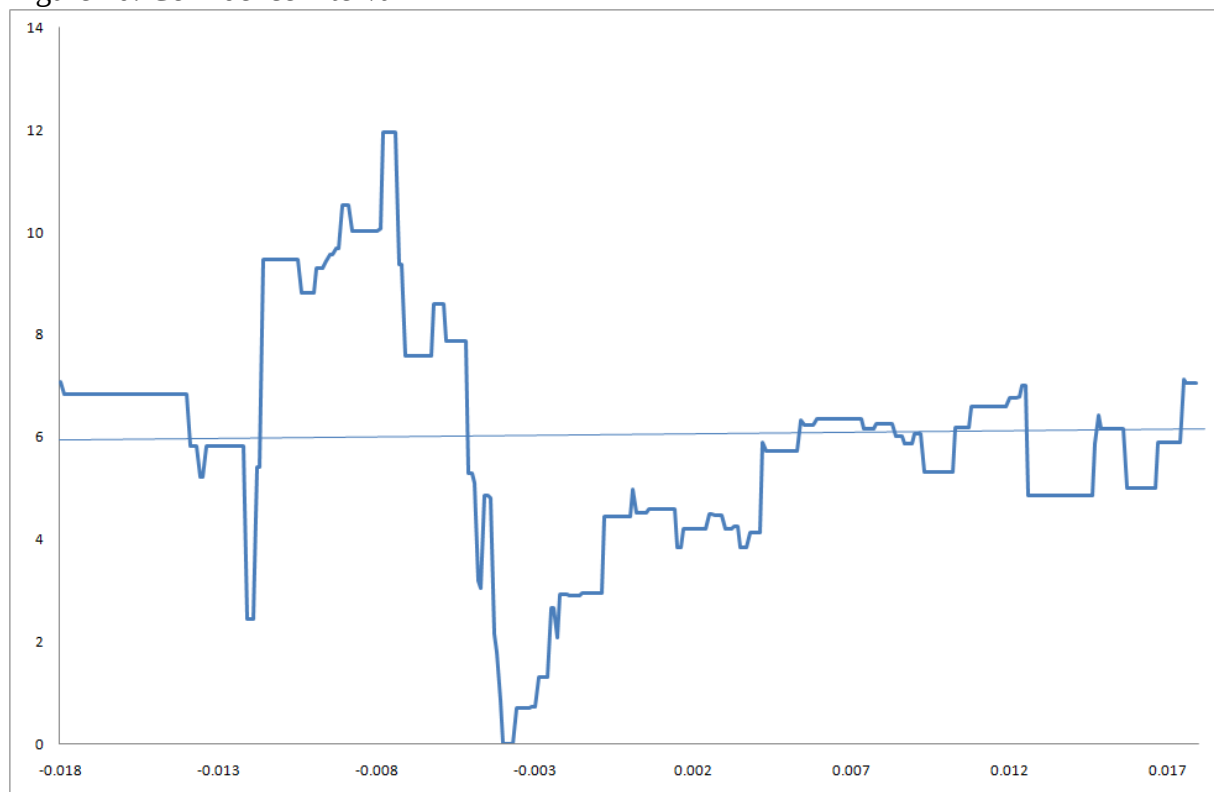


Figure 11: Confidence interval ITA

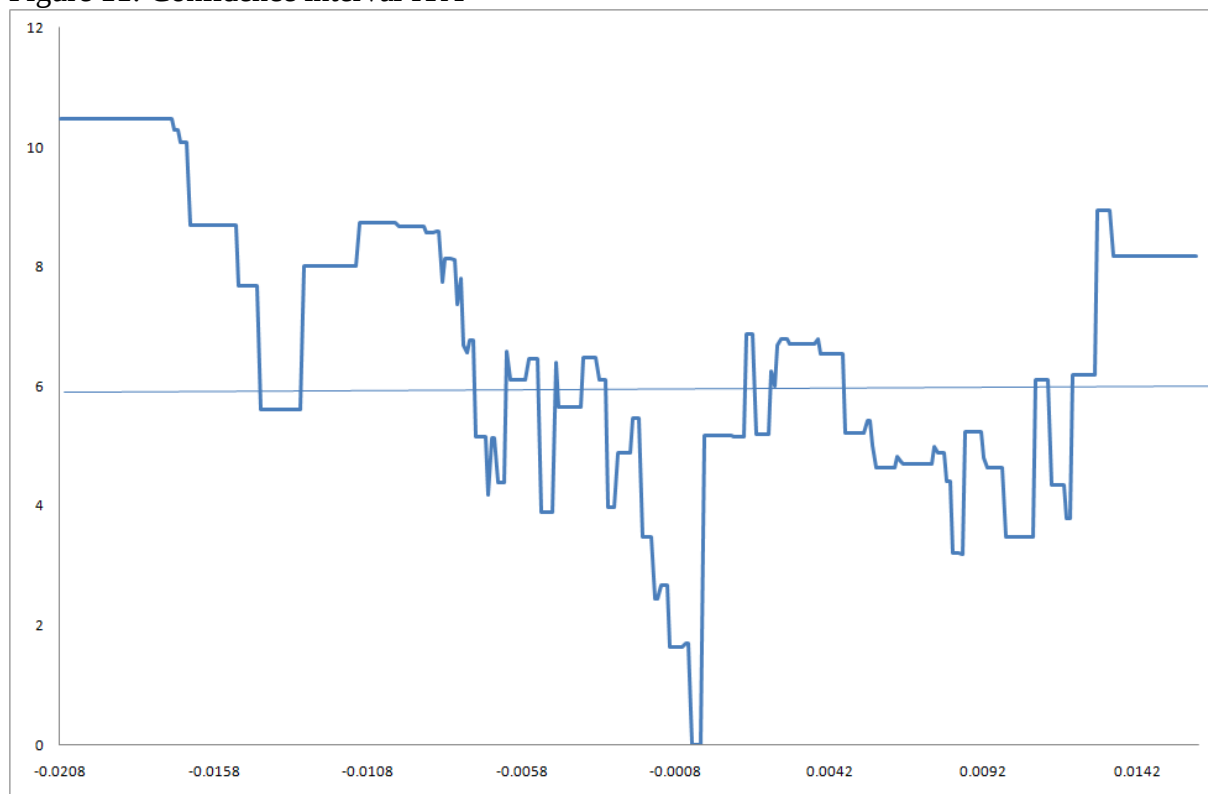


Figure 12: Confidence interval JAP

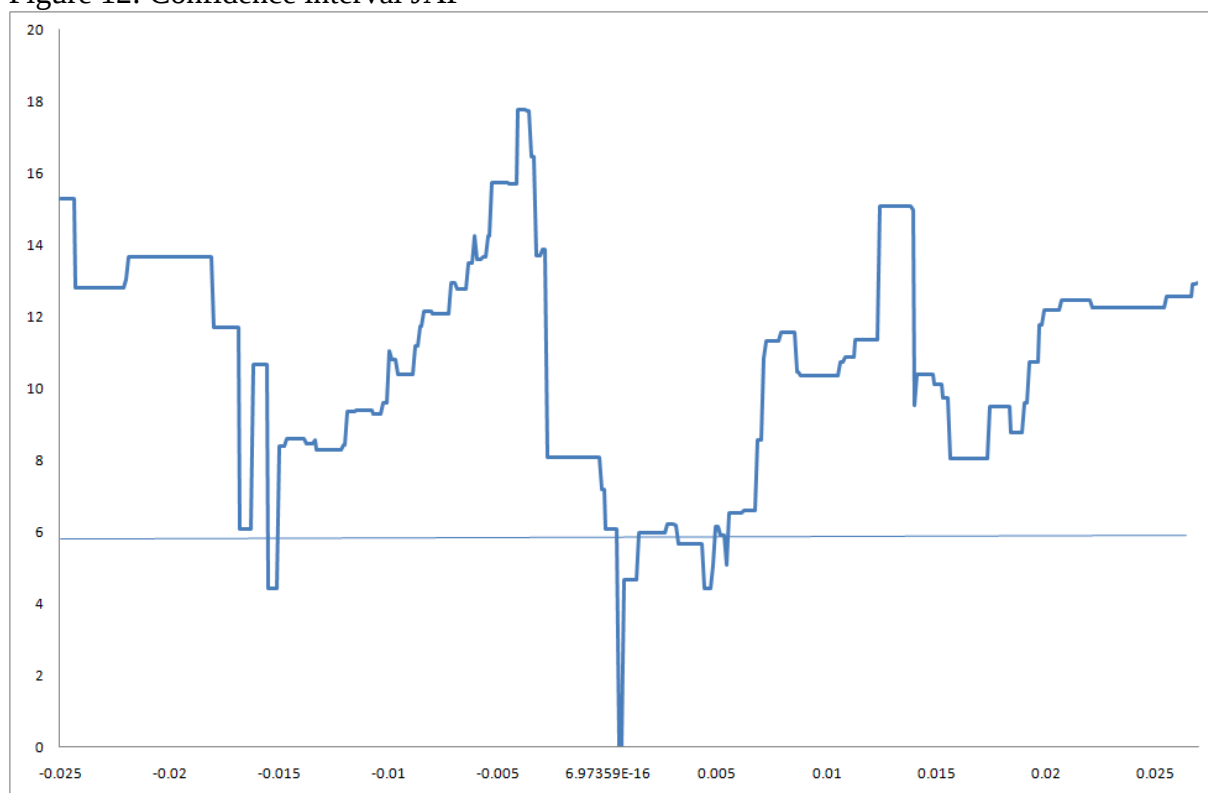


Figure 13: Confidence interval U.K

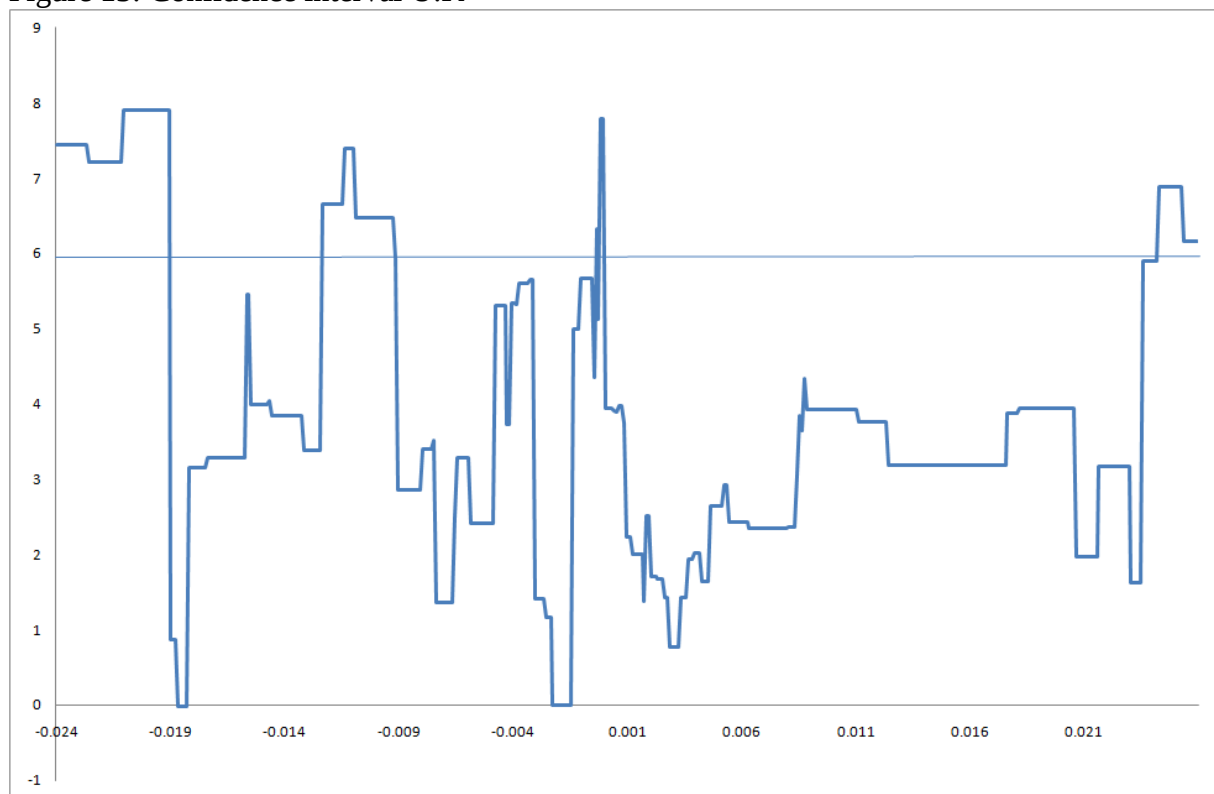
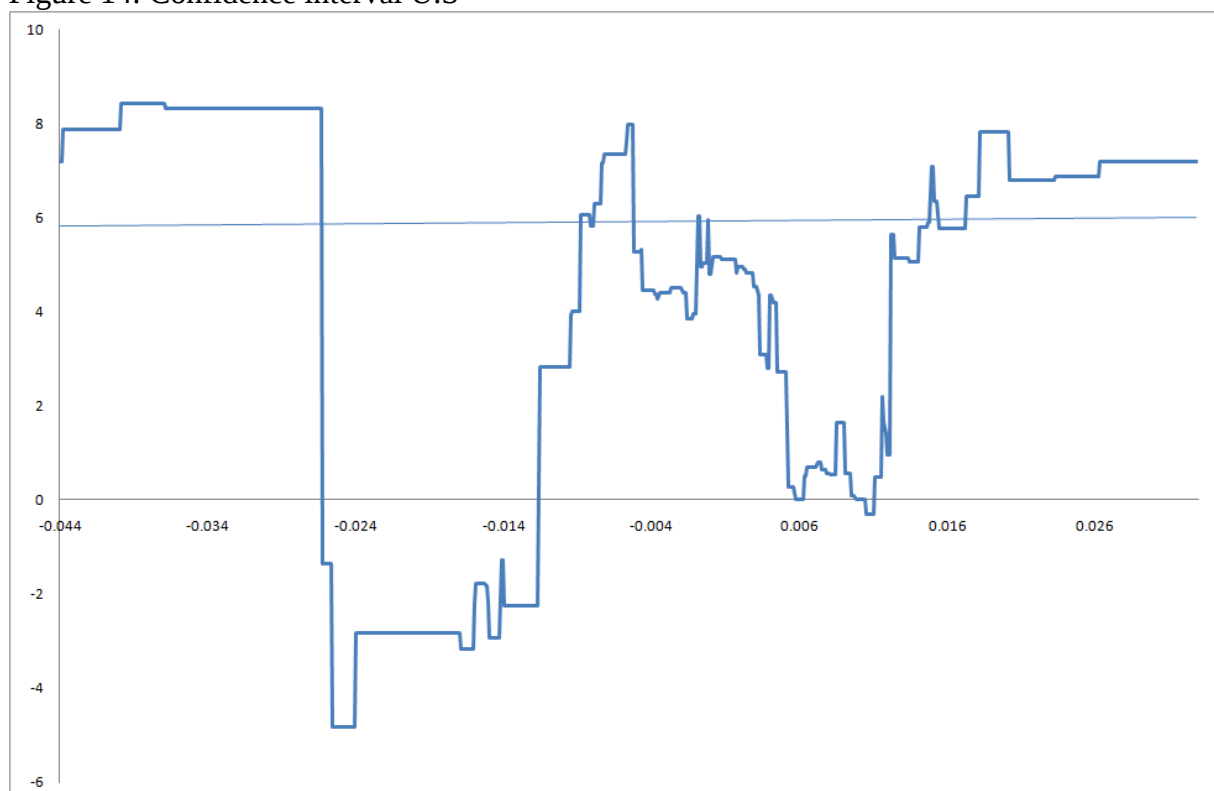


Figure 14: Confidence interval U.S



Appendix E

German Abstract:

Schon immer bestand großes Interesse daran den Zusammenhang zwischen dem Wachstum der Arbeitslosenrate und dem Wachstum des wirtschaftlichen Outputs zu erklären. Der erste dem dieses empirisch nachweisbar gelang, war Okun (1962), der eine inverses Verhältnis dieser beiden Parameter empirisch nachwies. Ob der Wichtigkeit dieser Entdeckung wird dieser Zusammenhang, der seither als makroökonomische Faustregel gilt, als „Okun’s Gesetz“ bezeichnet.

Diese Arbeit beschäftigt sich mit der Frage nach vorhandenen Asymmetrien in Okun’s Gesetz: Genauer wird der Frage nachgegangen, ob sich das Verhalten der Arbeitslosenrate nachweisbar ändert, je nachdem ob sich die Wirtschaft in einem Aufschwung oder einer Rezession befindet, und, falls dem so ist, ob Aufschwung oder Rezession das Wachstum der Arbeitslosenrate stärker beeinflussen.

Dieser Fragestellung wird anhand eines Samples, bestehend aus 7 OECD Ländern (AUS, CAN, FRA, ITA, JAP, U.K, U.S) wird mithilfe eines sogenannten „Regime-switching“-Modells, wie auch von Crespo-Cuaresma (2003) verwendet, nachgegangen. Besonders an diesem Modell ist die Tatsache, dass es in der Lage ist, den Wachstumswert ab dem man von Wirtschaftswachstum sprechen kann, endogen zu ermitteln. In den meisten bisherigen Studien wird dieser Schwellenwert als 0 angenommen, während das hier verwendete Modell nur solche Perioden als Expansion bezeichnet die über einem langfristig durchschnittlichen Schwellenwert liegen.

Wie auch in vorhergegangenen, ähnlichen Studien, können auch hier klare Indizien für bestehende Asymmetrien in Okun’s Gesetz nachgewiesen werden. In AUS, CAN und U.S haben Rezessionen einen nachweislich stärkeren Einfluss auf die Änderung der Arbeitslosenrate. In FRA, ITA und U.K wirkt sich ein wirtschaftlicher Aufschwung stärker aus. Für JAP können keine signifikanten Ergebnisse gefunden werden, jedoch, falls überhaupt, so dürften sich auch hier Rezessionen etwas stärker auf das Wachstum der Arbeitslosenrate auswirken.

Insgesamt werden demnach eindeutige Symmetrien festgestellt, jedoch kann aufgrund der länderspezifischen Resultate keine klare Richtung festgestellt werden. Dennoch sind auch solch unregelmäßige Ergebnisse hilfreich, da sie die speziellen Umstände jedes der betrachteten Länder hervorheben, und demnach sehr nützlich für politische Entscheidungsträger sein können.

Appendix F

Information about the author:

Alexander Frank, born on 18th of July 1984, began his studies of international business administration at the University of Vienna in 2002. After a more general starting phase of his studies, he decided to particularly concentrate on two areas of special interest, which are marketing and innovation- and technology management. Though, he decided to write his diploma thesis on a very specific issue of macroeconomics, Okun's law, which further proves that he is interested in many things apart from the areas he chose as specializations. As well important when talking about his studies, one has to point out his interest in languages. I.e., apart from German and English, he has learned French up to a very advanced level, and basic skills in Italian.

Apart from university, he shortly worked as project co-worker for a market research company, and he also successfully represented the University of Vienna at the Accenture Campus Challenge, which is a contest where the best Universities of Austria challenge in setting up innovative business plans.